# SURGERY

OF THE

# BRAIN AND SPINAL CORD

BASED ON PERSONAL EXPERIENCES

BY

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## VOLUME II

*WITH 94 FIGURES IN THE TEXT, 14 OF WHICH ARE COLORED, 27 COLORED FIGURES AND FOUR HALF-TONE FIGURES, ON FIFTEEN PLATES*


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# Preface

THE immense amount of material placed at my disposal through the kindness of local, provincial, and foreign neurologists made it possible for me to gain a thorough and complete review of the present status of the surgery of the brain and spinal cord, including diagnosis. While I am citing mainly from personal experiences, theoretic questions which offer nothing new have only lightly been touched upon or not at all. For instance, the characteristics and peculiarities of cerebral compression or the development of choked disc. These and similar subjects are thoroughly gone into in monographs by the various authors (*v. Bergmann, Kocher,* etc.), and it would entail needless repetition of facts known, to enter here into their discussion. I have therefore sought to illustrate important morbid manifestations with characteristic clinical observations.

The constant scientific intercourse with my Berlin colleagues, (*Jolly,* (†) *Ziehen, Oppenheim, Cassirer, Goldscheider, Henneberg, Jastrowitz Kalischer, Kron, M. Lähr, Lewandowsky, Hugo Liepmann, Maass, Kurt Mandel, Placzek, Remak* (†), *Rothmann, Scholinus, Schuster, Seiffer, Vorkastner,* initiated my assistants and myself into the intricacies of neurologic knowledge without which the accomplishment of this work would have been impossible. However, I am most grateful to *Hermann Oppenheim.* Hardly a week, frequently not a day, passed in which we did not consult at the bedside or in the operating-room. This invaluable and lasting connection, and the constant harmonious collaboration, bore in time fruit that we are now proud of in our operative therapy, despite the numerous and discouraging experiences.

I have been faithfully supported in the neurologic observations and careful following up of the cases at the Augusta Hospital by my assistants, *Dr. Dege, Dr. Groth, Dr. Hartig, Dr. Hübotter,* and *Dr. Patschke;* to no one, however, am I so highly

indebted as to my chief physician, *Dr. Emil Heymann.* To this gentleman and to the Prosector of the Augusta Hospital, *Professor Dr. Oestreich,* I am indebted for the microscopic examinations and the pathologic products. All findings referring to the structure of the central region were elaborated by Privatdocent *Dr. Brodman* and *Professor Heinrich Vogt.*

All colored illustrations and most of the figures in the text were executed by the scientific painter, *Mr. Max Landsberg.* In the last few years he has mastered a method of rapid sketching during the operations without in any manner interfering with my work. Only very few changes were made on the plates, and these in insignificant details, so that they truly portray the conditions as objectively presented to the eye of the observer. They are perfect.

I cannot express in high enough terms my appreciation to the publishers for their able support in getting up the work in proper form and style.

FEDOR KRAUSE.

BERLIN, September 25, 1911.

# Preface to the English Adaptation

THE translator considers it a great privilege to render service to the American and English surgeons in presenting an English translation of *Krause's* "Surgery of the Brain and Spinal Cord." Its excellence is acknowledged by all European surgeons, and its English version will, I believe, be a valuable aid not only to the surgeon but to every member of the profession interested in this particular branch of medicine.

It was a happy idea when the publishers decided to present the English-speaking profession with a translation of the work of *Professor Fedor Krause*, whose standing as an authority is established not only abroad but in this country as well.

The translator had a difficult task. If there are any shortcomings in his effort, it is an attempt on his part to reproduce the language of the author as accurately as possible.

The great features of this work are:

(a) The elimination of questions debatable and not settled.

(b) Illustrations of cases by typical observations.

(c) The numerous excellent plates and illustrations which embellish the text and are reproduced from conditions as found at the operating table.

In conclusion I wish to thank Mr. Francis J. Rebman, the publisher, for his valuable aid and untiring efforts to make the English adaptation a success.

MAX THOREK.

RELIANCE BUILDING, CHICAGO.

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In Volume I, observations have frequently been referred to that are described at length in Vol. II and Vol. III. It was therefore thought expedient to make the following changes in this part of the work.

Observation I, 4, pp. 84 and 85, changed to Observation I, 3, p. 307.
Observation I, 5, p. 169, changed to Observation I, 14, p. 387.
Observation I, 8, p. 52, changed to Observation I, 9, p. 356.
Observation I, 9, p. 167, changed to Observation I, 15, pp. 390 and 401.
Observation I, 10, p. 84, changed to Observation I, 18, pp. 360 and 415.
Observation I, 12, p. 36, is left out.
Observation II, 3, p. 72, changed to Observation II, 2, p. 521.
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Observation II, 6, p. 58, left out.
Observation III, 1, p. 91, changed to Observation III, 2, p. 539.
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Observation III, 3, p. 29, changed to Observation III, 1, p. 536.
Observation III, 6, p. 29, changed to Observation III, 7, p. 563.
Observation III, 5, p. 171, left out.
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Observation VII, 6, p. 138, left out.
Observation VII, 9, pp. 255 and 281, is described on p. 758.
Observation VIII, 1, pp. 150 and 196, left out.
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Observation XI, 1, p. 202, changed to Observation VI, 3, p. 658.

## A. BRAIN

## II. Neoplasmata of the Frontal Brain



## III. Neoplasmata of the Central Region

# THE SURGERY OF THE BRAIN

# Epilepsy

## INTRODUCTORY REMARKS ON PHYSIOLOGY

The cerebrum and its surface, of which this chapter will deal mainly, is the central region, and is also known as the sensory-motor area. If the soft coverings of the brain are detached, we shall find disclosed in the parietal region a groove, which distinguishes itself by two knee-shaped curves. This is usually designated as the fissura centralis or the fissure of *Rolando* (sulcus *Rolandi*). It divides the anterior central convolution from the posterior. Another equally important fissure is discerned below the first—the fissure of *Sylvius*. Between these two fissures we find the operculum *Rolandi*—forming the lower boundary of the central convolutions.

*Hitzig* and *Fritsch* were first to demonstrate that electric irritation of the motor area of the exposed cortex results in muscular contractions on the side opposite to the point of irritation; in other words, it is possible by such irritation to cause certain muscles or groups of muscles to contract, thereby establishing definite centres for these muscles or muscle groups that respond to particular irritations in the opposite cortical area. Looking through the older text-books on the subject we find that the points under consideration, that are more easily irritated, are almost regularly distributed in those portions of the brain-tissue located in front of and behind the fissura centralis.

The credit belongs to *Sherrington* and *Gruenbaum*,[1] the Liverpool physiologists, who pointed out as a result of their experiments, undertaken and accomplished on the brains of the gorilla, chimpanzee, and orang-outang, whose cortices were subjected to unipolar faradic irritation, that the so-called "mo-

[1] *C. S. Sherrington* and *A. S. F. Gruenbaum*, Observations on the Physiology of the Cerebral Cortex of Some of the Higher Apes. "Proceedings of the Royal Society," Vol. 69, 1901. Localization in the Motor Cerebral Cortex of the Anthropoid. "Transactions of the Pathological Society of London," Vol. 53, Part 1, 1902, p. 127 ff.

tor area" occupies the entire length of the anterior central convolution, without interruption, and in most places also its entire width, or at least the greater part of it enters into its composition. The area is seen to spread from there into the depths of the sulcus *Rolandi,* occupying in places its anterior

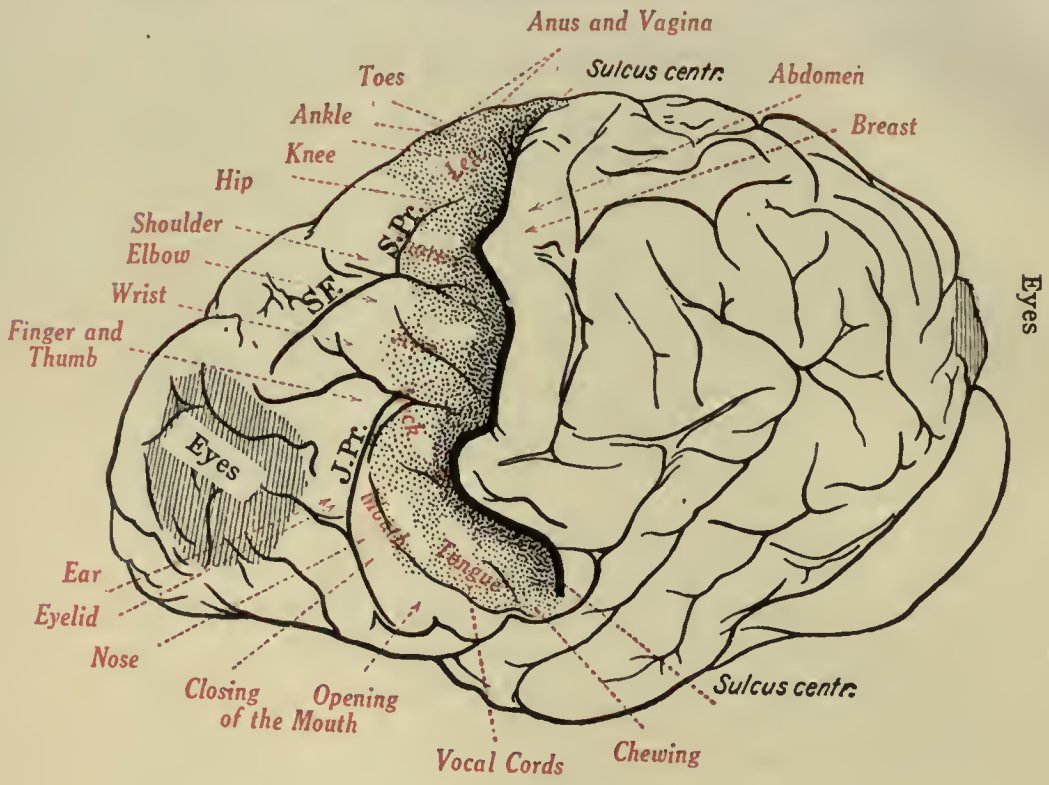


Fig. 64

Left Cerebral Hemisphere of a Chimpanzee (Troglodytes niger) showing the Centres Ascertained by Faradic Irritation according to *Sherrington* and *Gruenbaum.*

*SF*=Sulcus frontalis superior; *S Pr*=Sulcus præcentralis superior; *J Pr*=Sulcus præcentralis Inferior.

wall, at the same time expanding to the base. In some instances the area is seen to extend into the deepest section of the posterior border of the fissure. The motor-area has not been observed by *Sherrington* and *Gruenbaum* to spread on to the free surface of the posterior central convolution. Of all the nineteen cerebral hemispheres examined by these observers, the results were identical. Yet, while the area does extend to the

median surface of the large hemisphere, it does not reach down to the sulcus calloso-marginalis.

No limitations by fissure are seen in front of the motor area. It extends, however, over into the superior and inferior divisions of the sulcus præcentralis, overstepping this limitation, at times, in an upward direction.

Generally speaking, the boundaries of the motor area, as well as the arrangement of the sulcus are not subject to great variation. The fissures of the frontal region are too inconstant in their arrangement to be of value as borderlines for the functional centres. To this we must add individual peculiarities and the usual asymmetry of both hemispheres. On the other hand, the arrangement and location of the physiologic centres of the motor area are constant. They are depicted in Fig. 64. Only both limbs of the Rolandic fissure were accredited with being distinct points of real anatomic value.

The irritation of the anterior central convolution with mild faradic currents has constantly effected—to various observers—muscular contractions. On the contrary, no results whatever could be obtained by irritating the posterior central convolution, even with very strong currents. Consequently, slight injuries to the anterior convolution were followed by marked—although temporary—paralysis and descending degenerations of the spinal cord. It is noteworthy that the same sort or even greater injury to the region of the posterior convolution was followed by neither palsy nor degeneration.

*Sherrington* and *Gruenbaum* point out that the irritability of the motor area—tested by the weakest possible current—is practically the same in the anthropoids and the lower apes; although the region is in some respects far more complicated in the former, than in the latter.

For historical reasons as well as for the honor of German science it must not be overlooked nor permitted to escape mention, that it was *Hitzig*, together with *Fritsch*,[1] who in 1870 published the results of their experiments on the electric irritability of the cerebrum of the dog. Four years later the same observers have corroborated their findings as a result of experiments

[1] *Reichert's* and *Dubois-Reymond's* "Archiv," 1870, Heft 3.

on the brain of a lower ape (Innuus Rhesus), concluding that the cortical points in the dog which respond to "weak currents" by muscle contraction, have their centres in the anterior central convolution.[1] He adds, "the results obtained were highly remarkable," and further (page 133): "Under these circumstances, I am not inclined to designate the anterior central convolution of the ape as the true motor area of the cortex, or to concede that this area embodies in its superfices the seats for almost all skeletal muscles."

*M. Lewandowsky* and *A. Simon*[2] have furnished the final and convincing proof that only the anterior central convolution of lower animals is susceptible to faradic irritation. They have removed the entire anterior central convolution down to the frontal lobe in a series of monkeys (Macacus Rhesus) and in a seacat, and after the lapse of three to six weeks undertook electric irritations which were in the main bipolar. Though the authors named accord a distinct value to unipolar irritation with reference to being effective in cerebral localizations, they nevertheless availed themselves of bipolar stimulations; because they could, by so doing, employ much stronger currents, without experiencing other unpleasant effects from the passage of current through the body—which is quite annoying. During these experiments, attempts to obtain responses by irritating the posterior convolution with the strongest current, remained futile. We succeeded in getting a nominal reaction in only two cases in which remnants of the anterior central convolution were discovered in the depths of the central fissure. Control experiments have conclusively proven that the irritability of the anterior central convolution suffers in no way after analogous extirpation of the posterior convolution.

The question whether conditions are different in the human cerebrum is undoubtedly of the greatest possible moment. In view of this fact, I had the good fortune to be in a position to faradically irritate the human "motor area," during a great

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[1] *E. Hitzig*, "Über äquivalente Regionen am Gehirn des Hundes, des Affen und des Menschen." Idem, "Untersuchungen über das Gehirn," Berlin, 1874, S. 131.

[2] Zur Physiologie der Vorderen und Hinteren Zentralwindung. "Archiv für die ges. Physiologie," Bd. 129, 1909, p. 240 ff.

number of surgical operations on the brain, since the appearance of *Sherrington's* observations.

It is all important for the surgeon to always have a simple, yet well acting and responsive apparatus at hand. Experience, after many trials, has taught me to entirely abstain from the use of the galvanic current in this work. For this form of electricity, unpolarizable electrodes are indispensable. Furthermore, the contact of the electrode points with blood particles soon renders them useless. For an electrode, I am availing myself of the use of a pipette-shaped glass tube, the point of which is made to taper down to $1\frac{1}{2}$ mm. in diameter. A glass stopper is ground down to fit into one end of the glass tube onto the back part of which a thumbscrew is fastened, while into the other end of the tube a wire is inserted. The wire projects into the tube to a distance of 2 to 3 mm. from the point of the tube. The remaining space was plugged with absorbent cotton, which was made to protrude from the point. The tube was filled with physiologic salt solution. The current should be supplied from a chromic acid battery, and for measuring the strength of the current a good galvanometer is of great value. Working as outlined above, good results were generally obtained, yet the following very dangerous casualty happened to be my lot.

The patient was a young woman twenty-five years old, in whom the application of a 0.30 milliampère anode was followed by the onset of an epileptic attack with extremely hyperacute manifestations. In character the attack corresponded to epileptic convulsions seen in ordinary cases. It began in the right side of the face, rapidly spread to the right arm and leg, and terminated very quickly in general convulsive movements. In violence, this seizure surpassed anything of the like I have seen thus far. The respirations became stertorous. The heart stood still, forcing us to resort to cardiac massage. After some very anxious and ominous minutes the attack ceased, and three-quarters of an hour elapsed before the operation—which ultimately led to a cure—could be completed. I have never used the galvanic current since. I am depending entirely on the faradic current, the employment of which I have had no cause to regret. Even in the same patient the localization of the "primary spasm-

ing centre" was undertaken with faradism—after the lapse of time stated above—without the recurrence of any dangerous symptoms whatsoever. I will admit that an extreme hypersensitiveness of the cortex to the constant current may have existed in this case, for it is well known that preference is usually given to this current in experiments upon lower animals. The brilliant results of *Hitzig* were obtained from galvanic irritations.

### Unipolar Faradic Irritation

For a period of years, I have been using for faradic irritation a *Dubois-Reymond* induction coil, manufactured by *W. A. Hirschmann.* It is fed by an accumulator cell of two volts tension, and is recharged on the average of from six to eight weeks. An especially made case, furnished with a lock, permits the easy transportation of the apparatus. In order to connect the two screws of the sliding apparatus with those of the accumulator cell, the interrupting device must be set in action. The device, invented by *Wagner*, and modified by *Meyer*, consists of a hammer arrangement. The gradual withdrawal of a brass ball, which is attached to a metal rod, permits, by operating this device, to accelerate or decrease the rate of current interruptions. The exact adjustment of the secondary coil is accomplished by means of a cogwheel attached to the coil. The intensity of the current is gauged by the relative positions of the primary to the secondary coil. Personally, I prefer the secondary currents at all times. The resistance of the secondary coil of the induction apparatus amounts to 48.2 ohms, while that of the primary coil is only 4.8 ohms.

The strength of current required varies. Only the weakest possible currents should be used. Muscular contractions as well as epileptic seizures of the *Jacksonian* type were produced while using the faradic current. This current was so mild that applied to the tongue of an assistant, it was perceived by him as only a mild burning sensation accompanied by a slight acid taste, without being productive of any muscular contractions; not even single fibrillary twitchings. Four physicians whose finger-tips were moistened with salt solution permitted the application of the same current with the following results: Upon three of them, not the slightest impression was made, while by the fourth gen-

tleman—who was peculiarly susceptible to electricity in any form —it was perceived to be of a mild degree only.

Generally speaking, the first effects of irritation are noticed when at least one-third of the length of the primary coil is covered by the secondary; e.g., when the graded scale denotes a distance of 60 mm. Even then, the sensation imparted to the moistened finger-tip is only very mild, while on the tip of the tongue fibrillary twitchings and a mild sensation will result. The degree of current generally required will be 80 mm. on the scale, or at least half covering of the primary by the secondary coil. Active muscular contractions will then ensue, and the current will markedly be perceived by the moistened finger-tip, while the sensation at the same time will not be painful. In some cases where the pia mater was found to be thickened, stronger currents were required, and the results then obtained were not particularly objectionable. It was only rarely that we resorted to complete covering of the coil (120 mm. on the scale).

Regardless of the fact that most hospitals are now equipped with divers apparatus, such as rheostats, transformers, etc., for purposes of modification and grading of the main current supplied from a central station, I give emphatic preference to the handy and very effective apparatus of *Hirschmann*, because the results obtained with other appliances were unsatisfactory.

According to *Sherrington* finer localizations are possible with unipolar irritation than with bipolar faradization—hence my preference for the former mode of stimulation. The electrode I have devised is easily sterilized, and measures about 30 cm.[1] It is for this reason easily rendered aseptic and permits its ready connection with the conducting cord; it also avoids contamination with other parts of the electrode, by the hands of the surgeon. It terminates in front in a minute platinum ball. A gutta-percha handle—which may be readily boiled—assures exactness of localizations. Should the hand of the operator be moist, it will be necessary to surround the handle with a few thicknesses of dry sterile gauze. The other pole distributes its current through a large flat electrode, which is moistened with salt solution; it measures 70 square cm. and is applied to some

[1] Made by *W. A. Hirschmann*, Berlin, No. 24 Ziegelstrasse.

indifferent point of the trunk or extremities. An interrupter in the form of a simple compression lever may be attached to the electrode. I find it more convenient, however, to simply remove the electrode from the cortex each time, as the irritations should last only a brief period.

It is of great moment for our electric stimulations, to eliminate all possible conditions offering resistance to the penetration of the current. Above all, it is of paramount importance to eliminate œdematous conditions of the arachnoid membrane, if such be present. Before I proceed to irritate the cortex, under such circumstances, I scarify the arachnoid in a declivitous position, taking care not to injure a bloodvessel or the pia. The subarachnoid fluid will then be seen to trickle away—this may be enhanced by gentle pressure with a gauze sponge. Exact


Fig. 65

results will be obtained when the irritations are not undertaken on the cerebral convolutions—especially those near the sulci—before they are freed from these non-conducting fluids. Faradizations are also undertaken on the intact pia. The removal of the pia from the living brain would not only lead to serious injury to the superficial cell layers, but it may also completely destroy them, thereby frustrating our attempts.

The results obtained from faradic stimulàtion of cortices, the coverings of which evince pathologic conditions, such as chronic inflammatory states, scars, thickenings of the arachnoid along the course of bloodvessels, etc., besides being technically difficult, are very uncertain. The strength of current required under these circumstances is proportionate to the resistance offered by the tissues intervening between the electrode and the brain substance proper. The stronger currents carry with them the danger of undesirable stimulations of contiguous cortex tissue. For the representation of my scheme (Fig. 66, page 9), I have taken pains to select my cases, which were entirely devoid of objections and doubts; others were carefully excluded.

Only partial anæsthesia should be resorted to in cerebral far-

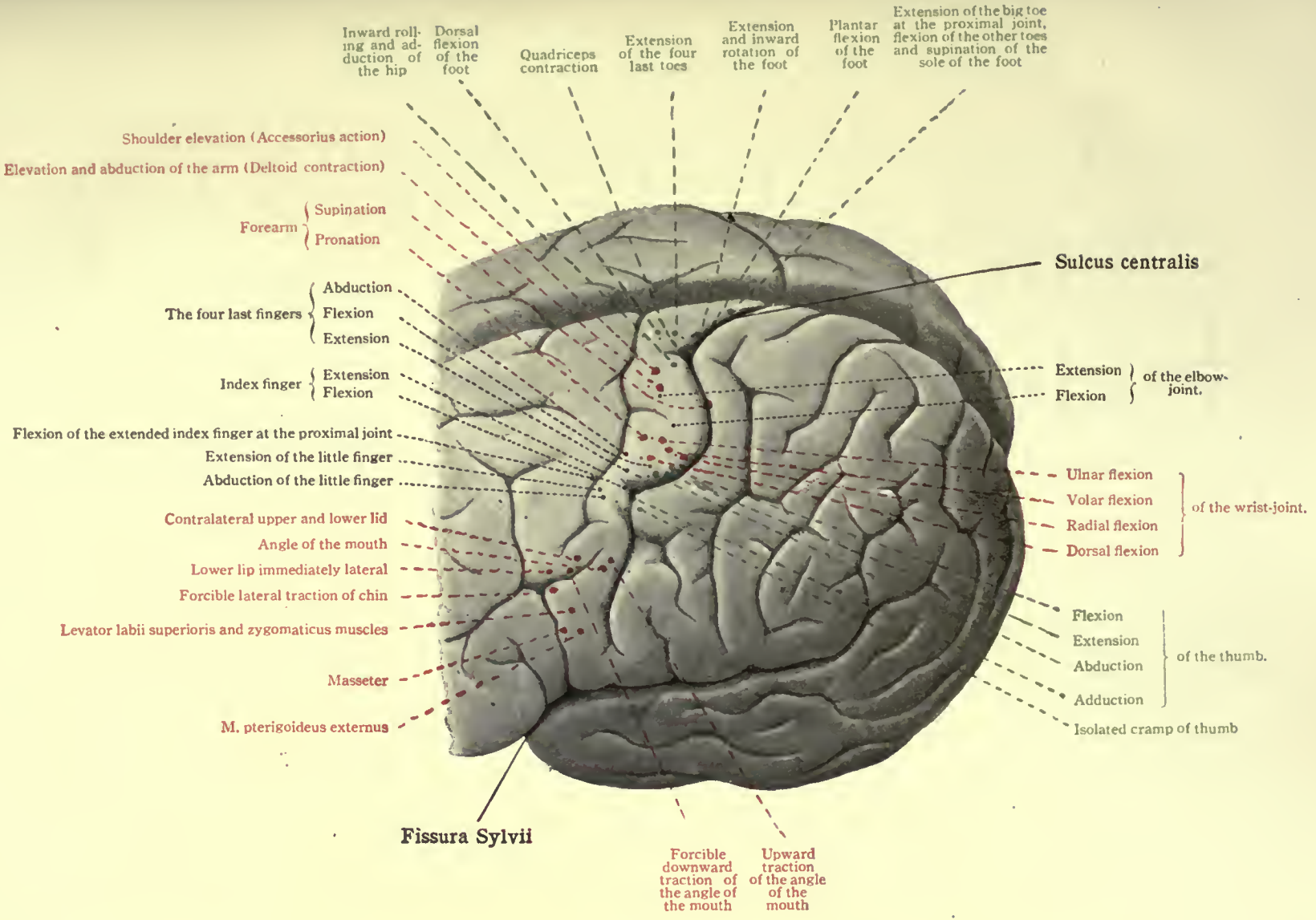


Fig. 66

Left Hemisphere of the Human Cerebrum and Results obtained by me by Stimulation with the Faradic Current.
All Foci are located in the Anterior Central Convolution.

adizations. Complete narcosis paralyzes the cortex. I have at times permitted patients to awaken during my procedures.

During our work, three physicians observe the patient. One inspects the face, the second the upper part of the trunk and upper extremities, the third, the lower part of the trunk and the lower extremities. Observations of muscular contractions of face and extremities are now dictated to the recorder, while the located centres are noted on a sketch of the cerebral surface by the artist. Proceeding in the manner outlined, I am quite sure of arriving at reasonably accurate conclusions.

In accordance with my experience, coupled with some observations on the cadaver and with the use of a great number of microscopic preparations, I must say that there is only one method applicable to human beings for purposes of cerebral localizations, and that is, electrical irritation. All other methods, such as determinations of points on the exterior of the shaved skull, or localizations according to convolutions and sulci, should be discarded as being entirely unreliable. As is well known, the sulci of the living brain cannot possibly be as clearly defined as those in the cadaver, because we dare not remove the pia, only after the removal of which the outlines of the sulci appear with distinctness.

Fig. 66 depicts the results obtained by me from faradic irritations. The anterior central convolution contains all the foci located. Their arrangement on the cortical surface is such, that the centres for the lower extremity occupy the uppermost portion of the convolution near the sinus longitudinalis. In animals, these centres also spread over the surface of the hemisphere, middleward. The lower extremity engages as its locus approximately the upper one-fourth of the central convolution. About one-half of the middle portion responds to stimuli with contralateral muscular contractions of the upper extremity, from the shoulders down to the fingers. The lower one-third of the convolution discloses, upon irritation, the foci of the muscles of the face and those of mastication. Here should also be found the centres of the muscles of the larynx, the platysma myoides, and the muscles of the tongue.

Experiments on animals have disclosed centres for the rota-

tion of the head and eyes in the opposite direction; these centres have their seats in the posterior division of the second and in the adjoining territory of the first (upper) frontal convolution. These centres may well be represented by marking points on my diagram table, directly in front of and a little above the centres of the fingers. While I was not as yet successful in definitely locating the centre for rotating the head in human beings, yet the following experience of mine warrants the assumption of having found the proper place for that centre, with quite a degree of certainty. The case was that of a young man, twenty-two years and four months of age, who, six and a half years prior to his coming under my care, sustained an injury to the left side of his head, corresponding to the motor area, by being struck with a stick, that resulted in epilepsy of the *Jacksonian* type. The attacks always began with strong rotation of the head to the right—the patient being at all times fully conscious, yet unable to voluntarily counteract the rotation. In succession there appeared twitchings in the right arm and right face, loss of speech and finally unconsciousness. At the time of the operation, the patient was twenty-four years old. A cyst was found which measured 22 mm. vertically, 29 mm. transversely, and 13 mm. in depth. It was located immediately under the cortical substance, which was thinned to the size of a sheet of paper and inseparably blended with the pia and the arachnoid. Cranio-cerebral diagnosis, together with the results obtained from faradic irritation showed the focus to correspond entirely with the foot of the second frontal convolution. (Compare exact observation on page 485.)

*Hermann Oppenheim*, who has referred this case to me for operation, has properly diagnosed the seat of trouble to be in the posterior part of the uppermost frontal convolution. He based his clinical diagnosis on the mode of onset mainly—rotation of the head. In the opinion of *Sherrington*, we are to look for the centres of the muscles of the trunk and chest in the free region between the centres for the upper and lower extremities. (See Fig. 64, page 284.)

As a basis for the scheme shown in Fig. 66, the brain of Observation I, 1 (see Plate XXIV, Fig. a), was made use of. Five definite foci were located in the case of this child, all

of which had their localization in the anterior central convolution —corroborated by necropsy.

In my first faradic irritations, the entire cortical area was exposed by trephining and then gone over with the electrode. In man as well as in lower animals, only certain points irritated responded with muscular contractions, while the more or less broad bands of intervening nerve-tissue have proven entirely indifferent to the action of the current. We are, therefore, forced to the conclusion that the responsive foci are separated from one another by smaller or greater portions of brain-tissue, which latter cannot be irritated even by strong currents. The figures illustrate this clearly.

The "focus field"—if I may be permitted to make use of the term, by which I mean the centres for the various parts of the limbs—are somewhat differently arranged in the anterior central convolutions of various individuals. In some cases they are situated in a more downward direction, toward the *Sylvian* fissure, in others more middleward. Single irritable points for portions of limbs or for the face area and the muscles of mastication, are always to be found in one focus field and adjacently situated.

Now, with reference to the irritability of brain tumors; there are, generally speaking, no responses whatsoever obtainable from any cortical tumor or its immediate vicinity. This, of course, stands to reason. On the other hand, I have been able to locate the position of a brain tumor by means of faradic irritation, in which case the entire tumor had a subcortical position and could not be recognized on the surface, macroscopically. The patient in this instance was admitted, suffering from symptoms of cerebral compression, accompanied by complete paralysis of the left arm and face. Notwithstanding the paralysis, we were able to get contractions of the hand, thumb, and finger muscles, as well as those of the forearm, by touching a yellowish-looking area in the cortex cerebri with the faradic electrode. The remarkable fact observed in this case was, that while impulses of the will were utterly impotent to produce muscular contractions, faradization proved preeminently successful. In many other instances of cortical neoplasm the reverse was true; patients were, to a certain extent, able to influence

their muscular systems through impulses of the will-power, yet irritations with the faradic current remained entirely ineffective.

Before entering into a discussion on

**The Results Obtained from Irritations of the Brains of Epileptics**

which is the most important question to engage our attention at the present moment—I must state at the outset, that in these cases where the cortex and the brain covering appear macroscopically to be normal, the results are varied and unequal in the extreme. In some cases, muscular contractions will appear immediately upon the application of the electrode-repeated applications always resulting in the same responses—in others, again, characteristically uncommon results will ensue. Yet, as I have mentioned above, the current must never be permitted to act on the same point more than three or four times in succession, allowing corresponding intervals to elapse between applications.

Faradization of the cortex cerebri in man is by no means an insignificant and innocuous procedure. In some instances where much time had to be spent in the localization and circumscription of a given centre, collapse has resulted; the symptoms of which, however, receded after some period of tranquillity. Collapse is particularly to be feared when the current is either too strong, or, if weak, it be permitted to act for a time longer than usual. We should always begin with the weakest possible current, and its strength, if need be, gradually increased by advancing the secondary coil. At all events, however, we must—in human beings particularly—be cautious in the extreme and avoid undue prolongation of the irritation beyond the time unconditionally necessary for the performance of the operation. For we surgeons do not labor for physiologic but for therapeutic purposes. Therefore, if we don't expect positive and important elucidations, absolutely necessary for our operative measures, from the use of cortical faradizations, they had better be left alone. In isolated cases, the unmethodic use of the current was followed by numerous large and fresh hemorrhages into the meshes of the pia and into the parenchyma of the cortex, as shown by microscopic examinations of excised portions of the cortical substance.

Moreover, it is to be noted that sooner or later the cortex loses its irritability to the faradic current—becoming fatigued or exhausted. This is shown by the complete absence of responsive muscular twitching in a previously overstimulated focus—which regains its irritability only after a prolonged period of rest.

Not infrequently, the irritation of a certain focus has been followed, not only by muscular contractions as outlined in Fig. 66, but varied movements accompanied the contractions as a sequence of faradization of contiguous portions of the cortex cerebri. For instance, movements of the thumb were accompanied by extension of the index finger at the proximal joint, with flexion of both distal phalanges, and ulnar flexion of the wrist-joint. To furnish another example: there followed upon the spasmodic contraction of the eyelid, contractions of the orbicularis oris, as well as contralateral twitchings of the sternocleidomastoid muscle, to an extent which caused the head to perform short and jerky rotatory movements. Only those muscular contractions which were obtained first, were utilized for representation in the illustration.

Only those points should therefore be designated as foci of the cerebral cortex in which responsiveness as well as susceptibility to the current are most marked. Our scheme represents only an abridgment of the various foci based upon numerous experimental irritations. Physiologic stimulation certainly runs its peculiar course, and to compare it with our electrical stimuli —even in their very finest possible shadings—is, at best, an extraordinarily rude procedure. By the way, I must state, that while pricking the œdematous arachnoid, I have casually scratched the pia and cortex, which resulted in muscular contractions that corresponded to the foci irritated.

We should, finally, not permit any one to be misled by the belief that all, or even the great majority of foci depicted, are present in all human beings.

In view of the many controversies heard of now and then, it must once more be strongly emphasized, that as far as the surgeon is concerned, the question whether the anterior central convolution only is subject to electrical irritability or that the posterior is in some respects equally irritable—is a purely academic one, which the physiologists may decide. The point of im-

portance for us is, to have a method at command which will permit us to find, with a positive assurance of exactness, the foci giving, primarily, rise to spasmodic contractions. Whether the centres lie a little more anteriorly or posteriorly, is, as far as the practitioner is concerned, a matter of utter indifference. It is very probable that just as we observe anatomic differences in various individuals, so do physiologic laws not always follow a stereotyped path. On page 294, I have pointed out the important rôle played by the faradic current in localizing subcortical tumors. In view of all that has been said, and on the basis of my personal experiences, I wish to reiterate once more that, *at the operating table, we possess in faradic stimulation of the cerebral cortex an indispensable method of great diagnostic value.* It offers the only possibility for exact localizations in the anterior central convolutions.

## Anatomic Proof for the Exclusive Irritability of the Anterior Central Convolution

### Macroscopic Findings

Now, we shall have to prove that the foci in man are actually located in the anterior central convolution. An orientation in the brain, exposed by operation according to convolutions and sulci, is well nigh impossible, even when the opening in the skull is made very large, as shown in the illustrations. The sulcus centralis is not as distinct in man as it is in monkeys. Above all, must the soft coverings of the brain, under all conditions, be left alone, and their removal not attempted, prior to faradization, as this would result in serious injury. In man, the sulci do not appear so clearly defined, and the convolutions are not as distinctly separable from one another, prior to exposing the gray matter. The only guides enabling us to properly locate the sulci—in the brain still covered by the ventral leaf of the arachnoid and the pia—are said to be the vessels in their course—mainly the veins. But, numerous observations on the living subject and in the cadaver have taught me that this mode of orientation is exceedingly unreliable. Strong veins are frequently seen coursing over insignificant sulci, while the sulcus centralis is marked by only a very thin vessel.

Only those observations were accepted and considered entirely unobjectionable in which I could verify my physiologic findings (irritations) on an anatomic basis after death of the patient. I shall now note the following observations and results, on account of their great importance with reference to the subject under discussion.

## OBSERVATION I, 1.

*Jacksonian Epilepsy without Findings. Excision of the First Spasming Centres of the Arm and Hand. Death in Collapse.*

The first case is that of a six-year-old girl, referred to me in January, 1903. She suffered from epilepsy of the *Jacksonian* type, the attacks originating in the right hand and forearm. On account of general weakness of the child, I declined to operate at this time, and measures were undertaken directed to the improvement of her general condition. The results of treatment were, however, not favorable, and the attacks recurred with greater frequency, invading at this time also the muscles of the tongue and lips. All this added greatly to katabolic conditions. Repeated entreaties from the parents of the little girl and her physician caused me to assent to operate March 22, 1903. The child was at that time six years and four months old. The skull, membranes, and brain proper were entirely devoid of pathologic conditions. The following foci were located in the primarily spasming cortical areas (Plate XXVI, Fig. a):

At 1, separation of the four last fingers and ulnar flexion of the right arm.

At 2, strong extension of the forearm and elevation of the entire arm ($45^0$ deltoid action); following this, dorsal flexion of the hand.

At 3, radial flexion of the hand, accompanied by flexion of the forearm at the elbow-joint.

At 4, extension of the thumb and index fingers.

At 5, extension and abduction of the arm; thereupon dorsal flexion at the wrist-joint. Somewhat prolonged faradization (a few seconds) resulted in a slight epileptic attack, akin to the one resulting from faradization of the space marked X. The seizure commenced with a forcible inward snapping of the thumb,

between the index and middle fingers, followed by clonic contractions of the hand and forearm. Seeing this, the irritations were at once suspended, without further recurrence of the seizure.

Repeated irritations, with the same strength of current, of what supposedly was thought to be the posterior central convolution, *e.g.*, the portion of cortex situated behind the thin and angular vein, yielded absolute negative results; the occasional

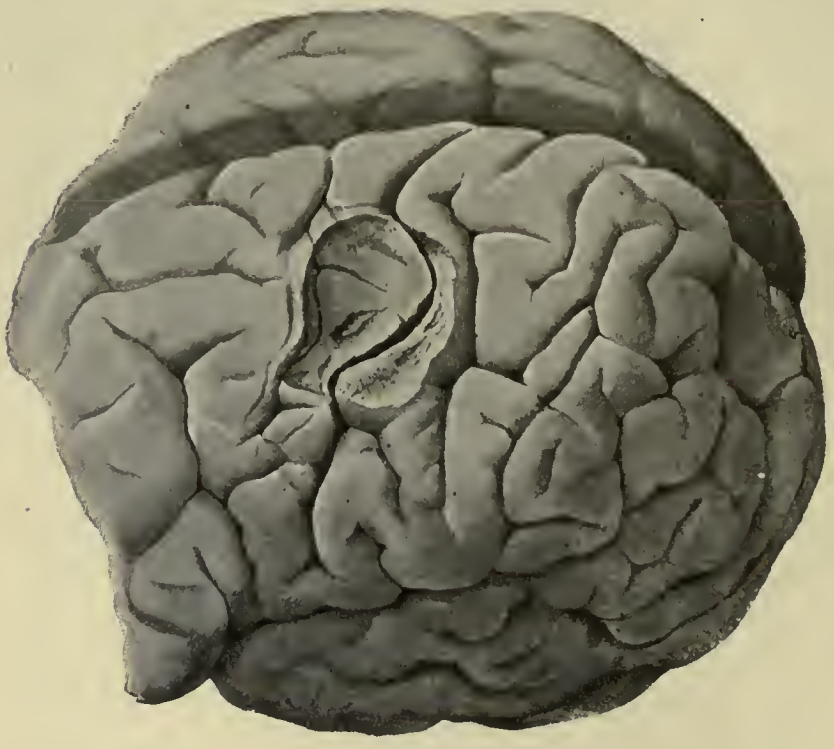

Fig. 67

return and touching with the same electrode of the foci described above, were always met with immediate and like responses.

This, therefore, proves incontrovertibly and conclusively that the cortical tissue, situated immediately in front of the angularly coursing vein (identified to be the anterior central convolution, at autopsy), is always faradically irritable, while the tissue of the posterior central convolution, located immediately behind that vein (central fissure), possesses no such irritability.

The excision of that area of the cortex outlined was now undertaken, down to the white substance, after primary deligation of seven veins supplying it. It measured 30 mm. in length, 24 mm. median width, and 5 to 7 mm. in thickness. On account of clinical evidence of sensory disturbances, during the

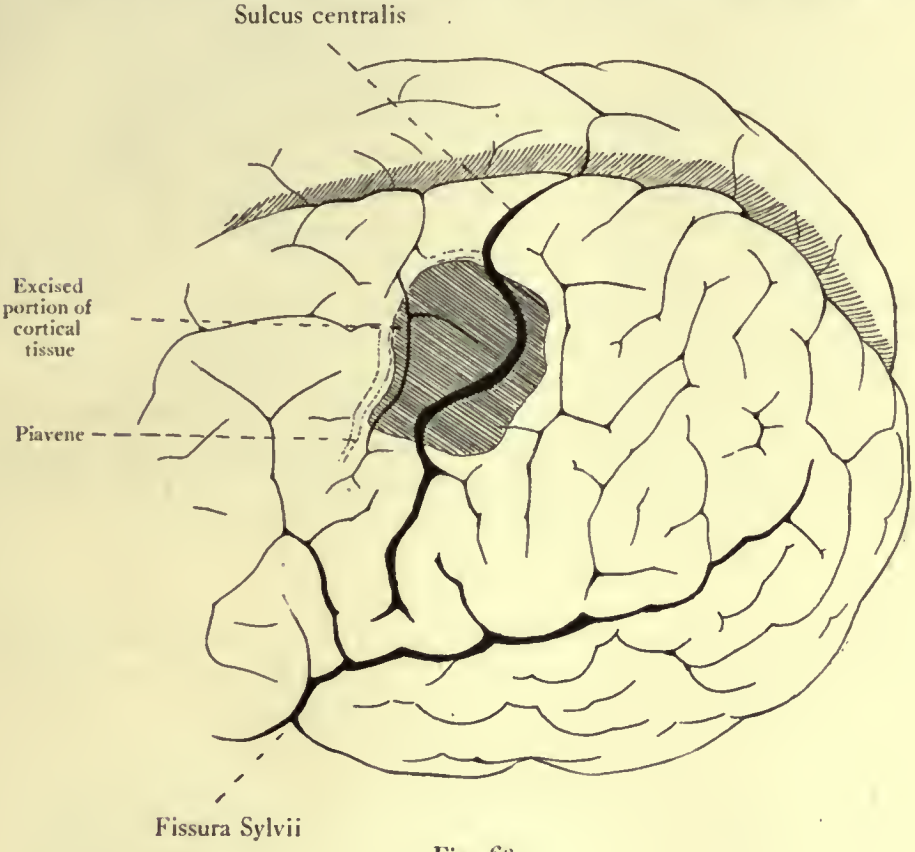


Fig. 68

spasmodic attacks, the excision in this case was purposely extended to the posterior—faradically not irritable—central convolution.

The operation was performed under light chloroform-oxygen anæsthesia. It is noteworthy, that it took only fifteen minutes to expose the brain, and a remarkably slight quantity of blood was lost. In spite of all, the child expired eighteen hours later in collapse. If I were not misled by the rapidity of the operation, and had I adhered to my originally outlined plan—to

operate in two sittings—the patient might have been saved. The necropsy (*Professor Oestreich*) disclosed no pathologic findings. There were neither hemorrhage, hyperæmia, nor anæmia. Œdema and inflammatory conditions of the brain and its coverings were conspicuously absent.

The position of the excised cortical portion is, for our present observations, of great importance. The illustration of the brain freed from its coverings, Fig. 67, as well as Plate XXVI, Fig. a, were drawn by the same artist. We see that all foci found to be irritable, belong to the anterior central convolution—exclusively. The impressions observed on the cortical surface, after the removal of the soft coverings, show a few remaining veins of the pia. The size of the veins in this case also did not conform with the importance of the sulci. A very long, thin, and in its upper part, slightly enlarged vein, ran in the central fissure, while in front and posteriorly to it, a few veins, 3 to 4 mm. thick, were seen. In this case, the central fissure corresponded anatomically with both angulations of the vein—corroborated by the physiologic irritations and the autopsy.

## OBSERVATION I, 2

*Jacksonian Epilepsy Following Injury to the Head and Insolation. Leptomeningitis. Excision of the Centre of the Hand. Death from Suffocation during Epileptic Attack.*

The second patient coming to autopsy was a man, thirty-eight years old. He always enjoyed good health, until 1897, when he met with an injury to the head and suffered from an attack of sunstroke, while in Africa, which was followed by *Jacksonian* epilepsy. The spasms originated in the right hand and were characterized by the enormous force of the contractions, so much so, that the hand formed a forcibly clenched fist, with the thumb pressed against the palm of the hand. Or the spasms would commence in the forearm with alternating flexions and extensions of clonic type, following each other in rapid succession. The forearm was semipronated. The spasms now rapidly invaded the lower part of the face, then the right side of the body, becoming finally general. In the beginning of

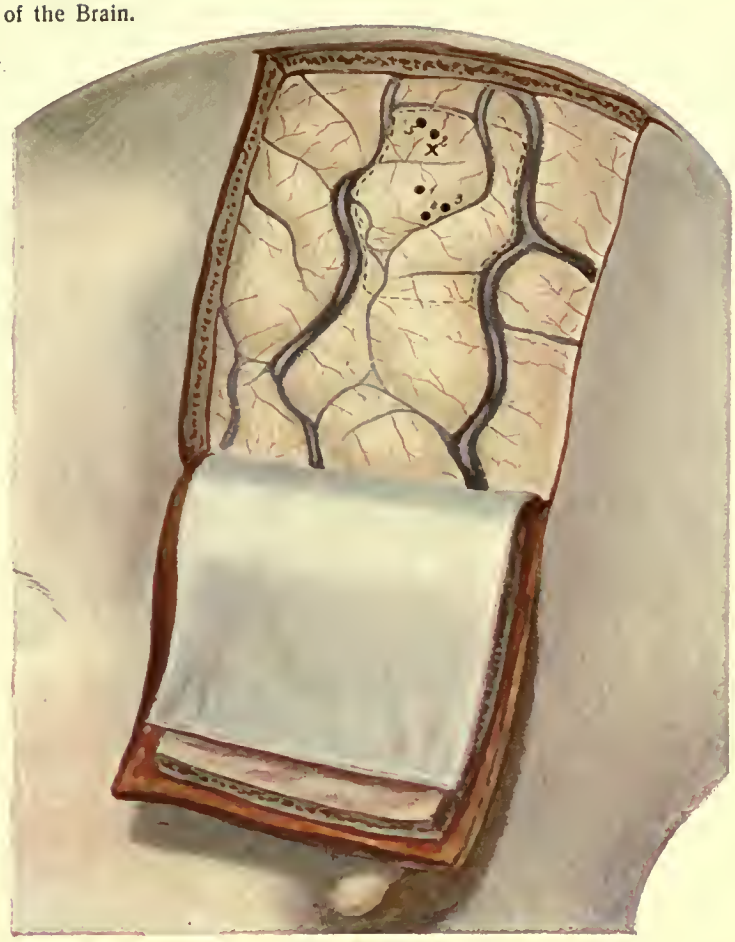


Fig. a.

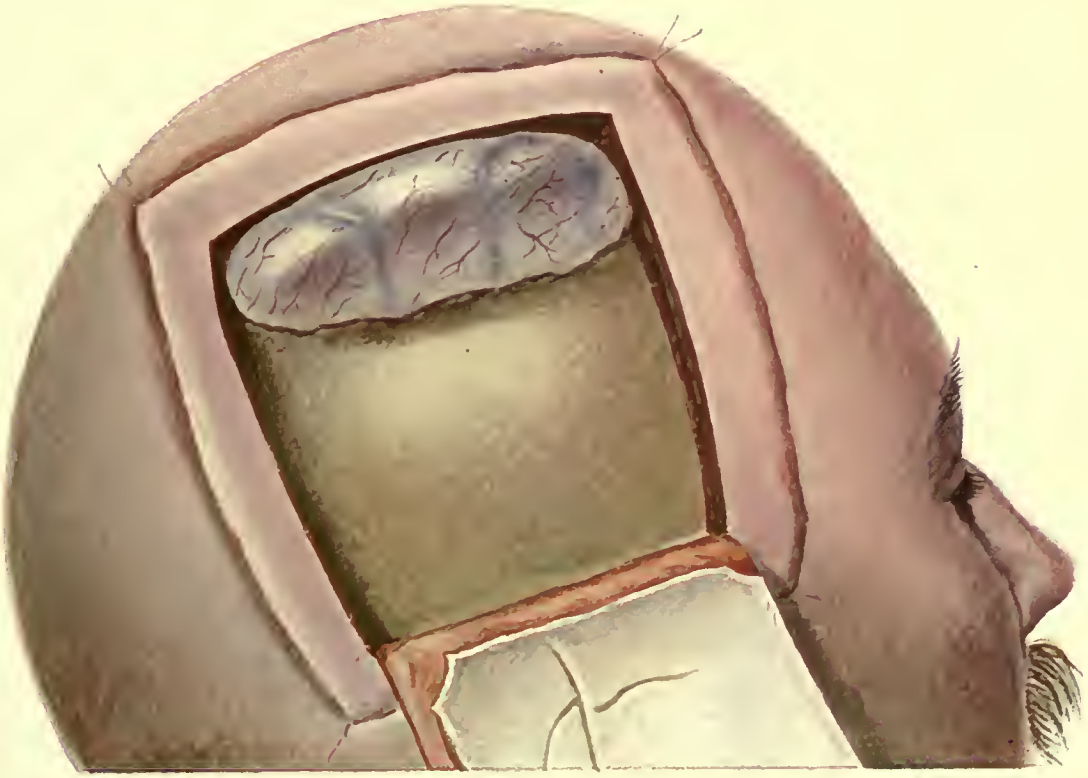

Fig. b.

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the seizures, the patient retained consciousness, the attacks finally culminating in complete loss of his senses. He frequently bit his tongue. His age bespoke inadvisability to undertake an operation, yet he urgently demanded intervention, because his memory was profoundly affected, and, as he expressed it, "nothing but the insane asylum or suicide face me, finally." Factors indicating an operation in this case were: the trouble originating from an attack of insolation and violent trauma applied to the left central region.

These attacks were observed by me, from January to the beginning of June, 1903. The first operation was undertaken, June 12th, of the same year. After the formation of an osteoplastic flap, the dura appeared to be quite tense and showed only slight pulsations in the lower part of the opening. The skull was remarkably thick, measuring in some places 18 mm., and it was intimately attached to the dura. A dural flap was fashioned June 16th, which was found markedly thickened ($1\frac{1}{2}$ mm.). A gush of cerebro-spinal fluid made its appearance. The arachnoid looked grayish white, œdematous and jellylike, over the entire exposed portion. In the course of the vessels, it looked almost white. The anæsthetic used was chloroform, superficially administered. The cerebral pulsations were now distinctly visible. No signs of hemorrhage resulting from the first operation were observed on the dura or arachnoid.

In order to free the arachnoid meshes from the existing œdema—to prevent its interference with the conduction of the faradic current—the soft coverings were scarified in the lower angle of the wound. The fluid trickled away slowly, after which the arachnoid was seen to snugly apply itself to the underlying sulci and convolutions.

The following primarily spasming foci were obtained from unipolar faradizations (Fig. 69):

1. Contraction of the right side of the face.

2. Flexion of the right index finger, the rest of the fingers slightly following.

3. Extension of the right wrist, *e.g.*, contractions of the extensors of the forearm.

x. Epileptic zone—typical epileptic seizures. These began with extension of the fingers, followed by flexion of the forearm.

Shortly thereafter, clonic flexor and extensor movements of the elbow-joint made their appearance, accompanied by adduction of the arm at the shoulder-joint, with flexion of the trunk

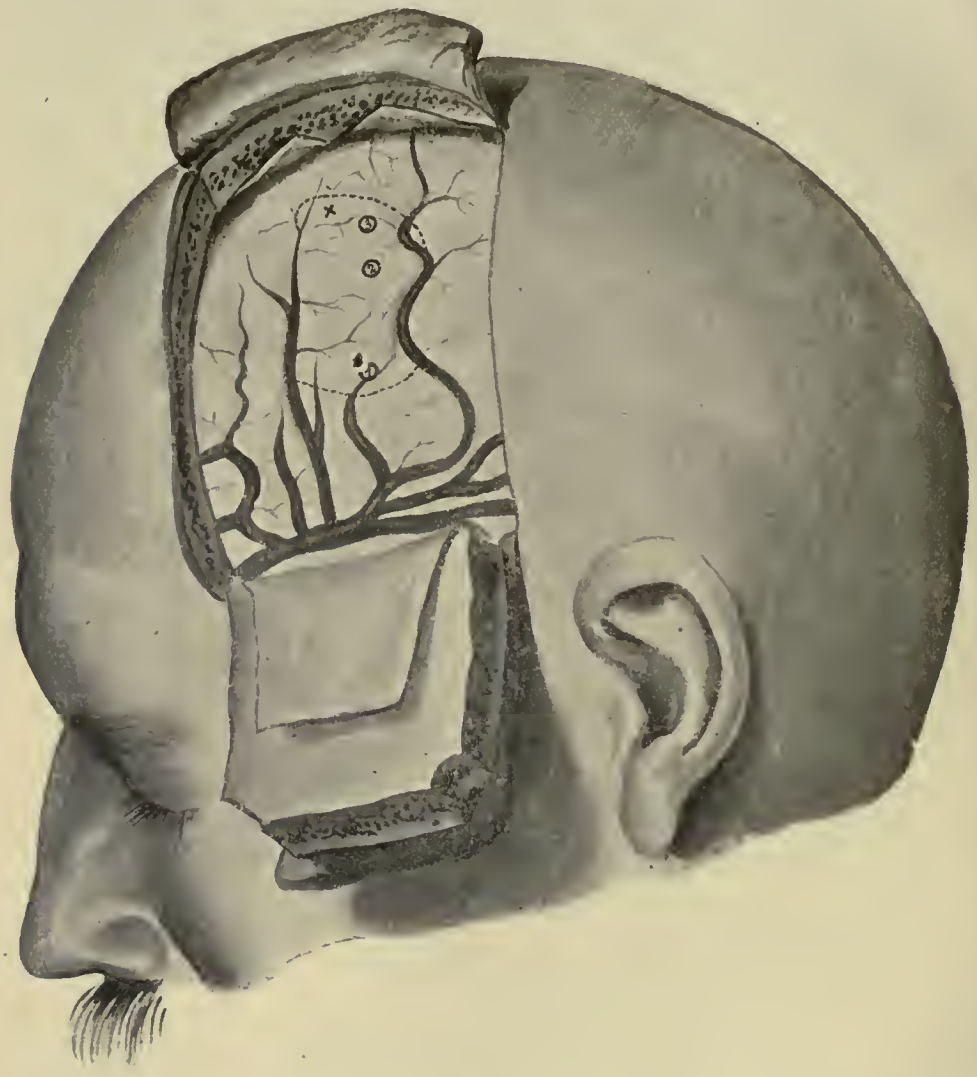


Fig. 69

toward the right side. Contractions of the right leg were also observed. While only focal or localized contractions occurred when applications were made to points 1, 2, and 3, the same applications, with the identical strength of current and same

length of time, were applied thrice to the area marked x, and a beginning epileptic attack supervened at each and every time. Anterior to and behind the focal area, attempts to irritate the cortex remained entirely negative. The veins surrounding the focal area embodying the centres of the face, fingers, hand, and forearm were ligated, and a section of cortex, measuring 38 mm.

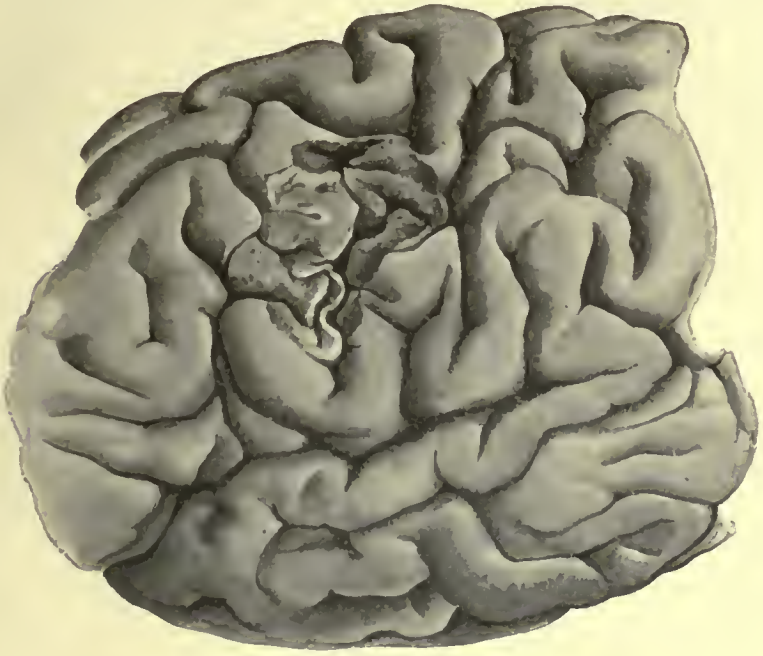


Fig. 70

in length, 20 to 24 mm. in width, and 3 to 7 mm. in thickness, was excised.

After the second operation the patient felt well. One and a half hours later, spasmodic contractions made their appearance, which, however, were of an entirely different character than heretofore. Instead of clonic twitchings as before, tonic contractions of greatest intensity ensued, affecting mainly the flexors of the right hand and forearm. Later in the day, clonic spasms of the other side of the body appeared (face and arm), the tonic condition described at the same time continuing in the right upper extremity. Corroboration was therefore found in this case, to the animal experiments of *Ziehen* (see page 323).

While nothing ominous was apprehended in the first attacks, a general, extraordinarily violent seizure of tonus supervened twenty-two hours after the operation, the diaphragm also becoming engaged in the general tonic spasms, and our patient suffocated, in spite of all efforts bent to avoid a fatal termination.

The autopsy (*Professor Dr. Oestreich*) disclosed changes in

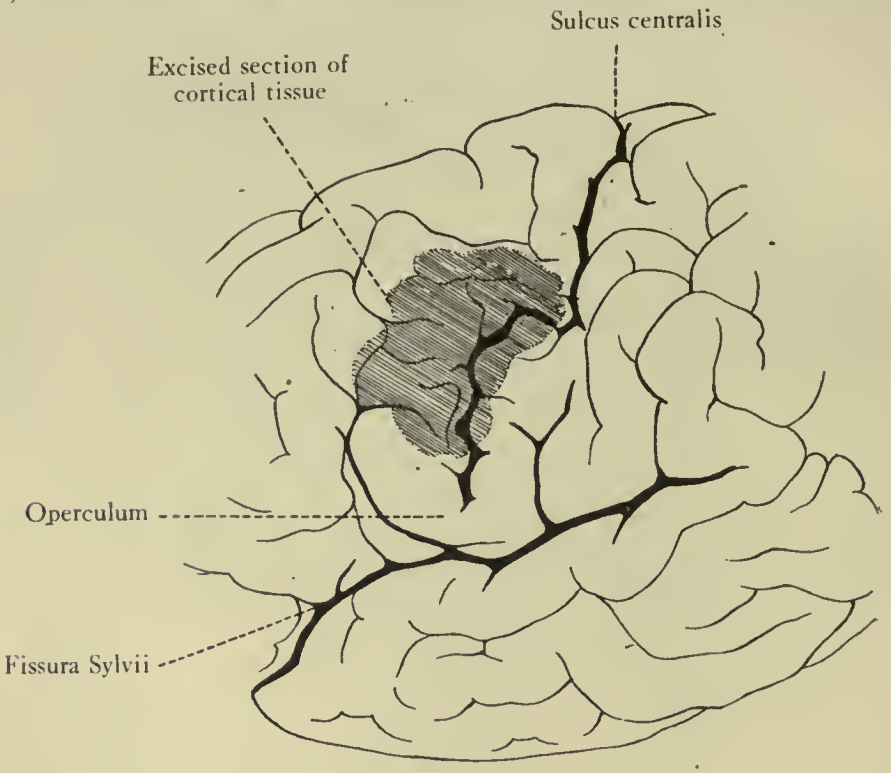



Fig. 71

the dura and arachnoid, mainly marked in the trephined area, the thickened changes of the dura, as well as the leptomeningitic changes were seen to gradually decrease toward the periphery. According to the necropsy report, the heart was found fatty and flabby.

Concerning the location of the foci found upon faradic irritation—with reference to the central fissure (see Figs. 70 and 71)—it was ascertained that they were all seated in the anterior central convolution. Although the excised cortical portion contains a small part of the posterior central convolution, faradiza-

tion of the latter remained negative. The central fissure could be located only after the removal of the pia. Its position was a very uncommon one, indeed. The veins were not of the slightest value as landmarks in locating the central fissure. You will observe, by comparing Figs. 69, 70, and 71, that the large vein corresponds to the central fissure only at its upper part, and that it sends a side branch to the back part of it. In the main it must be remarked, that the localization of the *Rolandic* fissure cannot be accomplished by vascular landmarks solely. It would be futile, nay well nigh impossible, to attempt to even approximately estimate the exact and certain position of the primary spasming centres in this case by anatomic landmarks solely.

## OBSERVATION I, 3

*Jacksonian Epilepsy Following Encephalitis. Most Marked Œdema of the Arachnoid. Excision of the Arm Centre. Death Five Days Later from Cardiac Weakness.*

A youth, twenty years of age, without any nervous taint, became ill with gastric symptoms, accompanied by fever, while cutting his canine teeth. On the afternoon of the fourth day of his illness, there suddenly occurred a general convulsive seizure, with unconsciousness, lasting until midnight and then abating after an outbreak of profuse perspiration and finally ending in tranquil sleep. On awakening in the morning, a left-sided hemiplegia, in which the left facialis territory participated, was found. Within the following year, the hemiplegia gradually improved, but there remained a weakness of certain muscle groups and diminished usefulness of the left extremities, principally the hand and toes. There was also a weakness of the left lower facial region, which was most marked when the patient was laughing, etc. Slight deformities developed gradually in the left foot and toes. The mental faculties did not sufficiently develop and he could not keep pace with his studies as a consequence. The most difficult subject for him to grasp was arithmetic. Up to his thirteenth year no seizures were observed.

Since that time there occurred again, periodically, spasmodic

attacks, on the average of about once a month. They began regularly in the left arm—without loss of consciousness—and were characterized by rotation of the head, then by the body, to the left side. At times the seizures would appear while the patient was standing. They lasted from one-half to one minute. As time passed on they became more frequent, and in the last two years they appeared almost every other day. Now and then ten attacks would follow each other in succession. Since 1900 they were ushered in by a groan or an outcry of anguish. Consciousness was now almost always lost. The spasms began in the left arm, at times also in the left lower extremity. The upper part of the body was thrown back to the right and then rotation to the left followed. Only very seldom did the seizures occur in the daytime. Very frequently pain in the little finger would be perceived by the patient prior to an attack. At times the painful sensation would make its appearance in the left thigh, or in the temporal region, at a point midway between the external ear and the upper wall of the orbit.

In view of the very marked clinical picture, there remained, at times, paretic conditions of the left hand and forearm for hours after the attack; and in compliance with the insistence of the father of the patient, who was a physician, the operation was performed in two stages—an interval of six days being allowed to elapse between the two.

Upon the first incision made into the much-thickened dura mater (over 1 mm.) the arachnoid protruded under the greatest possible tension, bulging in the form of a tightly—to a bursting point—filled bag of waters, all along the line of the incision, corresponding in size with the trephined area. (See Plate XXVI, Fig. b.) After detaching the dural flap, the arachnoid presented an œdematous and jellylike appearance, the extent of which I do not recall observing before. It filled the entire trephined opening, which measured 80 mm. square (see Vol. I, Plate II, Fig. a), and was closely studded with agglomerations of white tubercles the size of a millet-seed, that were grouped mainly along the veins of the pia. In one place, which according to its anatomic locality, belonged in all probability to the anterior central convolution, a yellow colored focus was observed, superimposing a vein, and measuring 30 mm. in length

and 6 mm. in width, consisting microscopically, of dense fibrous tissue.

To prepare the cortex for the proper reception of faradic irritations, elimination of the œdema was accomplished by a great number of scarifications of the arachnoid, all along the lower border of the wound. The surface of the brain presented itself now, normally and clearly. The place corresponding to

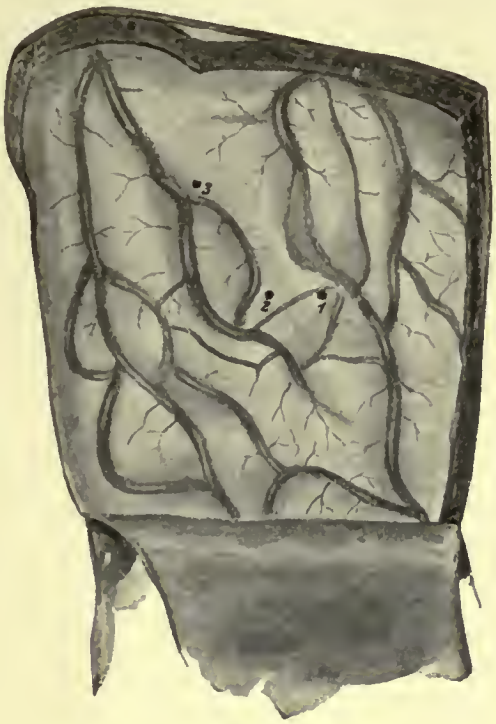



Fig. 72

the yellow spot just alluded to, was marked by a small depression in the cortex, slightly concaved. Faradizations with a current barely perceptible to the tip of the tongue, yielded the following foci (see Fig. 72):

1. Downward traction of the left angle of the mouth; contraction of the orbicularis oris; retraction of the left half of the lower lip, to the left and upward.

2. Drawing up of the left angle of the mouth.

3. Abduction of the fifth finger, clonic contractions of the forearm; ulnar flexion of the hand, contraction of the biceps;

smaller than the left. The thoracic and abdominal viscera showed neither pathologic conditions nor indications for the assumption that the patient succumbed during a spasmodic attack.

After hardening of the brain in formalin, and ablation of the pia, we were able to ascertain that the foci removed from the cortex were all located in the anterior central convolution exclusively. (See Figs. 73 and 74.)

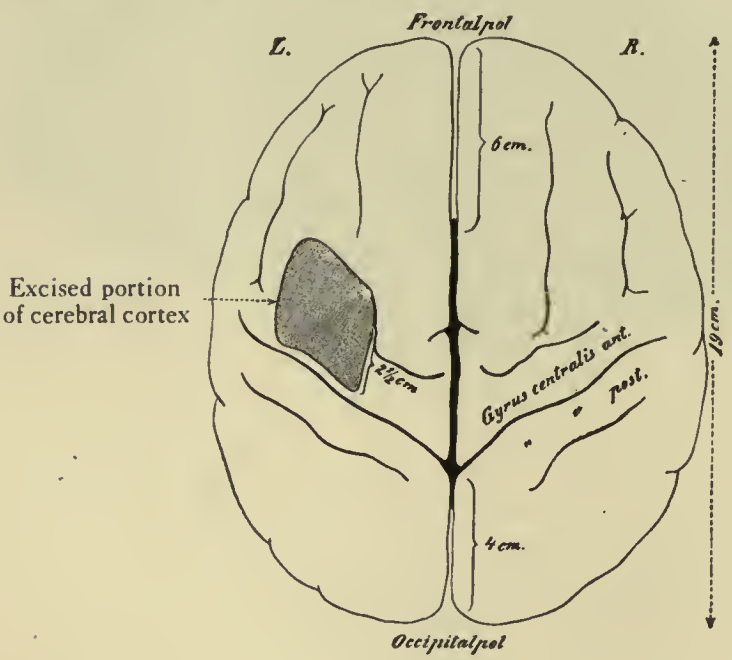



Fig. 75

The right cerebral hemisphere disclosed a picture of microgyrism. The place of excision was marked by numerous punctate hemorrhages which extended quite deeply into the medullary substance. (See Vol. I, Plate VII, Fig. c.)

Finally, I am prompted to return here to the observation of the case of cortical glioma, which has already been detailed by me on pages 106 to 108 of the first volume.

Unipolar faradic irritation, applied to point 1, yielded (see Plate XXI, Fig. a): Strong extension of the right forearm, followed by slight elevation of the arm. Point 2. Strong elevation of the right arm. Point 3. In the first three seconds, slight

masticatory movements of the lower jaw, then fibrillary contractions of the right masseter. No responses, however, were obtainable from the entire surface of the tumor. Equally so, faradizations of the entire area posterior to the three points just described were negative.

Death resulted seven weeks after the operation, and observation of the brain and study of the relative positions of the foci (see Fig. 75) clearly showed that the faradically irritable points were all located in the anterior central convolution.

In the four observations just spoken about, the anterior central convolution only—and no other part of the accessible and freely exposed brain surface—was found to be electrically excitable.

### Microscopic Findings

That our excisions consisted of parts of the central convolution, I am further able to prove by microscopic evidence with sections of cortical parts, which were prepared for me, partly by *Dr. K. Brodman*, of the Neurobiologic Institute of Berlin, and the rest by *Professor Vogt* of the Neurobiologic Institute of Frankfort-on-the-Main. To both of these gentlemen I am highly indebted for their aid.

Just as the physiologic peculiarities of the anterior and posterior central convolutions differ, so does the microscopic construction of their cellular arrangement display noticeable disparities. The anterior central convolution is principally characterized by the involution of the inner nucleated layer and by the presence of the giant pyramidal cells of Betz.

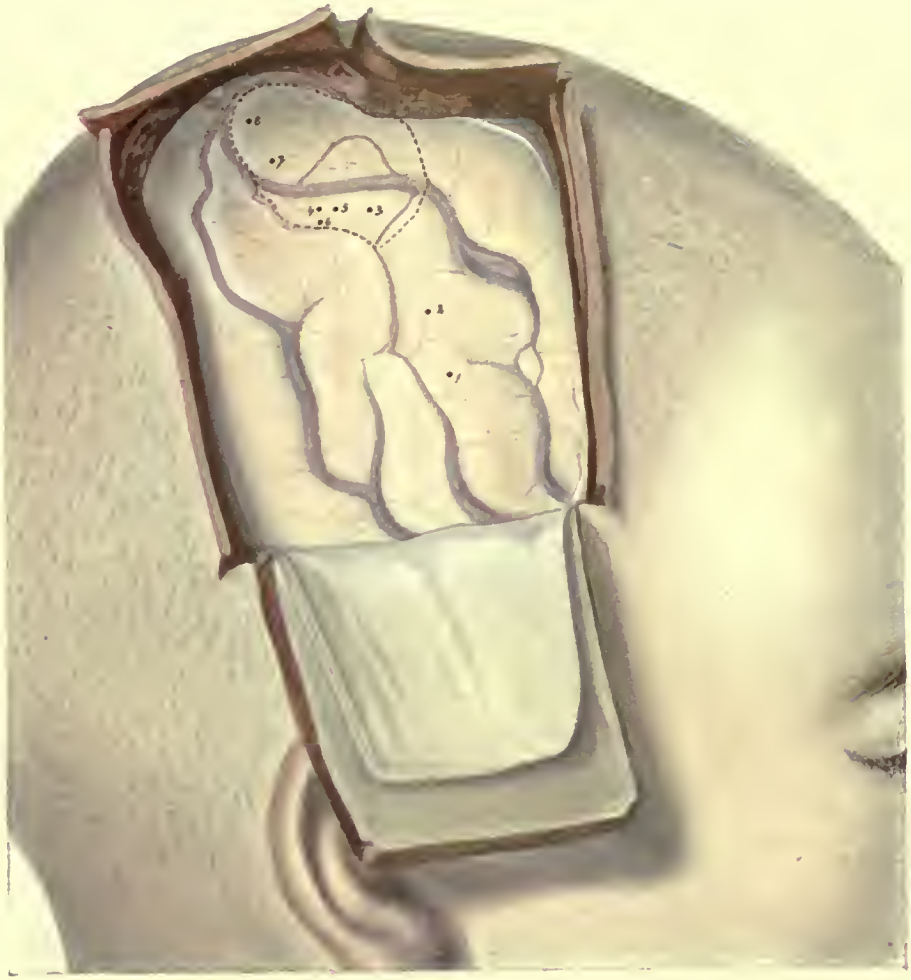
Further confirmation of the differences existing between the anterior and posterior convolutions may be obtained by the examination of the separate sets of nerve fibres issuing from them. *O. Vogt,* of Berlin, was able to show that the projection fibres of the anterior central convolution are in connection with a part of the thalamus opticus, entirely different from those of the posterior central convolution. Consequently, the directions of the two conducting paths of the cortical area are entirely different from each other. The first is connected with the corona radiata, the other with the lemniscus.

My colleagues, *Brodman* and *Heinrich Vogt,* inform me, that histologic examination of the excised portions enable us to recognize which of the two central convolutions the sections are taken from. Only in two cases was this impossible on account of the marked changes in the tissues. The first one is taken from Observation I, 10, page 360. The entire specimen (22 : 16 mm.) was cut serially after careful preparation. It presented most marked tissue changes. While the true cortical structure was still discernible, yet the characteristic anatomico-histologic construction was wanting. There was an almost complete disappearance of the columnar and stratal arrangement of the cortical nerve cells—seen in transverse sections. The cells were irregularly distributed and separated from one another by dense fibrous tissue bands. In places, the entire width of the cortex was replaced by scar tissue. At the same time, a severe leptomeningitis was seen to exist, at the site of the excision.

The five remaining sections of tissue were all examined by *Brodman* and were all taken from the convolutions anterior to the sulcus centralis of *Rolando.* Following are the reports showing the degree of pathologic changes observed in the "primary spasming" centres.

CASE 1.—On account of left-sided *Jacksonian* epilepsy, this youth, nineteen years of age, submitted to the operation of exposing his right central region. The main pathologic features were represented by (see Plate XXVII) white bands, surrounding the veins (leptomeningitis of slight degree) and œdematous infiltration of the arachnoid. Unipolar faradic irritation ascertained the following irritable foci, after the fluid had been drained off.

1. Lateral and downward traction of the left angle of the mouth, followed by contractions of the muscles of the left cheek.
2. Contralateral innervation of the upper and lower eyelids.
3. Extension of the index finger; upon further irritation also extension of the last three fingers.
4. Radial flexion of the wrist-joint, followed by flexion of the fingers.
5. Dorsal flexion of the hand; extension of the second to the fifth fingers. Inversion of the thumb.



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6. Extension of the thumb separately.

7. Volar flexion of the wrist-joint, followed by flexion of the second to the fifth fingers.

8. Forceful flexion of the elbow-joint.

Because the spasms were seen to originate in the fingers, the hand, and forearm, their centres—measurng 36 mm. in length, 25 mm. in width, and 6 to 8 mm. in thickness—were excised, after first deligating the veins. Healing terminated uneventfully, and the seizures, which were formerly extremely numerous, reappeared now, very infrequently. Macroscopically, the coverings of the excised and stained cortical tissues were found enormously thickened and much injected. Microscopically, diffuse round-cell infiltration, rich vascularity and a peculiar form of endothelial proliferation, especially around the walls of the veins—characterized the slides examined. The veins were increased in number, dilated and very turgid. Old blood pigmented thrombi in a state of organization were found in isolated places. The veins were unusually thickened throughout (about ten times their normal thickness). In the intima numerous large, round, and spindle-shaped endothelioid cell-proliferations are to be found, which encroach largely upon the lumen of the vessels. The cells are uni- and multi-nuclear, with opaque protoplasm and indistinct outlines; they frequently connect with one another by protoplasmic processes, so that distinct multinuclear giant-cell formations result. These new formations are found everywhere in the pia, with and without venous connections. They are grouped in tubular nest forms and may also be seen singly, accompanying veins; extending even into the cortical tissue proper.

Thick, fibrous bands and cords intimately connect the cortex with the pia almost everywhere. The surface of the cortex is covered by a thick, fibrous layer of glia tissue, internally to which numerous astrocytes are to be found. The layers composing the cortex are indistinct; the cells are faded and take anilin stains with difficulty. Recent and old blood-extravasations, small and large-celled infiltrations (also giant cells sparingly) and glia patches thoroughly permeate the entire thickness of the cortex, down even to the subcortical medullary parts.

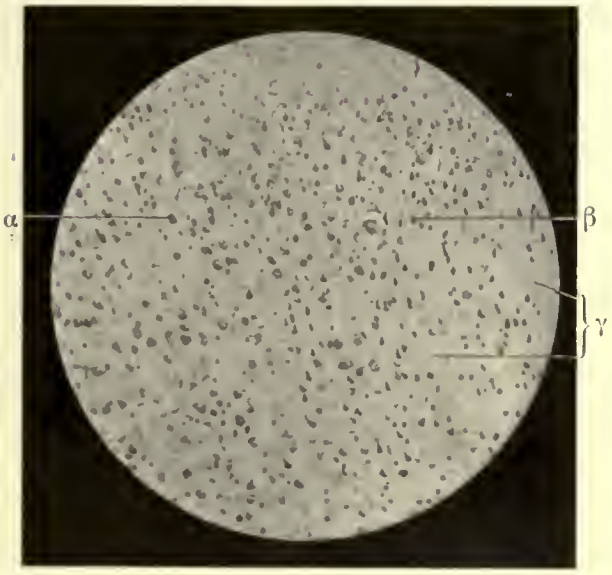
We, are, therefore, dealing here with subacute inflammatory

conditions assembling the picture of a diffuse hemorrhagic encephalo-meningitis. We must, furthermore, classify the proliferative processes of the veins to those forms of vascular disease which have been described by many as an endophlebitis obliterans, correlated to chronic infectious states.

CASE 2.—Man, twenty-two years old. Similar conditions as in Case 1. Besides a slight increase in the glia cells in the cortex, which are most marked in this instance in the second layer, no other pathologic changes are to be found. With reference to localization, it may be asserted with certainty that the excised portion belonged to parts anterior to the sulcus centralis.

CASE 3.—In this ten-year-old girl, the conditions found were also similar to those observed in Case 1, with the exception that the attacks in this case originated in the foot. Transverse sections of the excised cortex display the characteristic structure of the gyrus centralis anterior and the adjacent part of the gyrus frontalis superior. We find in only one circumscribed and proportionately small area, a disarrangement of the cell-layers accomplished by a narrow fibrous band, which traverses from without inward—in a radial manner—almost the entire thickness of the cortex. Around the scar, the glia cells are atypically arranged, being forced apart in places. *Nester Betz* giant pyramids abound in the deeper parts, and they are directly traversed by the scar. A coarse and broad glia border marks the outermost layer from its surroundings. The scar itself is free from inflammatory signs and is composed of delicate, cellularly deficient connective tissue. The cortical surface shows a pit as a result of retraction by the scar, overlying the same the meninges show vesicular detachment with moderate thickenings. They are also traversed by numerous new-formed bloodvessels. There are no cellular infiltrations and signs of inflammation are entirely wanting.

CASE 4.—Belongs to Observation I, 11, page 365. The meninges are moderately thickened, poor in cellular elements, and consist of compact connective tissue, free from infiltrations. There are numerous large extravasations of blood into the meshes of the pia and into the cortical substance, as a result of faradic irritation. All signs of a degenerative process of the cortex are present. Its structure is effaced, its thickness is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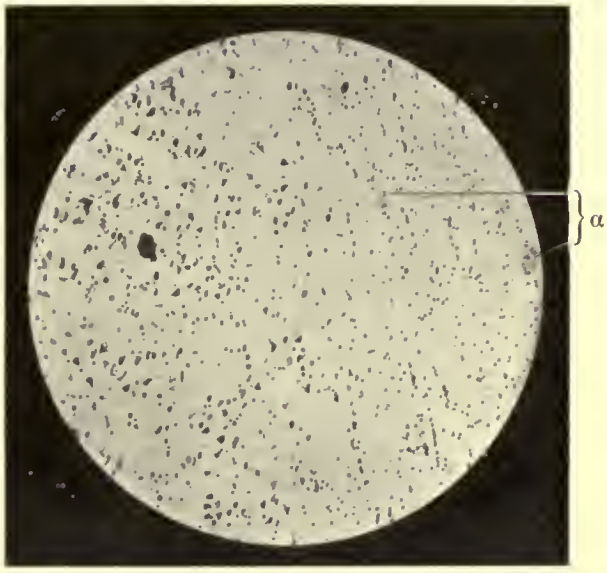
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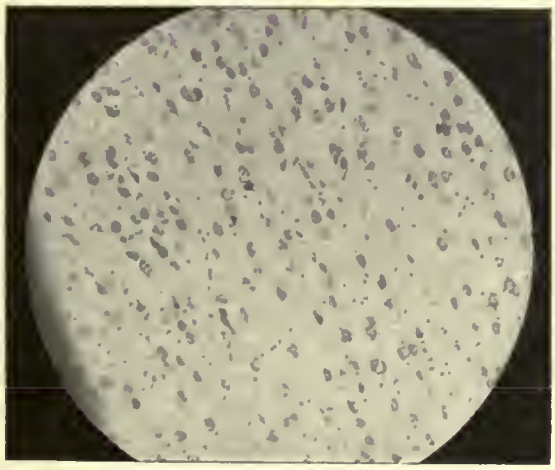

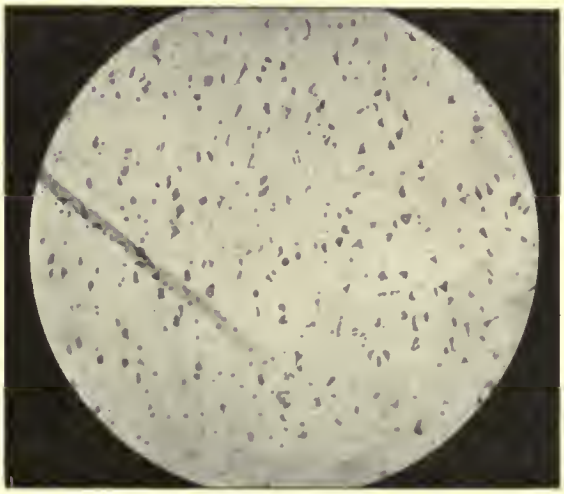

lessened, the nerve-cells rarified, the glia strongly increased, forming superficially a broad, dense seam which is intimately adherent to the pia in numerous places. The largest ganglia cells appear in the most varied forms of disintegration (swelling, nuclear dissolution, sclerosis). Although the section examined corresponds to the giant pyramid type, *Betz's* giant cells are only few, and these are involved in the disintegrating metamorphoses. In some places the parenchyma of the cortex is totally devastated, and in its place are to be found vacuolated non-stained spots or fibrous cords. Recent inflammatory conditions are totally absent.

CASE 5.—Belongs to Observation I, 3, page 307. The meninges, in this case, are strongly thickened and consist of large meshed, fine, fibrous connective tissue, poor in cellular elements. Marked vascular proliferation and inflammatory conditions are wanting. Close to the cortical surface, and in the depths of the sulci only, we find isolated perivascular round-cell aggregations. Cortex and pia are very closely adherent in their entirety. The cortical surface is also here covered by a wide glia seam, and its surface discloses, everywhere, diffuse strong glia cell proliferations, attaining their highest grade of multiplication in the outer cortical layers. Intrinsic vascular proliferations do not exist; only very scarcely do we find newformed capillary loops. Structural characteristics, as well as staining properties of the cortex, are very well preserved. Cortical measurements as to its depth, show them somewhat lessened. *Betz's* giant pyramid cells are absent in this section.

Eight more cortical sections were examined for me by *Professor Heinrich Vogt*, of Frankfort. According to his report, all sections belonged to the anterior central convolution. In only one of his cases was the structure destroyed to such an extent that the cyto-architectural locus could no longer be ascertained. Of these protocols, I shall repeat only three, accompanying the same with very instructive illustrations.

CASE 6.—Belongs to Observation I, 13, page 380. The excised cortical part has all the characteristics of a complete brain cicatrix. The cortex is reduced to half its normal size,

permitting only traces of nerve tissue to be recognized. The whole structure consists of glia which shows markedly increased nuclei and a dense entanglement of fibres, besides a few scarce, highly changed ganglion cells and traces of medullary fibres.

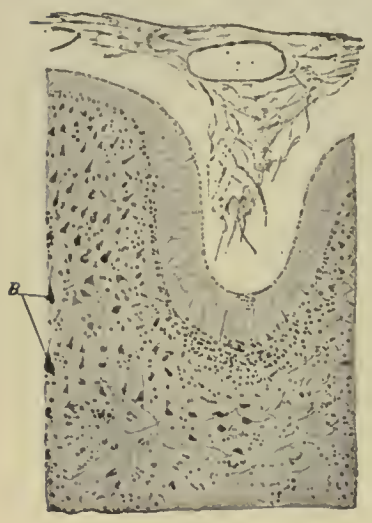


Fig. 76

Boundary of Brain Cicatrix. In the right half scar-tissue only. Complete absence of ganglion cells; increased glia. Gradual transition into normal tissue. The left side is also abnormal (narrowing, atrophic cell-forms, gliosis). *B. Betz's* giant pyramids, nearer the surface than in the normal brain. Cortex narrowed and sclerotic.

The cortex is seen somewhat widened to one side; larger cells, less altered in appearance and some ganglion cells make their appearance again. The cortical medullary fibres are also somewhat increased in size. The grayish-homogeneous ground substance permits the recognition of lessened nuclei and a decrease in the fibres. Recent inflammatory conditions are here also absent, yet the impression is distinctly gained that the inflammatory and atrophic processes are progressive, as recognized particularly by the sharp outlines of the spindle cells around the blood-vessels. Sclerotic changes of the same type are seen in some places of the excised cortical substance that is highly atrophic; these changes involve the underlying medullary substance as well.

We are, therefore, dealing here with quite an extensive cicatrix, which, it must be assumed, has resulted from an inflammatory process—perhaps an encephalitis—that leads to a complete atrophy of the cortex to a very marked extent. Enough signs abound in the inflammatory and atrophic portions to show the progressive nature of the process. There exists no distinct border-line between the normal and pathologic tissues, and, as stated, no recent inflammatory conditions; but, in their stead, there are ganglion cells in various processes of transition—from the normal to complete sclerosis—all of which strengthen our assumption set forth. There is no normally appearing cortex at any point. The large cells (B)

seen in Fig. 76 are *Betz's* pyramids, and these prove the identity of the anterior central convolution.

The pia is chronically inflamed and thickened.

CASE 7.—Belongs to Observation I, 14, page 387. Normal cortical tissue is seen at the margin of the section. In type, it corresponds to that of the anterior central convolution. (See Plate XXVIII, left half of Fig. a, and the entire illustration, Fig. b.) The rest of the section—as represented in the right halves of Figs. a and c—shows a chronic atrophic process. There is a marked decrease in the cells, numerically; they are irregularly distributed and show peculiar staining properties. While in the normal parts of the section the cells are of normal pyramidal shape with large clear nuclei and distinct nucleoli, those of the pathologic part appear in the form of small dark splinters with jagged outlines and large, distinctly visible processes (also a sign of degeneration). It is nowhere possible to distinguish protoplasm from nucleus; the entire cells are shrunken, regressively changed to a high degree, and functionally impotent. There are no ganglion cells, and marked devastation characterizes large parts of the cortical surface. Recent inflammatory conditions of the mesodermic components are not present—nor are they to be found in the border-line separating normal from abnormal tissue. The number of glia nuclei in the diseased part is scarcely increased, and the ground-substance appears less even; it shows slight irregularities of staining, not unlike grained paper; fibrous changes are seen in places. Nowhere is proliferation of the protoplasmic glia cells observable; the fibrous glia predominates in the diseased part. The characteristic spider and giant cells—found in new proliferative processes—are absent.

The impression is gained that we are dealing, in this case, with a complete process, which leads—after slight extension—to atrophic changes, as characterized by an increase in the fibrous glia, destruction of nerve tissue, sclerosis of ganglion cells, loss of cortical medullary fibres, and thickening of its ground substance. Strictly speaking, we should not use the term "cicatrix," because of the preservation of type and cellular arrangement as a whole, and the preservation of the size of the cortex; it is more proper to describe it as an atrophic process affecting

mainly the specific elements without materially harming the volume of the ground substance. The line of demarcation between the normal and pathologic is quite sharply shown in Fig. a. We must conclude that we are not dealing with a progressive condition, but with a pathologic one, that has arrived at a point of anatomic standstill; it may, however, act summarily as an irritant to contiguous parts.

Fig. 77

Capillary of the Anterior Central Convolution with Degeneration of Endothelium and Perivascular Infiltration.

CASE 8. (See Fig. d, Plate XXVIII.)—Boy, ten years old. Excision of the following foci in the right hemisphere: accessorius, facialis and opening of the mouth.

In this instance, the excised cortical portion—which undoubtedly belongs to the anterior central convolution—shows the ganglion cells and nerve fibres numerically and in form intact. Bloodvessel changes of strictly recent origin are to be seen; they show themselves in the form of vessel-wall changes, affecting the smallest vessels—desquamation of endothelial cells (see Fig. 77). An appreciable increase in the number of cells within the walls of the vessels are not seen; besides this, we find an infiltration in the vessel-sheaths as well as in the vicinity of the smallest vessels, consisting of lymphocitic elements and plasma cells. The vessel-sheaths are further filled with products of retrograde metamorphosis and cell-rests. The glia does not show, in the excised portion, fibrous, but in some places nuclear proliferation of slight degree.

## Jacksonian Epilepsy

The well-characterized forms of cerebral spasms—of which we shall presently speak—were thoroughly studied and described by *Hughlings Jackson.* Following *Charcot's* precedent, we designate them as *Jacksonian* or cortical epilepsy. *Jacksonian* epilepsy is no disease *sui generis;* on the contrary in it we re-

cognize a symptom complexus that manifests itself in various diseases of the brain and its envelopes. It is therefore caused by a number of etiologic factors. The term *Jacksonian* epilepsy has in Germany been universally adopted. The French even go a step farther: thus, *Trousseau* speaks of an epileptiform neuralgia in facial pain. In view of the marked clinical differences existing between genuine and symptomatic epilepsy, I must describe each separately. I should like to remark here, that the symptomatic form of epilepsy is seen occasionally to culminate in the genuine variety; even when the etiologic factor has been eliminated by operation (epilepsia genuina secundaria). At times, we meet with unsurmountable difficulties in attempting to differentiate between genuine epilepsy and epileptoid manifestations.

While, to-day, every epileptic attack is believed to originate in the cerebral cortex, the typical *Jacksonian* seizure must be looked upon as something singular. It concerns here, clonic spasms which are known to have their exclusive origin in the motor area of the cortex. (See Fig. 66, page 291.) The spasms follow the precise anatomic arrangement of the cortical centres, affecting first one, then the other, and so on in rotation; then the other side of the body manifests convulsive movements, which finally become general.

Only one-half of the body is usually involved in the spasms; sometimes only one limb, or even only a part of an extremity. For instance, if the spasms commence in the face, the next part affected will be the upper, then the lower extremity on the same side. The spasms may cease after occurring in one limb only. If the entire lateral half of the body be implicated, the convulsive movements will usually encircle the patient, by now attacking the lower extremity on the opposite side, then the upper limb, and finally the face. Sometimes a few twitchings in one limb will be followed by a generalization of the spasms. Consciousness may be retained or lost; the latter is usually the case where the entire body participates in the seizure. In some instances, consciousness is clearly retained in the beginning of the attack, the patient being able to observe his condition.

Should the epilepsy begin with spasms of the lower extrem-

ity, the next parts to be affected will be the arm and then the face. Spasmodic contractions of the thumb, followed by contractions of the other fingers, then the forearm, the arm, and lastly the face—mark the beginning and cycle of involvement in other instances.

Attacks may also be initiated by rotation of the head—the eyeballs following in the same direction—after which the arm, face, and so on become affected. As we have seen before, the centre for rotating the head is located in the lower part of the middle frontal convolution.

I have observed clonic spasms of the abdominal muscles on the opposite side, in a case of traumatic epilepsy, caused by the penetration of the blade of a knife into the central region. The same complicated symptom has also been observed in cases of tumors affecting the parietal and central regions. *Sherrington* located the centre for the abdominal muscles in apes, between the centres of the upper and lower extremities. (See Fig. 64, page 284.)

Very characteristic, indeed, are sometimes the post-epileptic *paralyses* and *pareses*, observed to follow these seizures. They remain preferably or exclusively in the parts thrown first into spasms, for a shorter or longer period. This fact enables us to determine the origin of the attack.

I was enabled—on numerous occasions—to induce a typical epileptic attack by touching certain foci within the cerebral cortex with the faradic electrode. In some instances where the localizations were attended with difficulties, necessitating a repetition of the procedure, faradizations of the same point—in the same patient—resulted each and every time in the same spasms. The careful observer will have no difficulty in ascertaining the first spasmodic parts, when touching certain foci. Interruption of irritation will suspend the spasms, as a rule, but by no means at all times. In isolated cases, the spasms could only be brought to a standstill after first putting the patient more profoundly under the influence of chloroform. Because we cannot obtain such reactions from parts immediately contiguous to the irritated focus in the cortex—using the same strength of current—it naturally follows that the foci or parts more susceptible to its action will be the first ones to respond

with spasms; hence we designate them as the "primary spasming centres."

Just as we are in a position to produce spasmodic contractions of the muscles of the body by electrically irritating the anterior central convolution, so there exist conditions in cases of *Jacksonian* epilepsy—at times known, at others unknown to us—which create irritations in the cerebral cortex, affecting first a circumscribed spot, then encroaching on contiguous parts.

The animal experiments of *Ziehen*[1] have taught us to differentiate between clonic and tonic contractions, and the relations they bear to one another.

When he applied electrical irritations after excising the forebone area, in animals, he found that "with weakly irritating currents, the forebone did not at all participate in the spasms; with currents of medium strength it reacted mildly, with fluctuating tendencies; with strong currents, it showed the same tetanic conditions as did the other extremities, but without the occasional clonic contractions of the same. Clonic spasms were never observed in muscle groups, the brain regions of which were first extirpated; there was always a purely tonic spasm, and this only with certain strengths of the current. It occurred only then, when tonic spasms supervened in the other extremities."

"From this we must conclude unequivocally, that clonic movements have their origin in the cortex, while tonic contractions spring from the lower motor centres. Clonic spasms should, therefore, be designated as cortical, the tonic as non-cortical."

I have described an analogous observation in man (compare Observation I, 2, page 302).

Sole reliance should not be placed in motor manifestations as guides for the determination of parts to be attacked operatively.

That the central area is justly designated as the sensory-motor region is also further proven by observations on patients operated on by me, as we shall see on page 397, in whom, after cortical excision, the morbid manifestations were not limited to the musculature only, but sensory symptoms as well made their appearance in the respective limb. Muscle groups which have

[1] *Th. Ziehen*, Über die Krämpfe infolge elektrischer Reizung der Grosshirnrinde. "Archiv für Psychiatrie," 1886, XVII, p. 99.

been attacked first, and have suffered mostly from the spasmodic contractions, will remain longest in a paralyzed or weakened condition, after cessation of the seizure. Sensory disturbances in the form of symptoms of exhaustion are of great diagnostic value in localizing the focus.

I shall now cite two instances. The first is the case of a young man, sixteen years of age, without hereditary taint, who was completely well until his eleventh year, and then, without any known cause, became ill in the following manner:

Tingling sensations in the right hand always ushered in the attacks. The patient was, at times, able to suppress the sensation by forcible and active pinching of the fingers. This failing, the sensation travelled upward along the forearm to the elbow-joint. Now, the attack began with strong flexory contractions of the thumb, the rest of the fingers, the wrist and elbow joints; at this moment the patient lost consciousness and the convulsive spasms became general. Throughout the entire five years, during which time the patient was afflicted with the malady, the attacks always commenced in the same manner and the spasms followed in the same rotation. The operation disclosed no visible pathologic conditions of the brain.

In the other case, which concerned a farmer, thirty-eight years old, in whom the trouble dated back to the sixth year of his life, when he sustained a violent fall against the right side of his head, and who was also free from hereditary encumbrances, the first symptoms noticed were tingling sensations in the left arm, appearing for the first time at the age of eleven years and reappearing only seldom in the years following. After enrolment into military service, at the age of twenty-one, these abnormal sensations made their reappearance with greater frequency and extended at this time up to the shoulder and to the left half of the neck and head. At much more infrequent intervals, sensations of compression of the left lower limb and a feeling of tight lacing of the entire left lateral half of the body were perceived by the patient. These sensory phenomena were of a transitory nature, however, and lasted a few seconds only. After slight exertion or slight exposure to cold, they would appear in the arm alone, on the average of about two or three times in a

week. Stronger seizures, involving also the head and leg, would ensue after more violent exertion or longer exposure to cold—consequently less frequently—say about two or three times every three months. All of these sensory manifestations were unaccompanied by spasms. The patient could, therefore, attend to his military duties without material inconvenience. At the age of twenty-nine, a period of eight years, following a severe exposure and strain at hunting, the first severe attack appeared. This attack was not preceded by any premonitory symptoms; the patient lost his senses at once and bit his tongue. Prodromal symptoms of a very severe grade always preceded the subsequent attacks, followed by spasmodic contractions of the left arm; the seizure finally culminated in unconsciousness, lasting from a few minutes to a quarter of an hour. More infrequently, the patient would lose his senses and collapse after a very brief premonitory stage of sensory symptoms. It was impossible to ascertain any particular cause for the seizures. There remained —after the patient regained his senses—a marked weakness of the left arm, which lasted at times for a number of hours. The most careful examinations and observations of the patient did not give us the slightest clew for the detection of an organic basis for the disease. The operation, however, disclosed the presence of an angioma of the right central region, very analogous to the one depicted in Vol. I, Plate VIII.

I shall detail a further observation in the chapter on *Neoplasms as an Etiologic Factor* (page 326).

## Etiology of Jacksonian Epilepsy

In one series of cases, *Jacksonian* epilepsy is caused by intoxications, such as lead-poisoning, alcoholism, uræmia, or diabetes; in others it results from infections, pneumonia, or meningitis. The forms of the first group as well as those of the second, in the acute stages, belong just as little into the domain of surgery, as belong those cases which develop on a basis of cardiac or renal disease, or arteriosclerosis, progressive paralysis, multiple sclerosis or hysteria. For the sake of completeness, I must mention here those cases of epilepsy of the *Jacksonian* type, which are produced in a reflex manner. Of these, I shall

speak in a subsequent chapter. They concern the surgeon inasmuch as they are produced principally by scars.

I think it practical, in view of my observations—based mainly on personal experiences—to divide the cases into three distinct classes, basing the classification on the pathologico-anatomic changes found at the time of operation. In the first group come those cases characterized by tumor formation in the motor area—irritating the same; the second class embraces cases directly connected with infantile cerebral palsies; while the third group calls for all those instances in which the field of operation —the central area—discloses no pathologic conditions at all. Stating this, it must be emphasized that in these cases no epileptogenic zones existed, that is, epileptic attacks could not be induced by pressure on the skull or any other part of the body. Places on the skull, from which a sensory aura emanated, could not be located. Further examination showed, that in our cases, at least—disorders of the ears, nose, gastro-intestinal tract, etc., bore absolutely no relation whatever to the production of reflex epilepsy. A history of trauma of sufficient magnitude—worth to be taken into consideration—was not obtained, and scars or painful spots as a result of trauma were equally wanting —hence our reports on the findings of the skull were marked normal.

## Neoplasms as a Cause of Jacksonian Epilepsy

In the chapter on *epilepsy*, only those cases should be taken into consideration in which *Jacksonian* seizures form the only symptom, and which symptom remains so until the exact state of affairs is disclosed by an operation. I have actually seen cases in which an absolute and lasting absence of any symptoms whatsoever, pointing to a tumor of the brain, existed, in which large and solid tumors were found at the time of operation. *Jacksonian* spasms mark by far most frequently the onset of the disease, and remain in the foreground of the clinical picture, no matter how intense and numerous the other symptoms may be.

Especially, there were no other symptoms present outside of the *Jacksonian* spasms, in cases of angiomata of the motor area. The conditions resulting from the extension of such tumors in

the cortex cerebri will, of course, be self-evident. The following case clearly illustrates the point in view.

## OBSERVATION I, 4.

*Jacksonian Epilepsy. Angioma of the Central Region. Operation. Cure.*

The patient (E. N.), a boy, eighteen years old, was afflicted, at the age of one year (1891), with a febrile disorder, which, according to the statement of his physician, was in all probability a meningitis. He made a complete recovery from this disease, with the exception that there remained a weakness of the entire right half of his body, which caused him to become a "lefter." In the further course of his disease, the right arm and leg became distinctly atrophied.

At the age of thirteen (March 6, 1904), while at play, he suddenly perceived a tingling sensation in the right hand and he became nauseated. He could still carry himself to the water-sink where he vomited and then fell unconscious. The vomiting was repeated until the same evening. On the third day, right-sided spasms appeared, involving, in an atonic paralysis, the arm on the ninth, and the leg on the eleventh day, respectively. It was with great difficulty that the patient could be aroused from his unconscious state, prior to the seventh day. The head was turned to the right; the eye-bulbs followed in the same direction. The patient was perfectly clear of mind on the ninth day again.

The temperature ranged between 36.4° and 37° until the fifth day. An elevation to 38° took place only once—on the sixth day of the disease. After this, he remained normal, and the pulse-beat remained somewhere between 54 and 68 per minute. After getting over this illness, the boy remained weak but otherwise well. The right-sided paralysis receded in the main.

In 1905 (one year later), the first typical attack of right-sided *Jacksonian* epilepsy made its appearance, repeating itself six weeks later. It commenced in the right arm, affecting then the right lower limb and leaving behind post-epileptic paralyses

which lasted a number of days. Gradually, the attacks became more frequent, appearing in the lighter forms every day and in the severer ones every fourth day. The aura consisted of a sensation of heat (a "blood wave," as the patient expressed it), perceived only on the right side of the body. Lately his memory suffered markedly, and temporal headaches tortured him day and night, almost constantly.

In the years following, physicians repeatedly observed the seizures. The weak and clumsy right arm remained at this time totally paralytic for fully half an hour; the lower limb suffered, in the meantime, to a lesser degree. The more severe the attacks, the more marked was the paralytic asthenia in the arm and leg following them. I have also observed the right lower facial region to participate in the paresis.

During my examination of the patient, on June 22, 1909, the left motor region was found to be sensitive on percussion. The sensitiveness was most marked over a point corresponding to the position of the centre of the arm, viz., a small space overlying the upper portion of the anterior central convolution. X-ray examinations proved negative. The right-sided hemiparesis affected the right arm almost to a hemiplegia. The same limb remained behind in development and looked cyanotic. Arm and lower limb showed spasms and exaggerated reflexes. Astereognosis of the right hand was the only sensory symptom present. The psychic condition and intelligence have also suffered to no small extent.

The patient underwent two operations at my hands: June 25 and July 5, 1909, respectively. The dura was found relaxed, the brain visibly pulsating. Underneath the dura a suggestion of the existence of varicosities was offered by the appearance of bluish-colored elevations, which were mainly marked about the middle of the field of operation.

During the second operation, while forming the dural flap, the first incision brought forth a gush of bright red blood which was controlled by digital pressure. The reflected dural flap brought to view a convoluted mass made up of intimately interwoven large and small bloodvessels, filling out the entire opening (75 mm. wide, 90 mm. high), made by the trephine. The conditions found here resembled those described in Vol. I,

Plate VIII, in an extraordinary manner. Starting at one end, the main branches of the angioma were now transfixed with fully curved needles, in rotation doubly ligated with linen, and cut. At four points, where the needle entered, arterial hemorrhage was so profuse that prolonged digital pressure had to be resorted to for its arrest. At the points of these bleedings, four strips of gauze were left, the ends of which were brought to the surface at the angles of the wound. They were left to remain *in situ* for a few days. The osteoplastic flap was then sutured in position as usual.

Wound healing was uneventful. Following the operation, complete paralysis of the right side set in; the lower limb, however, regained shortly thereafter its usefulness, to such an extent that at the time of discharge of the patient from my care (July 29, 1909) he could walk unsupported.

No attacks appeared since the operation (about the time of completion of this work, the end of 1910), nor did headaches of any sort recur again. The psychic condition of the patient has substantially improved and his general health is excellent. The trepanation flap has thoroughly united with the surrounding tissues and it does not bulge on coughing or on application of pressure; nor is there valve formation. The right lower branch of the facial remained somewhat paretic.

The right arm—inclusive of the fingers and hand—which was, prior to the operation, spastically paretic, has markedly improved; patient can raise it to a perpendicular position with out effort. The thumb can actively be flexed and extended, the latter with some effort. The other fingers are only of little use. There is only slight participation of the leg in the paresis; he can use his limb well. The sensation of "heart-welling," mentioned above, reappeared only once, while the patient was asleep in bed a few months ago; this he ascribes to sleeping on the left side, which he could never accomplish.

The case here described must be looked upon as one of genuine *Jacksonian* epilepsy, developing on a basis of infantile cerebral paralysis. We base our diagnosis on the findings, the result of our examinations and observations of this patient, and the data furnished us by his attending physician. Our assump-

tion is further strengthened by the long period—many years—that has intervened between the original disease, meningitis, and the occurrence of the first spasmodic attack. There was not a single symptom pointing to the presence or to the development of a tumor; for, headaches were not infrequently observed by me to be present in cases of infantile cerebral paralysis. This observation indicates with greater certainty than any amount of theoretical discussion may offer, the imperative necessity of attacking cases of *Jacksonian* epilepsy surgically, after a thorough but not too extended a trial with internal medication has proved inefficient.

It is especially noteworthy, that tumors of the central region may give rise to purely sensory manifestations of *Jacksonian* character, and that the sensory symptoms may be the only evidence of the existence of a neoplasm of even large size, until the discovery is made on the operating table. To illustrate this very interesting but not at all frequent fact, I shall cite the following case.

## OBSERVATION I, 5

*Jacksonian Epilepsy of Predominatingly Sensory Type. Fibro-Sarcoma of the Central Region. Extirpation. Cure.*

C. K., forty-one years old, manufacturer, sustained a gun-shot wound at the age of fifteen and a half years; the bullet penetrated the upper part of the abdomen, entering into the left half of the thorax, causing pleurisy with effusion which was cured by resection of ribs. The bullet remained in his body without causing any symptoms whatsoever; so much so, that he could do duty in the field artillery, going through eight manœuvres, without the slightest inconvenience. At the age of thirty-nine, while he was asleep in bed, he was suddenly surprised by an attack of spasmodic twitchings which were accompanied by rattling in his throat. He bit his tongue to bleeding. On awakening, he perceived a strange sense of suffocation, without being able to move or speak. His hearing remained unaffected, and while being examined, he followed every detail of the examination minutely. Half an hour later, he was mentally and physically well again. A little over a year

prior to this attack, he accidentally struck his right temple forcibly against the edge of a brick wall. While he was obliged to sit down at the time, he did not lose his senses, however.

Four weeks after the first seizure, another similar attack occurred, also during sleep; this time, however, the patient was awakened at the onset of the attack by twitchings of the tongue, angle of the mouth and lower jaw. Immediately following this, a strong downward traction of the lower jaw was perceived by him, accompanied by loud cardiac palpitation, a morbid contortion of the left arm in strong pronation and jerky movements of the left pectoral muscles. During all this time, the patient was markedly excited, after which his consciousness vanished. Ten minutes later, the attack was at an end. Recuperation in the fullest sense of the term ensued after the patient had been refreshed by sleep on the day of the attack.

On account of the continuous recurrence of the seizures, a diagnosis of epilepsy was made, basing the same etiologically on the bullet which was supposed to have remained. This was proven by the X-ray, two months later (September 30, 1909), to be correct. Its removal was effected by resection of ribs. It was found imbedded in a mass of adhesions in the pleura below the left axilla. In the meantime, the benefit of general medication and bromide preparations were given to the patient. Another attack made its appearance eight days after the operation just described, which ran its course differently from the others, and did not lead to unconsciousness; in the main, it consisted of a twitching of the tongue, accompanied by quivering of the left angle of the mouth. There was general excitement and violent palpitation of the heart. With one single exception (January 16, 1909, with tongue-bite and unconsciousness) the type of all subsequent attacks was as follows: they began with a dryness of the mouth and abnormal sensations (a feeling of vibration, sleepiness, numbness, or rigidity) of the left side of the mouth, upper lip, nostrils, and the tongue. Less frequently, visible vibrations of the left half of the tongue and angle of the mouth were observed. While the attack lasted the patient was able to actively move the parts named; then a sense of numbness of the left fingers set in, that began in the thumb that then spread, in a few seconds, to the index, third, fourth, and fifth fingers; thence

to the inner aspect of the palm of the left hand, finally ceasing at the wrist or travelling along the forearm. At times it attacked the arm, finally ending in the lateral region of the neck.

The seizures would occur two or three times a month—occasionally even that many times a day—and lasted from five to ten minutes by the clock. The patient knew that the course of his seizures were slow—hence, whenever he perceived the "critical sensations," he withdrew from company into a quiet place, where he assumed a reclining position, prepared to await the eventual attack. Sometimes palpitation of the heart and pains in the left chest were felt by him. In the last few months, the tingling sensations spread, singularly, to the left shoulder, the jaw, skin of the head and the auricle of the same side.

The patient was referred to me for operation by *Professor Hoffman*, of Heidelberg. Except the attacks described, there existed a very slight paralysis of the left facial region, especially in its lower division, which was coupled with a very slight weakness of the masticatory muscles on the left side. Otherwise the findings—including those of the eyes—were negative. My colleague, *Hoffman*, writes me that the lasting pareses speak against genuine epilepsy. He further says: "With reference to an anatomic etiologic factor, nothing certain can be said. Just in how much the violent blow was responsible for the affection is hard to ascertain. The indication for operative intervention, however, is well established. I am advising against *Neisserian* puncture, on account of the middle meningeal."

My examination corroborated the slight objective findings; I was even unable to find the participation of the masticatory muscles in the paresis. On the contrary, I observed a distinct deviation of the tongue to the left.

A slowly developing pathologic process in the lower division of the right central convolution was presumed. Whether we were dealing here with a tumor formation or other neoplastic conditions such as cysts, etc.—or perhaps with chronic inflammatory changes, resulting from the trauma, sustained in March of 1907—we were unable to decide. Conjoined examination of the patient with *Hermann Oppenheim*, January 18, 1910, elicited,

besides the slight facial paralysis, the presence of the *Babinski* sign in the right foot and an absence of the right abdominal reflex.

The operation was performed in two stages: January 20th and 31st, respectively. Reflection of the dura at the second operation at once brought to view a yellowish-red tumor (mi-

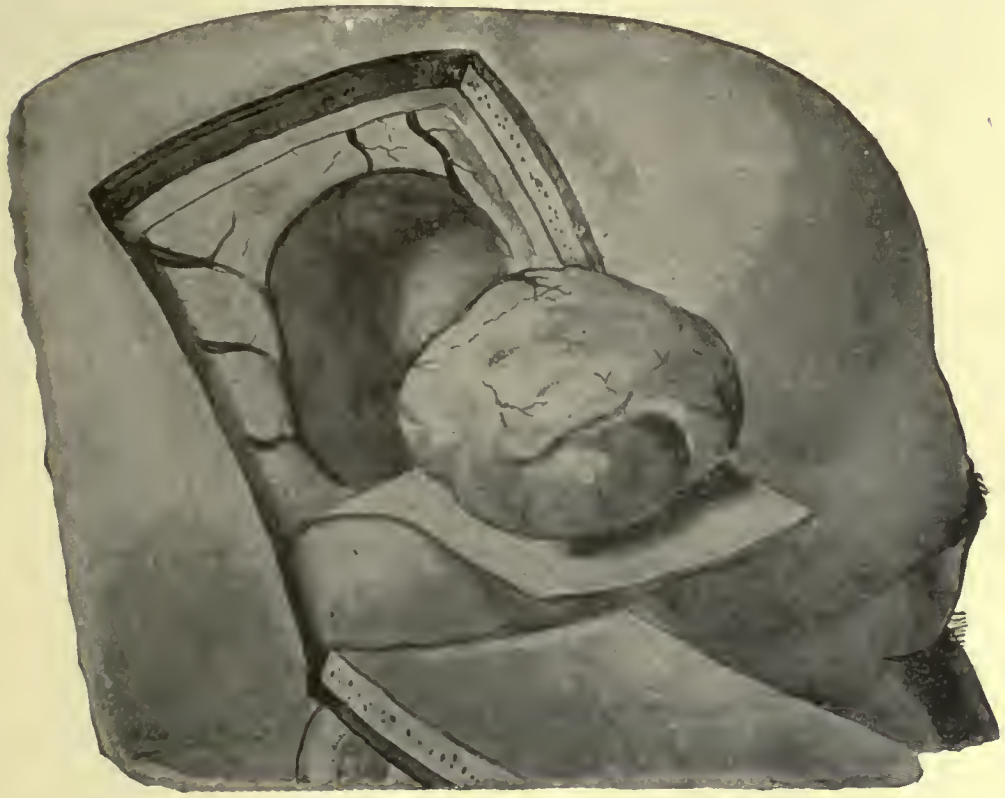

Fig. 78

croscopically shown to be a fibro-sarcoma), which was broadly united with the surface of the dura, that evidently originated from it or from the arachnoid. Color and consistency differentiated distinctly the smooth, slightly gibbous surface of the tumor from that of the surrounding brain. After careful elevation of the neoplasm and its adherent dura, it was possible, without difficulty, to detach it from the brain substance with the closed scissors.

Isolated bloodvessels stretched close to the brain-trough in three different places; they were ligated with catgut close to the brain substance and then divided peripherally to the ligature (tumorward). The vessel ends still attached to the tumor squirted every time, that signified that an adequate blood-supply was still furnished to the tumor from the base of the as yet undivided dura. Proceeding in the manner described, we were successful in entirely lifting the neoplasm from its bed, so that it now hung on the base of the dura flap only, the division of which completed the extirpation.

A cavity the size of a small apple remained in the tumor-bed, that was now subjected to a most thorough and minute examination for tumor-rests; because, just in such cases, remnants of tumor tissue may penetrate into the brain substance, as we had occasion to observe in numerous instances. The bed was found perfectly free and the surface of the tumor presented a smooth appearance without the slightest breaches of continuity. Numerous transfixions of vessels and the application of two additional ligatures at the borders of the incised dura, completely arrested the hemorrhage still present. The cavity in the brain substance proper straightened itself only partially, a space the size of half of a *Borsdorf* apple still remaining. Regardless of that, however, the osteoplastic flap was sutured into position, entirely dispensing with any form of tampon or drain.

The post-operative history shows no untoward events. Three weeks after the operation the patient left his bed, and five days subsequently he returned to his home. Besides the already existing slight paresis of the territory of distribution of the facialis, no other disturbances of innervation occurred. The stereognostic condition of the left hand still persisted, to a very slight grade only. Fourteen days after the operation, the facial paresis could no longer be demonstrated, the same being also true of the stereognostic sense of the left hand. A complete cure has therefore been accomplished. On March 10th we find our patient back again at his avocation as manufacturer, attending to his usual duties as heretofore. A physical examination of his person made by me, June 10th, thoroughly convinced me of his complete restoration to health. On October 10th (about the time this work went to press) his health remains excellent, despite a severe

attack of influenza from which the patient was suffering in the beginning of July.

## Infantile Cerebral Paralysis as a Cause of Jacksonian Epilepsy

In this category of *Jacksonian* epilepsy, those patients predominate in number who, in addition to having suffered from cerebral infantile paralysis, became epileptics. This malady develops on a basis of an encephalitis or a meningo-encephalitis. In cases of acute encephalitis, damaging conditions ensue, which are mainly, if not always, of an infectious character; perniciously affecting, at first and in the main, large portions of brain-tissue. The similarity of this condition with acute anterior poliomyelitis (spinal paralysis of children) is striking (*v. Strümpell*). In the latter cases, we frequently find extensive portions of the body become sympathetically affected, while the patient is suffering from what appears to be (symptomatically) an acute infectious disease. Following this, restitution to normal of active movements of many muscle-groups sets in. Those parts, the large ganglion cells of the anterior horns of which were destroyed, remain permanently paralyzed. Cerebral as well as spinal paralysis may be observed in the same individual at different times. In the case of a boy six years of age, who was referred to me for operation on account of a *Jacksonian* epilepsy, a spinal paralysis developed at the age of one year and three months, the remaining pareses of which improved and finally disappeared under a course of baths and massage, administered to him by his attending physician. At the age of five years, the same child became suddenly ill again, this time with all symptoms of an encephalitis (fever, unconsciousness, clonic spasms). Following the acute stage, that lasted three weeks, there remained a left-sided hemiplegia, with participation of the facialis and *Jacksonian* spasms.

### Pathogenesis of Jacksonian Epilepsy

The symptoms accompanying an acute encephalitis are: general spasms, unconsciousness, and high temperature. Even in the first stage of the disease, only a circumscribed portion of

brain may be affected. If the central convolutions and their fibre tracts be the ones implicated in the morbid process, we will find the spasms predominating or entirely limited to one—the opposite side of the body. A characteristic example of what has just been said is furnished by the following observation.

## OBSERVATION I, 6

*Acute Encephalitis. Jacksonian Epilepsy. Healing of the Wound, but no Result.*

A boy, eight years old, hereditarily free, and up to this time perfectly well, took suddenly ill with high fever, vomiting, and general bodily spasms, that were accompanied by unconsciousness and frothing at the mouth. There was no cyanosis, however. This condition lasted for two days, after which the fever subsided and the vomiting and spasms ceased. Eight days later, a generalized spastic condition occurred again. From this time on, twitchings of the hand—principally of the fingers—that would rarely also appear in the foot, were observed by the mother of the patient. The contractions have not completely disappeared since that time. There were days, to be sure, when they would leave for a number of hours, but in the main they were constant. During all this, consciousness was always retained. Two months later, the mother observed—while the boy was asleep at night—that he was continually groaning, while so doing, spasmodic flexions of the right arm at the elbow-joint would occur; the same limb executed at the same time short blows; and the fingers and hand remained spasmodically turned inward. The spasms and groaning would disappear a few minutes later. After a few weeks, the seizures occurred also in the daytime. Occasionally, the right leg would also participate by carrying out short flexory movements. The mother of the patient has never seen spasmodic motions in the face.

One-half year subsequent to the onset of the disease the patient was admitted to the hospital. The boy was physically weak but mentally mature and always kept his right hand against his chest; the arm being flexed at the elbow-joint. He

carefully watched his right lower limb while walking, rotated it inward, and stepped in pes equinus fashion. While he was reclining in bed, the short tremors of the extended thumb and fingers were striking; the right limb lay meanwhile quiet. He could move voluntarily all fingers of the right hand at their articulations; this was accompanied by fine tremors. The flexors of the right arm and leg were tense and the reflexes were exaggerated. The *Babinski* and *Oppenheim* signs were absent. Disturbances of a sensory nature could not be detected. The stereognostic sense was retained in the spasmodically contracted fingers. The coarse power was much stronger on the left than on the right side; the same was true of the upper as well as of the lower extremities. Electrical examination with the constant current disclosed quite a distinct reduction of the electric irritability of the musculature of the right lower extremity. The reaction of degeneration was nowhere demonstrable.

The spasms were observed to commence with traction of the biceps of the right arm, followed by flexion at the elbow-joint, pronation of the forearm and flexion of the hand and fingers. Quite synchronously with these movements, the right lower limb executed short jerky contractions with its flexors. The facialis did not share in the spasms. Short, non-articulated cries were uttered by the boy during the spasmodic contractions. He retained consciousness in these, as well as in all other previous attacks. He was able to relate all incidents referring to the seizures from start to finish.

Judging by the mode of origin of the disease, we were in all probability dealing here with a meningoencephalitic focus, that had its location in the left anterior central convolution. A tuft of white hairs over the left central region bore evidence of an underlying disturbed state of nutrition.

At the operation, the dura appeared somewhat thicker than usual. After its opening, the scarification of the arachnoid permitted the escape of a large quantity of liquor. Bluish-white streaks traversed the pia, that accompanied the veins in some places; in others they appeared as scars within its substance. A cicatrix of this nature, measuring approximately 2 cm. in length and $\frac{1}{2}$ cm. in width, was found at the upper anterior angle of the trephined space. It ran close to the sinus longitudinalis, ex-

tending to the anterior central convolution in close proximity to the falx cerebri. Isolated, yellowish-looking, and necrotic streaks traversed this scar, contrasting with its bluish-white color. The wound following the excision of the cicatrix healed per primam intentionem. No marked influence over the spasms was noted in the course of the past year.

The pathogenesis of *Jacksonian* epilepsy is here laid before us, to a certain extent. The persistent weak muscular contractions of clonic character in the right hand, and the occasional accompaniment of similar states in the right lower extremity, clearly indicate an irritation of the respective portions of the left anterior central convolution. If such irritations of the parts indicated be of short duration, that is to say, where they occur from time to time, and if they increase in intensity and extent, typical *Jacksonian* seizures will necessarily result. Should the original irritation extend to contiguous parts, more and more muscle-groups will become involved in the tonic or clonic spasms, as the case may be, so that the spasming zone may embrace all the centres of one lateral half of the body; or, the other side may also become similarly involved and the spasms may then become general. The greater the extent of involvement of cortical tissue, the greater the liability to loss of consciousness. Suspension of consciousness signifies exhaustion of the cortical centres; the same explanation holds true of the pareses and paralyses following in the muscles principally affected.

The nature of the irritation remains in many instances obscure. It may depend upon the finest possible molecular changes within the ganglion cells which will forever remain inaccessible to observation. That we are bound to renounce hope of ever making these changes known is practically certain; for it would be folly on our part to expect to see the necessarily postulated changes occurring within the nerve-cells while we are thinking or acting, or to recognize such changes during the reception of impressions or exercise of movements. In such cases of *Jacksonian* epilepsy, the exposed cerebral surface appears normal. At other times again, visible changes, such as arachnoid conditions, scars, and cyst formations are found. Of these, however, more will be said later.

In pathologic instances, such as previously mentioned, the cause of the spasms may be conjectured only. To the exact solution of the problem involved a new factor, as yet unknown to us, will have to be added, because those changes are known to exist in persons entirely free from epileptic seizures, in any form, not even the slightest muscular twitchings. An irritating factor exercising its deleterious effects upon the cerebral cortex is essential in the production of epilepsy. Such irritation we must presume to exist in all patients in whom epilepsy is known to have developed, in connection with infantile cerebral paralysis. We are consequently still in the dark with reference to those particular unknown changes, and we are compelled to speak of a "disposition" or "predisposition" in these instances. Furthermore, we know, that epilepsy that is characterized by a great frequency of the attacks is, excepting the status epilepticus, frequently interrupted by periods of rest, of shorter or longer duration. We are, therefore, obliged to assume the existence of a certain combination of stimuli—a certain cumulation of pernicious factors, if you please—that precipitate an attack.

There are many cases which leave no room for doubt that the epilepsy is the direct result of the infantile cerebral paralysis, or that it, at all events, developed on a basis of predisposition on the part of the afflicted.

Now, to return once more to the first stage; we find that acute encephalitis first produces a paralysis of one limb or a hemiplegia, with, or without involvement of the facialis, or even more extensive disturbances. In connection with the paralysis of the extremities, I have known strabismus to develop. In the further course of the disease certain parts recover, and finally there may remain a paralysis of one upper or lower limb, or, perhaps, only a part of one extremity may suffer. Children, as a rule, recover quite rapidly from the severe acute disease, and months or even years may elapse—in one of my cases sixteen years had passed—before spasms occur in the paretic parts. Disturbances of speech are observed in left-sided involvement of the brain. In children the power of speech already developed may be totally lost. I have observed disturbances of articulation and word construction to mark the beginning of the attacks—in the later stages of the disease—in quite a number of cases; this

soon culminated in complete paralysis of the power of speech that persisted for quite a while, after the spasmodic attack had passed.

It sometimes happens that encephalitis recurs after years of absence, or that first one and then the other hemisphere becomes affected. I have seen such a case, once. The patient in this instance was observed by a number of very competent men—(he resided in a city which was the seat of a university).

## OBSERVATION I, 7

*Recurrent, Bilateral Encephalitis, Jacksonian Epilepsy. Cure of the Wound. Observation not as yet Completed.*

A boy, thirteen years of age, became ill with a right-sided acute encephalitis at the age of a year and a half. There existed forced movements of the right upper and lower extremities, day and night. The acute stage lasted five days, after which the fever gradually receded and the forced movements ceased. The remaining paresis of the left extremities gradually disappeared, under the influence of electrotherapy, insistently administered for a period of two years. During that time the child went through attacks of measles, whooping-cough, influenza, and acute enteritis. Immediately following the enteritis —at the age of three and a half years—another attack of acute encephalitis set in, also on the right side. Fever and forced movements were identically the same as in the first attack. The temperature lasted only five hours this time; venesection caused it to disappear.

Following this attack of encephalitis, the boy developed a lasting contracture of the left hand (claw-hand). The left lower extremity remained in a pes equinus condition. Constant exercise brought about a condition of improvement sufficient to enable him to grasp objects with the left hand. Persistent use of his left lower limb, finally permitted him to make use of his tricycle, and although he was slightly limping he nevertheless joined mountain-climbing parties. At that time the mental state of the patient was unaffected and sharp; he was attending school successfully. Attacks of loss of consciousness, accompanied by mus-

cular twitchings and forced movements of the left extremities, made their appearance at seven years of age. As time passed on, the attacks became more intense and were of longer duration; they finally lasted five hours at a stretch. They were preceded by an aura of brief duration. During these attacks, there existed complete loss of consciousness; their occurrence was subject to great variation at times—they would appear daily and then again perhaps not recur for weeks. While the psychic state recuperated quite rapidly, there remained an apparent languor at study. The left lower limb remained behind in development.

Just about the time when the parents of the boy had decided to have him operated on, for the left-sided *Jacksonian* epilepsy (he was at that time ten and a half years of age), another attack of acute encephalitis set in, this time, however, on the left side. The high temperature (40.5°) fell after three days. The pyrexia receded by lysis and was accompanied by an improvement of the clonic-tonic spasms of the right extremities. Besides a certain dulness and mental apathy, there remained after the last seizures, severe pareses and spastic conditions in the right arm as well as pes equinus in the lower extremity of the same side.

There was a gradual improvement in the general conditions of the right side, to a slight extent only; there still remains, however, since the last attack of encephalitis, an inability to walk. In time the boy has learned to stand.

At the time when the boy came to me for operation he was thirteen years old. The seizures at this time were ushered in with rotation of the head and eyeballs toward the right, followed by clonic and tonic spasms of the left extremities. The spasms soon spread to the right side of the body, being preceded this time by rotation of the head and eyes to the left. The conditions found at the operation—July 21, 1910—were very unfavorable. The exposed right central region and the hemisphere of the same side—easily accessible to inspection—were markedly injected. There was a general atrophy of the brain substance, shown by a great many marked trough-shaped impressions and concavities. Local and focal pathologic conditions amenable to surgical treatment were entirely wanting. The cortex was

extraordinarily sensitive to faradic irritation; every application of the weakest current resulted in flexion of the left hand and fingers, immediately followed by a general spasming seizure, that could be subdued only after putting the patient more profoundly under the influence of chloroform; 22 cm. of a clear yellow fluid were obtained from puncture of the lateral ventricle. While excising the "primary spasming" centre a severe general spasm resulted, evidently brought about by the mechanical irritation. Wound healing was perfect. Nothing can as yet be said with reference to the further course of the disease.

The following **etiologic factors** for the encephalitis or meningo-encephalitis must be mentioned, basing the same on my personal experiences: Scarlet-diphtheria, whooping-cough, dysentery, influenza, pneumonia, vaccination, erysipelas, and insolation. Finally, cerebral paralyses may result from trauma to the brain inflicted during parturition. Of the last-mentioned form, I shall speak in a subsequent chapter, on account of its correlation to trauma. (Compare p. 367.)

Lues may also give rise to *Jacksonian* epilepsy. Generally speaking, however, we find that the exhibition of mercury and the iodides in cases of unilateral spasms on a syphilitic basis will cause them to vanish and the accompanying paralyses to disappear. Trephining was only considered once, on account of the great frequency of the attacks and the threatening involvement of the respiratory centre. I have, nevertheless, consented to operate on a case of congenital lues, at the requests of the physicians. In this case the boy was fifteen years old and showed evidences of syphilis in the form of *Hutchinson* teeth and a retinitis pigmentosa. The disturbances made their appearance when the boy was two years old. In spite of vigorous treatment with mercury, the iodides and pilocarpine, general spasms supervened at the age of three years. The spasms repeated themselves for weeks, and the institution of a new course of mercurial treatment has caused them to lose their character—becoming now distinctly *Jacksonian* in type.

Since that time on, the attacks began with tetanic spasms in the right arm. In spite of the administration of bromides they became more frequent, and the speech as well as the intelligence

became gradually sympathetically involved. A distinct atrophy of the right extremities developed at the age of six and a half years, and the picture of a clear cut hemiparesis resulted. The part affected mostly was the right arm. There existed at the same time diminished sensibility. The reflexes were exaggerated. The attacks always began in the right arm; at times they would be limited to that side, at others the opposite side would also become involved, while at still other times they would become general and end in unconsciousness. Operative interference seems in this case justified, because thorough treatment with antiepileptic remedies proved entirely ineffectual, and because the intellect became more and more affected. This condition, which has lasted now for many years, has in similarity very much in common with epilepsy developing on a basis of infantile cerebral paralysis.

The coincidental occurrence of new infectious diseases may evoke *Jacksonian* attacks, after the paralysis or weakness of certain parts has become stationary; even after the lapse of many years. I remember a case of cerebral paralysis occurring in a girl three years old, after an attack of whooping-cough. Sixteen years later the girl contracted influenza, during which the first *Jacksonian* spasms developed in the paretic parts, soon terminating in general convulsions.

Unilaterally developing epilepsy does not necessarily always mean a uniform and augmented progressive state of affairs; that is, there may occur improvement or cessation of the existing conditions; then, again, marked aggravation may be noted. After an interval of rest, lasting months perhaps, during which time the patient considers himself—and apparently is—perfectly well, an unanticipated severe seizure soon shatters all hopes.

Not infrequently the patients show great irritability of temper, becoming furious at times, or the psychic deviations manifest themselves by tendencies to weep without provocation, exaggerated affection, or other abnormal states of the mind. In the further course of the disease the psychic development suffers; even idiots not infrequently develop from patients afflicted with these forms of epilepsy.

### Anatomic Changes

The exposed arachnoid quite frequently displays *extensive œdema*, which may be so marked that the appearance of the fissures and convolutions become entirely obliterated. Scarification and pressure with gauze sponges, however, may bring the vessels, sulci, and convolutions into a distinct state of recognizability again. In places the arachnoid shows *connective tissue and cicatricial thickenings.* There are numerous grayish-white strands, mainly along the course of the vessels, interspersed with nuclear plaques (compare Vol. I, Plate II). In one instance, a fairly large, flat, and yellowish-looking focus was found. Microscopic examination shows all these infiltrations to consist of old connective tissue and cicatricial changes of the arachnoid and pia.

Although previously stated, I wish to reiterate once more, that faradic irritation can only be effectually executed when the existing œdema has been eliminated by scarifications; otherwise strong currents will be required, the employment of which will give results utterly useless for our purpose, or perhaps give no results at all.

In the case of a girl, twelve years of age, who six years prior to the present writing was attacked by a transitory left-sided paralysis accompanied by general spasms and unconsciousness, there developed *Jacksonian* spasms, during a severe illness of scarlet-diphtheria, said spasms beginning in the left lower extremity. Upon exposing the right central region, four years later, I found in its upper division, immediately contiguous to the sinus longitudinalis, three, pea to bean sized, yellow and necrotic-looking foci, which united the pia, arachnoid, and the inner layers of the dura into an intimately blended and inseparable mass. Yellow and purulent detritus issued from its centre during the excision. The microscopic examination (*Professor Oestreich* and *Professor H. Vogt*) shows us that we were dealing in this case with a chronic inflammatory condition with generally marked inflammatory changes in the vessel walls and infiltration of the perivascular structures with polynuclear leucocytes. Calcareous changes were found in some places.

In other cases of cortical epilepsy, following cerebral infan-

tile paralysis, extensive *cicatrices* are found on the cerebral surface, yet we are not in a position to diagnose the existence of such a condition from the symptoms solely. A thick, white and radiate scar, measuring 3 cm. in width and 4 cm. in length, was found, in the median division of the anterior central convolution, in the case of a fourteen-year-old girl, in whom the diagnosis of porencephalitis was made by a neurologist. Trephining disclosed a normal looking dura. The scar undoubtedly corresponded to the position of the arm centre, in the anterior central convolution, because, exactly in front and immediately below it, the position of the lower facial was determined by faradic irritation.

Softening of the brain tissue in more or less circumscribed areas may be the sequence of encephalitis, or single or multiple cyst formations may result—as I have had occasion to observe in a number of instances while operating. The cortex may also be involved in atrophic and sclerotic changes to a greater or lesser extent.

*Cysts* may be seated in the arachnoid, in which case they are firmly attached to the inner surface of the dura; their removal should be preceded by opening and evacuating them. If such a cyst be found in a position corresponding to what has faradically been established to be the "primary spasming area," no doubt need be entertained as to its ability to evoke spasms. I have encountered a number of such instances. The arachnoid is usually found œdematous in the immediate vicinity of these cysts. The brain substance proper, or the subcortical medullary layer, may harbor such cysts. I shall cite instances of both varieties later on.

Concerning *scleroses*, in particular, I have repeatedly found that in these cases the brain substance is uncommonly hard to the touch, which made itself manifest during the introduction of the puncture-cannula into the lateral ventricle, and during the insertion of needles for the ligation of vessels; I have also felt this hardness while excising the respective cortical portion. This explains the necessity of unusually strong currents to obtain muscular contractions—if such contractions be obtained at all. In some instances my efforts to get results from the application of very strong uni- or bipolar faradizations were

absolutely fruitless. In another case—that of a boy ten years of age—in whom all these abnormal conditions were found to exist, the use of very strong faradic irritation was followed by positive results. The microscopic examination (*Professor Heinrich Vogt*) revealed the following conditions:

"A diffuse transformation, which is mainly demonstrable in the cortex, extends to the upper layers of the medullary part. Grossly, we are dealing with a pathologic condition of the vessels of small and smallest calibre, showing collectively the following vessel-wall changes. All endothelia, as well as the endothelium lining the fine capillary loops, are increased in numbers. The cells are individually enlarged, showing, in longitudinal section of the vessels, large protoplasmic bodies, the distinct nuclei of which stain deeply with the anilin dyes. At times the endothelial plug proliferations are seen to encroach upon the lumen of the vessels, while in other places they form closely set rows of cells, presenting the appearance of cylindrical epithelium. The low magnifying power shows us that the vessels are markedly increased in number and that newformed capillary loops spring from them; these are lined with proliferated endothelium, which invade the neighboring tissues in the form of capillary buds. We have here, before us, a condition the main characteristic of which is vascular proliferation, involving mainly the upper layers of the cortex. The adventitia of the larger vessels shows, outside of nuclear proliferation of the exterior of the vessels in numerous places, nothing abnormal. On the other hand, places abound in which the degenerated endothelial cells are seen to be detached and cast off, as it were, in these, as well as in the larger vessels. Infiltrations of the perivascular spaces are only sparingly seen, and wherever found they are devoid of their characteristic arrangement and composition."

The cytoarchitectural arrangement of the excised cortical part proves it to belong to the anterior central convolution. The ganglion cells do not deviate from their normal mode of arrangement. The glia cells are increased in numbers, and the pathologic glia is richer in cellular elements. The changes described, extend over the entire extirpated area, and it is not improbable that this pathologic state affects the entire cortex, or at least

that it embraces more territory of the cerebral hemisphere than the mere excised cortical part. While no macroscopic evidence is offered, the vascular changes, demonstrated microscopically, may give rise, in some instances, to symptoms of irritation (spasms).

Further changes, involving a large part of the hemisphere—such as relatively small and flat convolutions (microgyrism, indicating deficient development), and a certain degree of vascular richness of the cerebral surface—were seen in operations on exposed brains, and in sections of larger sizes. Finally, exploratory punctures not infrequently disclosed an accumulation of a considerable quantity of fluid within the lateral ventricles. Ordinarily, I found no increase in the intraventricular pressure; this is shown by the comparative ease with which it is aspirated, and its failure to evacuate spontaneously. After the aspiration of 40 to 50 cm.$^3$ of fluid, a trough-shaped depression in the cortical surface made itself noticeable. In these cases the use of subcutaneous ventricular drainage with silver tubes of small calibre (compare Vol. I, p. 163 ff.) are, as a rule, ineffectual.

In isolated cases the fluid accumulation within the lateral ventricles was so marked, and the cortex consequent to the pressure thus created so thinned out (25 mm.), that while inspecting and palpating it a strong impression was gained that the thinned cortex was on the point of bursting. For the highest degree of such changes, compare Observation I, 12, p. 368.

### Focal Symptoms in Infantile Cerebral Paralysis

In cases of cerebral infantile paralysis, there result distinct focal symptoms, consequent to the relatively frequent circumscribed anatomic changes, within certain parts of the cerebral cortex. Foremost of all, are the spastic pareses and paralyses of the limbs of one side of the body. This represents the most important form of all focal diseases occurring in children, and it must, therefore, be looked upon as the most important phase of a set of conditions at present under consideration. Even though the symptoms were at the outset not so marked, and have in the course of time apparently completely vanished, close examination and observation will not infrequently reveal the

presence of certain evidences remaining from the original paralysis. For instance, a slight motor disturbance in a small, spastically paretic muscle-group, will naturally manifest itself more forcibly in the fine mechanism of the hand, than as an awkwardness of the lower limb. *Freud* and *Rie*[1] have tried to connect certain forms of lefthandedness with disturbances of innervation of such nature.

Not only the muscles of the extremities, but those innervated by the facialis and the motor branch of the trigeminus, as well as those of the eyes, must also be taken into consideration. Aphasias must also not be overlooked—principally motor aphasias and symptoms of hemianopsia. Briefly stated, we must apply all knowledge we possess of cerebral localization to practical utility, striving thereby to arrive at definite conclusions with reference to the actual seat of the trouble.

Symptoms accompanying the aura are also of distinct importance; so are also all focal symptoms occurring immediately at the onset of the seizure which we are in the habit of ascribing to exhaustion of all the areas embraced in the spasming portion of the brain. Such focal symptoms may be found in an entire series of cases, and they may occur even at times when the seizures have lost their *Jacksonian*—and have assumed the general type. Outside of motor symptoms, those of a sensory or reflex nature must also be taken into consideration.

### Operative Interventions in Infantile Cerebral Paralysis

On account of the marked changes occurring in the brain and its coverings in cases of *Jacksonian* epilepsy, in connection with infantile cerebral paralysis—and in order to avoid repetition—I shall describe the operative methods in the following paragraphs.

We should never operate in the acute stage. We must always wait and see if epilepsy develops after the encephalitis has passed and the patient has recovered from it. After that, and only after a thorough, but not too extended trial of medication directed to improve the existing conditions has failed,

[1] *Freud*, Die infantile Cerebrallähmung. "Nothnagel's Handbuch," Vol. IX, Wien, 1897. *Freud* and *Rie*, "Klinische Studie über die halbseitige Cerebrallähmung der Kinder," Wien, 1891.

should an operation be undertaken. We are not as yet in a position to tell, from the clinical symptomatology alone, whether the case is one amenable to surgical treatment; that is, whether the etiologic focal conditions (cysts or similar conditions) are removable or not. I have found such conditions repeatedly and removed them. As long as the resisting powers of the patient have not suffered, and as long as the disease has not become thoroughly enrooted, the outlook for recovery is very favorable.

The anatomic locus for the surgical intervention depends upon the conditions ascertained beforehand. The motor region, especially the anterior central convolution, will, most frequently, have to be bared to its entire extent. On the other hand, it would be wrong to look upon this area as being the only one subject to surgical exposure. If the etiologic factors be located, or certain focal symptoms point to other regions of the cerebral cortex or to the subcortical centres, the operation will naturally have to be undertaken in those localities. Be this as it may, the brain surface must be freely exposed to a considerable extent, regardless of the particular anatomic locality. Operations of this nature should be performed—in order to make them as free from risk as possible—in two sittings. At the first stage trepanation is executed with the formation of a large osteoplastic flap, followed in five to eight days—if need be, even later—by the making of a dural flap, which now permits the inspection of the cerebral surface. The performance of the operation in more than one sitting may be undertaken without fear; especially is this true in those cases of epilepsy that have lasted more than one year. In instances of the latter kind the danger of the procedure is materially minimized.

All cranio-cerebral constructions and guides do not amount to much more than approximate indicators. They may prove of practical value mainly in operations of the central area in outlining the position of the *Rolandic* and *Sylvian* fissures on the shaved skull, thereby frequently enabling us to bring at once into view, in the opening created by the trephine, the portion of the cortical surface we are aiming at. An approximate landmark is only necessary, on the surface of the skull, in locating the parts to be exposed, because a large open-

ing must always be provided for in either case, as the illustrations clearly show. Presently, I am using the construction of *Krönlein*, exclusively. I am generally pleased with it. It has always been my experience that in certain types of skulls, one may reach too far anteriorly, a fact which must be borne in mind in forming the dural flap.

Just as little as we depend upon cranio-cerebral determinations alone as landmarks for the brain surface, just as little dare we depend upon the various anatomic points of the exposed cerebral surface solely. The variety and inconsistency of the sulci and convolutions, and more so of those of the pia veins, are altogether too gross to be of real value.

The observations of *Sherrington* on the brains of anthropoids, bearing on the subject before us, have already been alluded to. *Monakow*[1] entertains the same views. He says: "It is certain that the special position of individual foci, as well as the entire extent of the irritable zone, stand in no relation to the sulci whatsoever. To outline the motor area, taking the position and course of the sulci as an index, is a method entirely too crude and unreliable." Moreover, we must not forget the great individual variations. To locate a given centre, the faradic current, and it alone, is the method of reliance at our command. We cannot expect to obtain satisfactory results in these cases, without availing ourselves of the use of this important method in focal localizations. It is fortunately very rare, indeed, when this valuable aid forsakes us.

The advise of surgical interference in a given case is a proper one, if the changes anticipated or found are of such nature that we find in them an explanation for the existing complexus of symptoms; because with the removal of the cause we hope to do away with the effects.

Yet, conditions that are recognizable with great ease, are unfortunately not of frequent occurrence; at times, again, the diseased conditions found are of a comparatively insignificant nature; in some of our cases the entire trouble consisted of a circumscribed leptomeningitis. In investigating such cases we

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[1] *C. v. Monakow*, Über den gegenwärtigen Stand der Frage nach der Lokalisation im Grosshirn. "Ergebnisse der Physiologie," 1 Jahrg., Wiesbaden, 1902, p. 617.

must above all be systematic; we must proceed from the "primary spasming" centre, probing our way down into what may prove to be a subcortical process (of the existence of which we had no inkling), and if need be we may resort to incision. In cases which contain no cysts, but, instead, an increased fluid accumulation within the lateral ventricle, we must ever remember that there are cases of hydrocephalus which do not betray their existence by increased size of the patient's head and frequently coexist with epileptic attacks. In these cases the method of *Anton v. Bramann,* of puncture of the corpus callosum, or if the intraventricular pressure be marked, my method of subcutaneous permanent drainage with gilded silver tubes of small calibre, may be used to advantage.

In the first place we have to consider the excisions of the primary "spasming centres" of those cases of *Jacksonian* epilepsy, in which no anatomic basis is found. With reference to this, compare chapter on this subject, p. 388. In other instances again I have excised centres, in which a number of anatomically changed areas, situated quite distantly from the "primary spasming" centres, were also removed. In the following observations—well serving for purposes of illustration—we find a characteristic example. (See Observation I, 10, p. 360.)

We shall now speak of the technic in these cases. After first ligating all bloodvessels, as described in Vol. I, pp. 25–27, my excisions extend into the white substance, to a depth—including the soft coverings—of about 5 to 8 mm. As a rule, it is not a difficult matter, while operating, to bluntly detach the pia mater and its vessels, for the purpose of arresting all hemorrhage on the cerebral surface. To accomplish this, I first doubly ligate any veins that may perchance be seen crossing the field of operation, after which I sever them between the ligated points. While elevating the pia, using as tractors the ligatures still attached to the cut ends of the vessels—or to the pia itself—it is slit with a knife all around the area occupied by the spasming centre, after which it is gently detached with a pair of blunt-pointed and closed scissors. In this manner two small delicate flaps of pia are formed. Despite all precautions, however, there will sometimes occur bleeding from the small arteries and veins that will then have to be clamped and ligated individ-

ually. After the flaps of pia have been detached to a certain distance they may then be grasped with dissecting forceps and their further detachment accomplished by the aid of small gauze pledgets. After that we are face to face with the exposed "spasming centre."

The excision of the centre, down to the white substance, is then accomplished in the usual manner. The hemorrhage encountered—which is ordinarily not marked—may be controlled by gauze pressure. Should this not suffice then the insertion of fine ligatures may be necessary for its control. The two small pia reflections are now carefully replaced, and gently pressed against the defect created in the brain, for a short time. The dura is next replaced. While this method of procedure is somewhat more difficult than the first one, I have not as yet been able to see any difference in the results obtained from them.

Now, a number of observations will follow that will show the various changes found.

## OBSERVATION I, 8

*Subcortical Encephalitic Cysts. Jacksonian Epilepsy with Complete Imbecility. Operation. Cure of Imbecility for Seventeen Years.*

This observation is very important, for the reason that seventeen years have elapsed since the performance of the operation. The patient may therefore be considered cured. With the disappearance of the epilepsy, which was accompanied by complete imbecility, the mental condition simultaneously vanished.

The patient, a lady, thirty-two years old, free from antecedent taints, at the age of two years, suffered from a severe inflammation of the brain. Two years later she developed spasms which became more and more frequent as time passed on, and which always began either in the left half of the face, the left arm, or in the left lower extremity; they remained confined to these parts or they would become general. The spasms were followed by loss of consciousness that lasted for

hours; later on they would continue even for days at a time. The previously meek child now became stubborn and lazy. Gradually mental disorganization set in which finally led to complete idiocy. In the last year preceding the operation there would occur spasms of the left arm and the left half of the face, that lasted for hours. The general condition of the patient was much affected by the spasms.

She was admitted to the hospital on November 7, 1893. She was at that time fifteen years and eight months old. The left arm, mainly the left hand, were weaker than those of the right side. The girl, who was of strong build showed, besides these changes, atrophy of the muscles of the same limbs. Paralyses and sensory disturbances were absent. The reflexes were normal. The movements of the left hand and fingers were uncertain and ataxic. Percussion of the head showed the entire right side to be painful; otherwise the patient complained of slight headaches only. Choked disc and hemianopsia were wanting. She impressed one as being a confirmed idiot.

The attacks were observed for nine days in succession. Their average duration was about a minute. They began at times with a cry, and left the patient unconscious. The spasms appeared first in the left hand, then in the forearm, extending then to the left arm, the left leg, and finally becoming general. One or two such spasms occurred daily.

The patient was operated on November 16, 1893. The anæsthetic used was chloroform. After ascertaining the position of the central fissure on the shaved skull, a large *Wagnerian* flap was formed, the base of which was reflected over the right ear. The dura domed into the excision very forcibly and the veins were turgidly filled. After separation and detachment of the dura, a large quantity of clear fluid escaped from the arachnoid spaces. The central convolutions lay freely exposed. Faradic irritations (which were in this case bipolar) resulted in twitchings of the lower facial region (1 in Fig. 79), the shoulder, as well as the arm (2) of the left side. The centre for the lower extremity could not be ascertained. The puncture of the brain (*) above the facial centre, immediately underneath the cortex, proved successful, and a large quantity—about 100 ccm.—of clear waterlike serous fluid was evacuated. We were evidently

dealing with an encephalitic cyst, located in the subcortical region. It was incised to its full length (-----), and drained. A strip of iodoform gauze was then introduced into the space

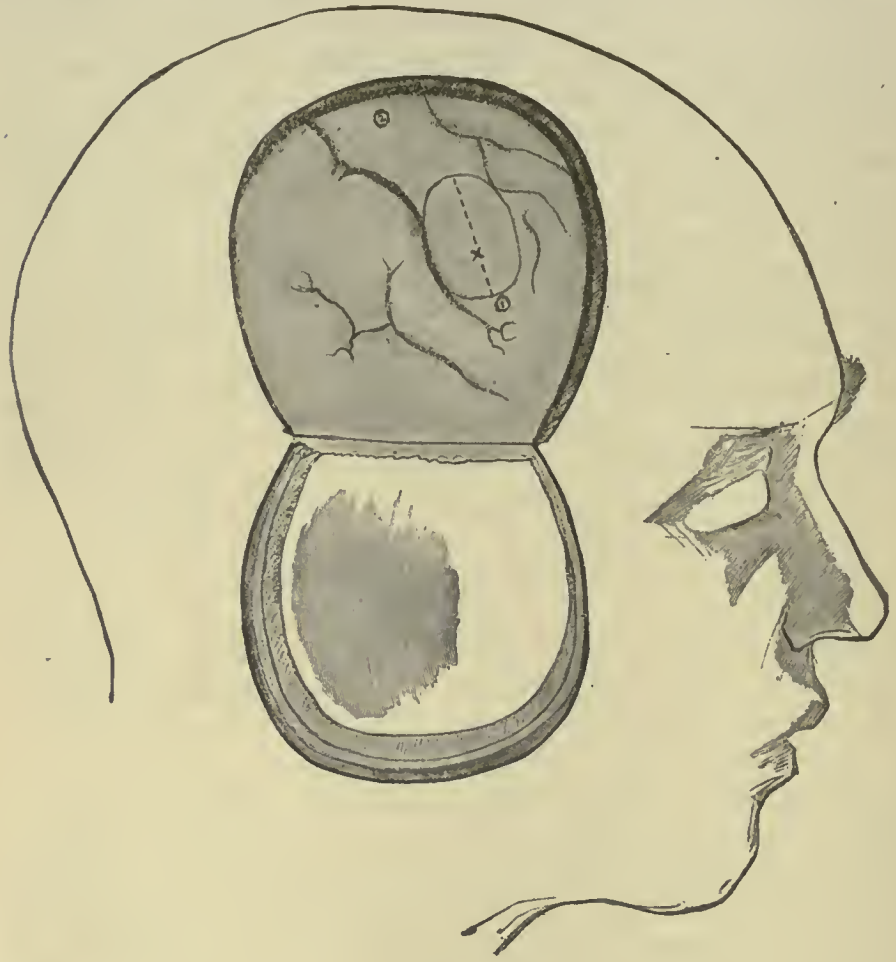

Fig. 79

Cyst of the Anterior Central Convolution, Opened by a Vertical ( ⋮ ) Incision. For explanation of 1 and 2, see text. The flaps of dura resulting from the transverse incisions were purposely omitted from the drawing for better representation. (Semidiagrammatic.)

created by the sinking in of the brain—between it and the bone—the osteoplastic flap replaced and sutured into position. The wound healed without complications and no disturbances of a spasming nature were noted.

On the 17th of November two epileptic seizures appeared again which in type were like those seen prior to the operation. On the 19th the patient was more active mentally. Her answers were quick, and she asked many questions. On the 29th of November she kept herself busy sewing and reading. She began to memorize the multiplication table, and remembered the numbers well. She answered all questions readily. On the 2d of December her left hand was found distinctly stronger than before the operation. On the ninth of the same month there occurred a spasming seizure that lasted only a short time. On the 13th a typical attack was observed akin to those prior to the operation. On the 14th, two attacks. The 16th, one seizure. On the 19th the wounds were found healed and the patient discharged. Following the last seizures the patient's mental condition relapsed to its former state, to a marked degree; so much so, that she appeared just as idiotic as she did when first admitted to the hospital. The spasms in the left arm, however, did not recur again.

Only two more attacks occurred since the patient's dismissal; one eight days, the other three weeks later. Since then—a period of seventeen years—the patient remained free from spasms and attacks. While her mental state was worse in December, 1893, there followed a rapid and lasting improvement since January, 1894. Since 1896, the girl is doing general housework, reads newspapers and magazines, frequents theatres and attends parties, in the social functions of which she participates with zeal. Her mother speaks of her as being "neat and orderly, extremely 'deliberate' in every detail, as well as willing and obedient." She creates the impression of being of mediocre talents. While she is somewhat slow in thinking, her general mental condition is that of a well person. Physically she is a robust specimen of health. Of nervous disturbances the following were demonstrable until 1904: At times slight tingling sensations occurred in the palm of the left hand which lasted only a few moments; the lower branch of the left facial was slightly paretic; this was observable only when the patient was laughing. The grasping power of the left hand was at that time weaker than that of the right; the previously ataxic movements, however, were now just as normally performed as those of the other hand.

Since the last examination—January, 1908—all these disturbances have disappeared. The left facial and left hand show no deviations from the normal, whatsoever. The mental status is that of a girl of ordinary intelligence of the middle classes. The osteoplastic flap has healed completely, leaving behind absolutely no defect.

A number of such cysts may exist in the same patient, as shown in the following example. This case is particularly remarkable for the reason that the involvement of one particular part of the body steps into the foreground, overshadowing all other symptoms.

## OBSERVATION I, 9

*Multiple Encephalitic Cysts. Jacksonian Epilepsy. Healing Following the Operation. Subsequent Course Unknown.*

This little girl was twelve and a half years old when operated on. At the age of three she was afflicted with a severe, febrile form of dysentery, during which an encephalitis developed and which according to all indications and appearances was located in the left central region of the cerebrum. While unconscious, clonic spasms of the right arm and right lower extremity supervened, followed by a paralysis of those extremities, which lasted two months, and then gradually disappeared, leaving only slight disturbances behind. Since that illness six years passed, during which time no spasms occurred. Eight years after the said illness, typical *Jacksonian* spasms occurred which commenced in the right arm and then advanced to the lower limb of the same side. The attacks became more numerous and stronger; in addition to this the child became idiotic. On days when spasms were expected the hands were profusely bathed in perspiration. Immediately preceding the seizure both scleræ became markedly injected, the patient complained at the same time of pain immediately above the left eye.

The child appeared physically well. Its right arm was found somewhat weaker than the left; its appearance and measurements did not show any decrease in circumference. The strength of the right hand was hardly less than that of the left.

The movements in the same arm were, as far as could be determined, normal. On the other hand, there was an appreciable difference in the size and power of the right lower limb as compared with that of the left side. The circumference of the right calf was 30 cm., that of the left, 34 cm.; the right thigh measured 44½ cm. in circumference, the left, 45½ cm. While the active movements of the hip and knee evinced sufficient power on the right side, the dorsal flexion of the foot of the same limb was much weaker than that of its opposite fellow. During the execution of the movement alluded to the foot assumed a varus position (paresis of the proneal group). Active movements of the toes of the right foot were impossible, the strongest effort being only rewarded by a very slight and barely perceptible movement of the big toe. A certain degree of clubfoot was apparent while the patient was walking (pes equino varus). Besides this, the patient's walk reminded one of a cock's tread; this was due to slight spasms in the ankle-joint and to some extent also in the knee-joint.

Of the reflexes, only the right patellar was exaggerated. Ankle-clonus, as well as *Babinski's* and *Oppenheim's* reflexes were absent.

There were no perceptible sensory differences between the right and left sides as tested by needle-touch and brush. The child never complained of pain. The right lower limb was always found cooler to the touch than the left—corroborated by the same observations of the patient's mother; in the arm this phenomenon was not observed. Paralyses of the ocular muscles did not exist. There were no abnormalities of the tongue and palate. The ophthalmoscopic examination was negative. In view of all that has been said, we must conclude that we were dealing with a pathologic condition of the anterior central convolution, e.g., in its upper division (foci for foot and toes). *Hermann Oppenheim*, when referring the case to me for operation, wrote as follows:

"The monoplegic character of the affection in this case is a favorable circumstance that speaks for operative intervention, that is, we find the lower extremity alone affected to the exclusion of all other parts (mainly distally, peroneus group). It is therefore hoped that the etiologic focal condition may be

found sharply or relatively circumscribed in the upper part of the anterior central convolution."

Six days following the first exposure of the brain, December 3, 1906, there appeared a small, whitish, cupolalike elevation about the middle of the dural surface. The dura did not pulsate. On account of the close proximity of the sinus longi-

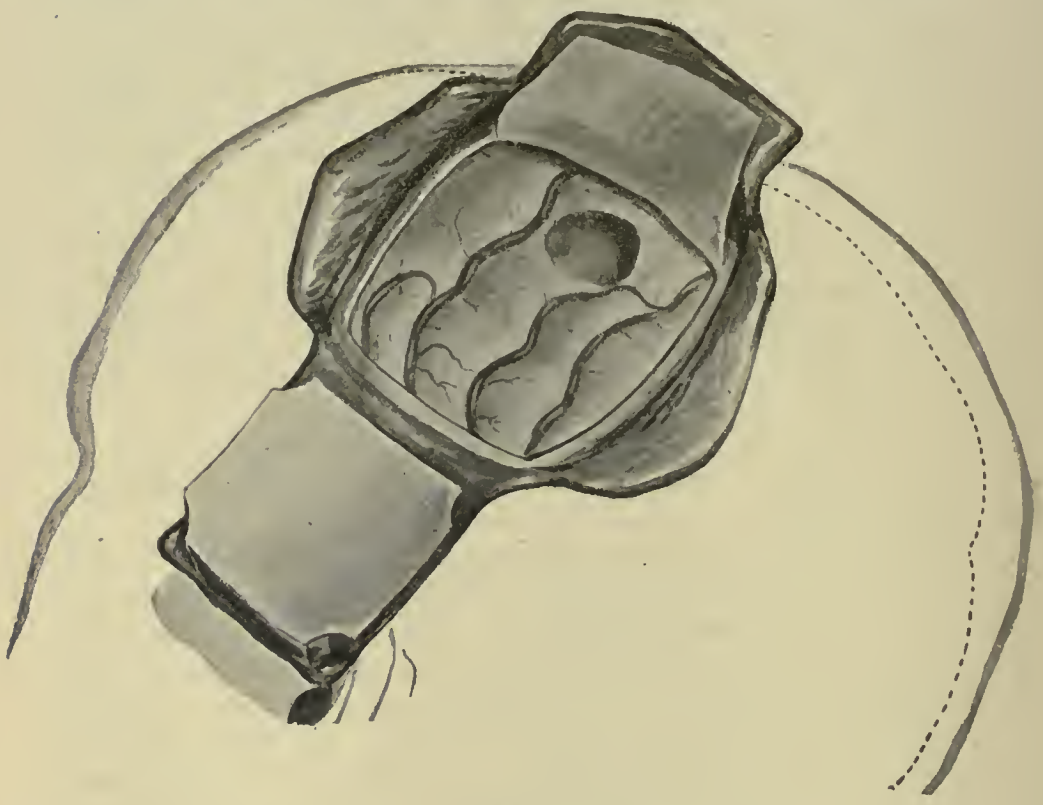

Fig. 80

The Dotted Line Indicates the Sagittal Line

tudinalis the base of the dural flap was placed above. A large quantity of fluid drained away after opening the dura; this, however, did not improve the turbid and jellylike appearance of the arachnoid (see Vol. I, Plate II, Fig. b). In order to remove this condition the arachnoid was scarified; during this time a cyst, the size of a cherry, was opened into, the contents of which consisted of a clear waterlike fluid. The wall of the cyst was whitish and of fair thickness. Anteriorly to it, toward the forehead, another

cyst was found, separated from the first by a ledgelike partition. A third cyst, somewhat smaller than the second, was found in close proximity to it. The circumference of this entire three-locular cyst, the chambers of which were in communication with one another, was that of a fair-sized walnut. It measured longitudinally 40, transversely 26, and in depth 20 mm., respectively. After a considerable quantity of œdematous fluid had been drained off, the pia was seen to apply itself closely to the convolutions and the pulsations were now distinct.

The envelope of the cyst, consisting of the pia and arachnoid, was now split, a part of it excised and the cyst cavity packed with vioform gauze. The dura flap was fastened below with three linen threads and the osteoplastic flap sutured over it. Healing was uneventful. January 2d the child was sent back to its home (Russia). I could get no responses to my inquiries with reference to the further course of the conditions.

It must be emphasized that cyst formations of the same part of the brain are not necessarily followed by epilepsy. I have operated on a laborer, thirty-one years of age, in whom two cysts were found, the size and situation of which were entirely analogous to those described (caused by the cysticercus cellulosa) in which case neither attacks of an epileptic nature nor spasms of any sort were ever observed. Furthermore, the motor and sensory paralyses, in this case, as well as the symptoms of cerebral pressure clearly indicated the diagnosis and the seat of the new formation.

### Porencephalitis

In Observation I, 8, we have found a brain-cyst in a subcortical situation; in Observation I, 9, a multilocular cyst, which was covered by the arachnoid and pia, only. In the latter instance we had before us a case named by *Hesch* porencephalitis. These cases consist of malformations of the brain substance, which originate from the brain surface, and together with it penetrate into various depths, extending at times even to the lateral ventricles. If there is now an accumulation of a considerable quantity of cerebro-spinal fluid, within such new formations *porencephalitic cysts* result. They are situated on

the surface of the brain, and are covered with pia and arachnoid. The view formerly held, that porencephalitis results from prenatal arrest of development only, can, in the present light of our knowledge, no longer be sustained. They undoubtedly may be acquired. I have seen this to be the case in a number of instances of cerebral infantile paralyses.

A thoroughly convincing case is the following.

## OBSERVATION I, 10

*Porencephalitic Encephalitic Cysts. Jacksonian Epilepsy. Operation on the Cyst and Simultaneous Excision of the Primary Spasming Centre. Cure After Seven and a Half Years.*

A man, twenty-three years old, hereditarily free, developed normally until four months old. At that time, while at an outing on an excessively hot summer day, he was suddenly attacked with spasms. The physician attending him diagnosed the case as one of meningitis which left behind a paralytic weakness of the right arm and the right lower extremity. In other respects the child remained well and his mental and physical development progressed normally. At the age of eleven years he began to suffer from fainting spells, or from peculiar sensations in the right forearm. From the age of thirteen on, there developed an epilepsy which manifested itself by spasmodic contractions of the fingers of the right hand, the thumb and the forearm; at this juncture there would be a loss of consciousness, after which the right lower limb and finally the entire body would become involved. The seizures were accompanied by biting of the tongue and frothing at the mouth. The spasms occurred daily, sometimes as often as four or five times in a day. The longest interval of rest was fourteen days. I observed these seizures for a considerable period. Post-epileptic paralyses and weaknesses remained for hours at a time following the attacks. The memory as well as the psychic competency suffered a set back to no small degree. The memorizing of the small multiplication table caused the young man much trouble and effort. He gave the impression of being an imbecile. Besides this he developed a marked nervous irritability; the slightest noise, e.g., rustling

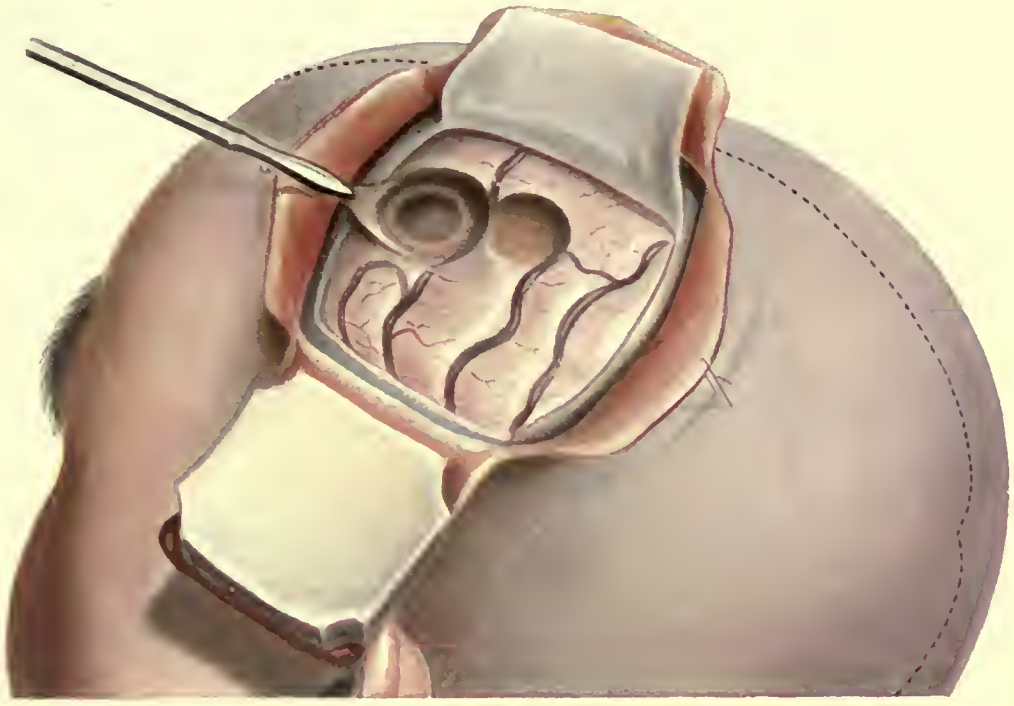

Fig. a.

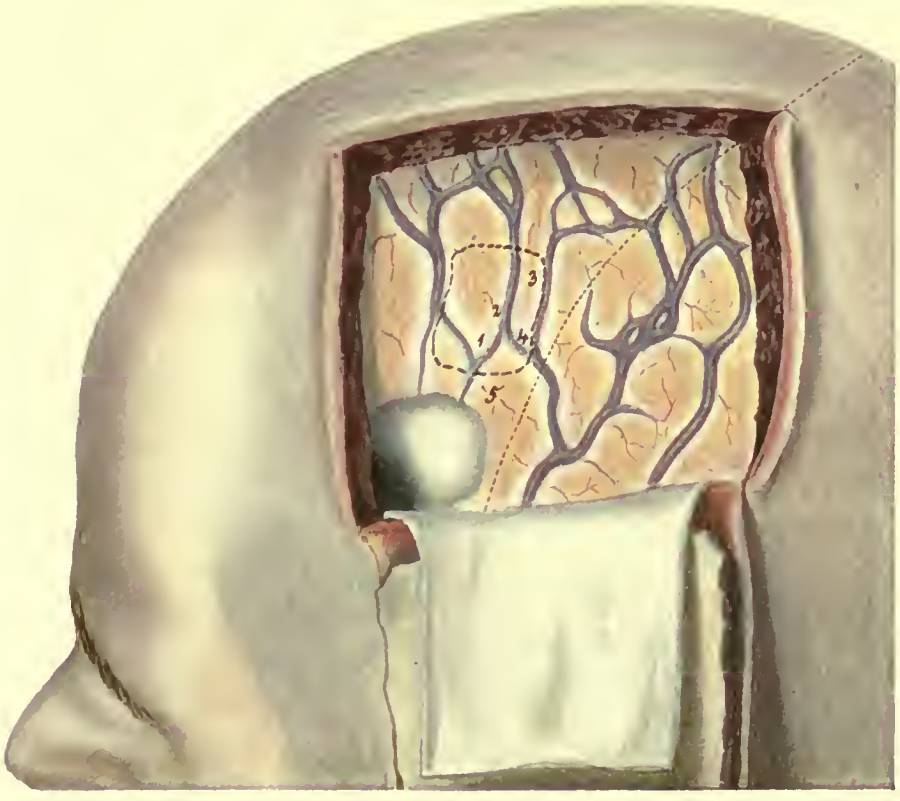


Fig. b.

of paper or of the leaves of a book caused him to shrink in terror.

The operation was performed in two sittings, the 19th and 24th of February, respectively. Distinct pulsations through the stretched dura mater were seen only in the anterior half of the opening made in the trephined bone. Besides leptomeningitic changes, a smooth-walled porencephalitic cyst, filled with a clear fluid, was also found in this particular locality, toward the anterior lower angle of the wound (Plate XXIX, Fig. b); it was the size of two walnuts put side by side. It was situated under the arachnoid, and caused, by its presence, a corresponding defect on the brain surface. Simultaneous with the trickling away of the œdema of the arachnoid consequent to scarification, the cyst emptied its contents. The arachnoid was of a jellylike appearance. Its direction was medianward and obliquely downward. The cyst gradually narrowed down to the form of a funnel. It measured 2½ cm. in depth, 4 cm. in width, and 2 cm. in height. White and glistening scar-tissue covered the floor of the defect, evidently replacing the pia. Topographically the cyst was located below the facial centre; this was determined by faradic irritation at No. 5 of the illustration. Irritation at point 1 caused movements of the little finger, at point 2 extension of the same finger, at 3 extension of the entire hand, and at point 4 spasm of the thumb.

It is noteworthy that faradic irritation at point 2 was responded to by a typical epileptic attack; the patient was at the same time in superficial chloroform narcosis. It began with trembling and extension of the little finger, followed by spasmodic contractions of the thumb and extension contracture of the hand which was in "claw" position. Following this, the thumb was forcibly snapped into the hollow of the hand, and it was at the same time strongly flexed at its last joint. It remained in that position throughout the entire seizure. There followed, now, flexion at the elbow-joint with pronation of the forearm, which executed short clonic blows; at the same time there was tonic elevation of the arm and abduction. Immediately following this there were flexion of the arm at the elbow-joint, strong tonic extension of the little toe of the same side; a second later the other four toes became strongly and tonically flexed in a

dorsal position. Immediately following this, there were clonic contractions of the muscles of the arm and leg, so that the knee-joint executed movements of flexion and extension. There were also clonic contractions of the muscles of the right side of the trunk which turned the body concavely toward the right. Twitchings of the muscles of the back of the neck then occurred, throwing the head in backward positions. At times spasmodic contractions of the right angle of the mouth were noticed; this was accompanied by clonic grinding motions of the lower jaw.

The attacks lasted on the average about two minutes. The contractions of the right arm were so strong that it took a powerful nurse to restrain them.

In accordance with this finding the primary spasming centre was located above the cyst and separated from it by the facial centre. Besides providing for adequate drainage and thorough tamponade of the cyst cavity—the drain measured from the surface of the skin 63 mm. in length—the excision of the primary spasming centre was accomplished (1, 2, 3, 4) to an extent of 22 mm. in length, 16 mm. in width, and over 5 mm. in thickness. (The dotted line seen in the diagonal one, in the trepanation opening, indicates the outline of the linea *Rolandi* marked on the surface of the skull prior to the operation; object, to indicate the position of the sulcus centralis.)

The wound healed without complications. Of course, there were the usual disturbances accompanying cortical excisions, of which I shall speak in the chapter on *Results of Cortical Excisions,* on p. 397. The boneplate united thoroughly and valve formation did not exist.

On the day following the operation, the patient noticed a sensation of perfect tranquillity in the right arm and hand. It will be remembered that, prior to the operation he constantly perceived in that arm and hand unpleasant sensations of agitation. Excitements of any nature—pleasant or unpleasant—were followed in those parts by sensations of a most disagreeable kind, which the patient described as "if something would shoot into his hand and arm."

The patient describes his condition at present as excellent. The last examination was made in October, 1909. While prior

to the operation the attacks would occur four or five times daily, at times even more frequently, and the longest period of rest he enjoyed was fourteen days, they have not recurred more than five times in the first four years following the operation. The first post-operative attack occurred May 31, 1904, after a violent blow against the head; the second September 28, 1904, without known cause, and a third seizure February 27, 1905. All were ushered in by a peculiar sensation in the right hand; they have not recurred since the operation. He now had sufficient time to recline. He fainted twice, snoring and groaning, without the occurrence of spasms. The third time he felt only dazed. The right hand spasmed only once. Three more slight fainting spells had occurred since, viz.: February 13, March 4, 1906, and May 19, 1907, respectively. The parents of the patient described the same as slight and insignificant.

Thus the extraordinary improvement in the mental state of the patient is the more remarkable. The formerly practically imbecile patient has, since January, 1904, received private instructions in history, geography, German, arithmetic, stenography, and in single and double entry bookkeeping. Later on he also studied French and English, and he has made remarkable progress in all these studies. In the beginning he could not—as he stated —concentrate his mind sufficiently; this condition has gradually vanished and he has acquired remarkable will-power. According to the statements of his father he learns easily and thinks with logic. He has frequented a business college since April 1, 1906, spending there hours daily, after which he felt somewhat fatigued. The subjects here studied were: Commercial Law and Laws of Exchange, Commercial Principles, Geography, French, Arithmetic, and Bookkeeping.

Prior to the operation the young man was extremely irritable and timid; these morbid manifestations have since completely disappeared. While previous to that time it was impossible for him to have social intercourse of any sort, he now moves in good society, and creates the impression of a normal, intelligent, and extremely well-mannered young man. Regardless of the six abortive attacks that have occurred since his dismissal from under my care, he states that he enjoys good health and

with each succeeding year he notices more and more improvement in his general bodily condition. The dizziness and cardiac palpitation have not recurred since 1906. At entertainments his vivacious behavior is more noticeable than in previous years. While his manner of speech is, at times, somewhat hesitating, he speaks, nevertheless, more fluently and quietly. He meets strangers with greater confidence in himself.

Our patient attended, since October, 1907, the business college at Köln, from which institution he graduated in September, 1910, and he is now preparing to accept a position in a bank. The principal of the above-named institution expressed himself in warm terms of commendation with reference to the progress made by our young man in his studies as well as in mental improvement. Physically he appears in blooming health; he is in no manner nervous, and has gained so much reliance and confidence in himself, that he sojourned through Switzerland for two months with no one accompanying him. As a student he lived all alone, without any one's supervision, which just a few years previous he would not have dared to do. Although he is not abstinent from divers pleasures or the use of alcoholic beverages, and has not been under treatment of any sort for the past few years, no attacks of any description, and no fainting spells have occurred since May, 1907, a period of more than three years.

### Porencephalitic Cyst Outside of the Central Region

Typical *Jacksonian* attacks may also be caused by cysts, which, while located in the neighborhood of the central region, do not encroach upon it and leave its area entirely free. We have seen in the case just described (Observation I, 10), that the large porencephalitic cyst was situated away from the primary spasming centres of the hand and forearm; it will be remembered that it was even situated below the facial centre. The recurring attacks may be explained by the periodic accumulation of fluid within the cysts from time to time. The increased tension and size irritate the contiguous brain-tissue, and thereby evoke the spasms. The resorption and relaxation following this, cause the subsidence of the seizures; this is followed by a period of rest of shorter or longer duration, until refilling occurs again.

This interpretation is the more probable since immediately preceding or in the beginning of the attack, the patient invariably complained of a sensation in the region of the left half of his skull, as if something attempted to jump through it. This undoubtedly points to heightened pressure conditions.

Epileptic attacks may also result from cysts which are situated outside—but not too distantly—from the central region. An example follows.

## OBSERVATION I, 11

*Porencephalitic Cyst of the Parietal Lobe. Jacksonian Epilepsy. No Results Following the Operation. Death Eight Months Later, During an Epileptic Seizure.*

The patient in this instance coming for operation was a man, twenty-one years of age, who, until the tenth year of his life, had never been ill. At that time he was suddenly attacked by *Jacksonian* spasms which originated in the left hand. A half year prior to the time of my operating on him another surgeon exposed his right central region. Because no visible changes were found on the cortical surface no faradic irritations were undertaken and nothing further was done. After personally observing the patients for months in succession, and complying with the very many requests, I decided to expose the central region again. On account of the strong union existing between the dura and the bone, the latter could not be preserved. The brain was not found covered by dura in the upper half of the cranial cleft; in its stead the pia and the cicatrized arachnoid formed the covering. In the lower half of the cleft, the dura was found so closely united with the cerebral surface that its attachment could only be accomplished with the aid of a knife. For that reason the cerebral surface did not have the normal, smooth appearance, but it was found markedly irregular and uneven, and much changed in general appearance, as may be readily seen in Fig. 81. As a consequence of these surface conditions the faradic irritations failed almost completely. Only at the point marked x in the figure was I able to obtain movements of the fingers and hand, and even these were not

characteristic. The suspected primary spasming centre (outlined in the illustration by dashes) was excised to an extent of 32 mm. in length and 21 mm. in width.

About the middle of the posterior border of the opening in the skull, closely adjoining a large vein, there was found a flat, excavated defect; which evidently resulted from the first opera-


Fig. 81

tion, shown by the dural changes found here, which measured 14 mm. in diameter. While I was gently depressing the cerebral surface into the skull with a gauze sponge, another defect in the form of a deep cavity came to view. Another osteoplastic flap, with its base situated posteriorly, was therefore reflected, and a cavity now appeared that measured 15 mm. in diameter and 21 mm. in depth; it was located posteriorly and downward, and was covered by normal-looking non-adherent dura. The

cavity did not reach into the lateral ventricle, however, and its base was covered by brain-tissue.

While most of the changes described were evidently the direct result of the previously performed operation, the last-described defect was the sequel of a porencephalitic cyst that was located behind the central region, within the parietal lobe. The cyst was dealt with in the same manner as described in the last observation, and the wound was then closed. Four weeks later the patient was discharged, but his epilepsy was in no way improved. Eight months later he perished at his home during a severe seizure of spasms.

Regardless of the position of the porencephaly—for the origin of which the anamnesis gave us no explanation—the important point in this case is the fact that the results of faradic irritation were practically *nil;* this was due to the cortical changes resulting from the previous operation. At all events, the primary spasming centre could not be ascertained with the necessary degree of accuracy. The cortical excision was consequently executed more on an anatomic basis than upon faradic results. As previously stated, our work in this case was entirely insufficient and guessed at, so that we were not at all surprised when, following the excision, there resulted neither paralyses nor any noticeable influence over the spasms. The last observation teaches us anon that for localization of cerebral foci, faradic irritations, and these alone, are our reliable guides and of real practical value.

## Injuries at Birth

The cases coming under this caption may, in the broadest sense, be looked upon as cases of traumatic epilepsy. Cases of epilepsy, developing on a basis of infantile cerebral paralysis, are clinically analogous to the class of cases under present consideration, and the anatomic findings at the time of the operation as well as the histologic changes of one set coincide with that of the other to a very marked degree. At all events, the cases presently considered depend on severe lesions of the brain during birth, which result either from severe compression of the central region by the blades of the forceps, or

trauma resulting from the pressure of a disproportionately large fetal head against the bones of a deformed pelvis, during long-continued expulsive efforts in the second stage of labor.

Lastly, asphyxia neonatorum, following protracted labors, must be looked upon as an etiologic criterion in epilepsy. Large hæmatomata of the fetal skull are frequent enough, and in cases of severe labors there may result hemorrhages into the brain substance proper or between it and the dura. *Virchow* has shown that the large veins entering the sinus longitudinalis may be torn off at their point of entry into that channel.

Two characteristic instances will now be cited, one resulting from a breech presentation, the other from a forceps delivery.

## OBSERVATION I, 12

*Breech Presentation. Jacksonian Epilepsy. Lateral Ventricle Degenerated into an Enormous Cyst. Wide Opening and Excision of the Remarkably Thin Cyst Wall. Plastic Covering. Cure.*

Lottie B., of perfectly healthy parentage, was born September 24, 1902, in the eighth month of intrauterine life. The labor—the second of the mother—was very difficult and lasted three days. It was a breech presentation, and after a prolonged period of waiting, the five and a half pound baby was extracted without chloroform at the request of the mother. There were no visible marks of trauma or any other changes on the baby's head.

Forty-two hours after the delivery, there occurred, without fever or other general systemic disturbances, spasmodic contractions of the left forearm and hand, which soon became generalized. They lasted continually for four days—day and night—with slight remissions only. Following this, the arm and lower limb of the left side became paralyzed. The lower extremity recuperated from its paralytic condition after some months, but the arm remained weak. Four days later the spasms ceased, recurring daily thereafter, on the average of about four or five times per day. They were characterized by a suddenly appearing corpselike pallidity of the face, turning of the eyes, and

what seemed to be a complete loss of consciousness. This condition would last only a few seconds and would be unaccompanied by spasms or twitchings; the latter was the case a few times only, when twitchings of a slight degree were observed in the left arm and leg. Such attacks were repeated until the end of the second year. At that time there occurred, without any known cause, immediately after breakfast, strong general spasms; they were accompanied by frothing and bleeding from the mouth consequent to biting of the tongue. Following the attack, which lasted about half an hour, the child remained in a state of unconsciousness for fully four hours. When the senses were regained, no other paralyses were found outside of those already existing—the left arm and the left leg to a slight extent.

In the years following, slight spasmodic conditions of the left side were observed, which would occur every few days. There was no loss of consciousness during these slight attacks, but the child perceived sudden sensations of fright which appeared suddenly and on an average of about six to seven times daily. At the approach of such a sensory manifestation the child would press its right hand against the præcordium and exclaim: "I am so afraid, it comes again." If not watched by her mother or the nurse she would fall to the floor. These sensory seizures would last a short time only—not longer than a minute. This condition lasted until the child was about five years old. On the 6th of December, 1907, as the child awoke at six o'clock in the morning, there again occurred a severe attack with generalized spasms, foaming at the mouth and unconsciousness, which lasted fully an hour. Immediately after she awoke, her general condition was good, she ran around as after the first attack, and there were no other paralyses outside of those existing from before.

In the following two and a half years there was—under the exhibition of valerian, bromides, and opium—comparative freedom from trouble; the sensations of fear, however, persisted. Sometimes they would be as frequent as seven times daily, at other times, again, they would not recur for a full week. Despite continued medical treatment, there occurred (January 21, 1910) a marked aggravation as well as a noteworthy change in the condition of the little patient. She awoke at that

time at four o'clock in the morning and cried: "Mother, I believe I am getting the spasms." True to her premonition, they occurred at once; at this time the extremities remained quiet, but the entire face contracted spasmodically. Consciousness was lost, but the frothing at the mouth and biting of the tongue were not observed at this time. Simultaneously frightful choking was observed; this was accompanied by vomiting of large quantities of mucus. Similar attacks occurred now every fourth or fifth day, without participation of the limbs. Only once—at the end of February—there was unconsciousness which lasted half an hour, after which the attacks disappeared as unexpectedly as they came. Soon thereafter the child was seen to run around as unconcernedly as before. An attack of the nature just described occurred on the night prior to the operation.

In the beginning of April, 1910, *Drs. Schulte* and *Eickenbusch*, of Hamm (Westphalia), brought the child—at that time seven and a half years old—to me. Both physicians witnessed the operation which disclosed most extraordinary changes of the brain.

The mental condition of the child was far advanced for its age. Her intellect did not suffer at all. The time for operation seemed therefore well chosen. Physically, the child was not strong. Besides the existing paralyses of the left extremities, no changes at all could be found. The face, the eyes as well as the ophthalmoscopic examination were normal. The left arm appeared, on the whole, thinner and paretic. The fingers and the hand were found useless. There were spastic contractures of the shoulder, elbow, hand, and digital joints. Hand and fingers were in extreme flexion consequent to spastic contraction of the flexors, while the extensors were visibly flabby and paralytic. The forearm was rigidly fixed in semipronation and the elbow-joint rigidly flexed in a rectangular position. The left lower limb was found atrophic and about three fingers' breadth shorter than the right. The shortening mainly affected the leg and the femur to a slight extent only. The foot was also smaller. There were spasticities of the knee and ankle joints, which were not as marked, however, as those of the upper extremity. The child was able to walk around. In the left arm and to a lesser degree in the left leg all reflexes were found exaggerated. The

*Babinski* sign was present on the left side and absent on the right. Both patellar phenomena were increased.

In the right—normal—extremities, the reflexes were only slightly exaggerated. The sensory phenomena were, as far as could be determined, normal.

Trepanation of the right central area, without opening into the dura, was accomplished on April 11, 1910. The rhomboid flap measured 56 mm. in breadth, and 65 mm. in height. Strips of bone were next broken off at the anterior upper and lower borders of the cleft, so that the entire cleft was now measuring 62 mm. in width and 75 mm. in height. The dura was found tense without visible pulsations. On account of the weakness of the child the second operation was not performed until April 25th; the scar of the skin was bluntly detached and the osteoplastic flap reflected.

After the formation of a flap of dura, the base of which was directed downward, there appeared in the posterior upper portion of the exposed brain a bluish, translucent, and large cyst, which apparently was filled to the point of bursting; its presenting wall measured 4 cm. from above downward, and an equal distance from before backward. These figures, however, do not represent the whole size of the cyst surface, because it reached backward and, for a considerable distance, under the bony cleft in the skull. It was covered by pia and arachnoid, which did not distinguish themselves from the bluish color of the cyst-wall. The arachnoid appeared in the anterior upper section considerably œdematous, the elimination of which was accomplished by scarification. The normal cerebral convolutions came now to view. A number of well-developed pia vessels were found coursing on the covering of the cyst. The latter was opened for a distance of about 5 to 6 cm. between two such vessels. Two bleeding branches had to be ligated with catgut. A part of the cyst-wall, the size of the palm of the hand, measured about ½ mm. in thickness. The various strata composing the pia, arachnoid, and the brain substance could not macroscopically be distinguished from one another. Two wide strips were taken from the cyst-wall and placed in a 10 per cent. formalin solution and sent to *Professor Heinrich Vogt*, in Frankfort-on-the-Main, for examination. The findings were as follows:

The contents of the cyst were waterlike and colorless in appearance. Within this fluid the normally looking tela choroidea was seen floating. Besides this, all tissues composing the median and under wall of the lateral ventricle were found normal and their form unaltered. We had therefore before us an enormously dilated lateral ventricle covered by an extremely thinned wall; 160 ccm³. of fluid were evacuated by means of an aspirating syringe. There still remained a large quantity of fluid, which was carefully sponged away with gauze pads. The remaining cavity measured 70 mm. from above downward and an equal distance from the front backward. Measured from the dura medianward, its depth was 50 mm. The cavity was so large that the clenched fist of the child could easily be introduced into it.

The large flap of dura was utilized in covering the defect. Strips of bone, measuring 25 mm. in width, were now removed from the anterior and posterior borders of the cleft by means of rongeur forceps. The measurements of the opening were increased thereby to 87 mm. in width and 100 mm. in height. As a result of this procedure two new flaps of dura were gained—a posterior and an upper one; both were deflected into the brain cavity, thereby covering the posterior and upper portions of the median wall of the lateral ventricle. In spite of our efforts to completely cover the defects, there still remained a space in the brain substance—the median and under surface of the lateral ventricle—which was entirely uncovered and which measured 2 cm. posteriorly and 3 cm. above. A plastic operation on the dura, utilizing the fascia lata in its performance, we did not dare to undertake. A portion of brain surface measuring from before backward, 4 cm. in width, and situated anteriorly, still remained entirely uncovered.

During the entire time consumed in the operation the cavity in the brain did not diminish in the least, in this respect contrasting with the behavior of cavities resulting from the extirpation of neoplasms. In this case the cavity retained its full dimensions of width and depth until the closure of the wound. We found no difficulty in replacing the osteoplastic flap, which was superimposed over the incompletely covered brain, without the slightest tension of the skin at the borders of the wound.

There resulted a depression on the surface of the skull, corresponding to the position of the replaced trepanation valve, which measured about 2 cm. in depth. The wound in the skin was closed with interrupted sutures, and drainage was entirely dispensed with.

The wound healed per primam intentionem. There remained, however, in the upper anterior angle of the wound, for the first six days following the operation, an opening the size of the thickness of a knitting-needle, and a similar space in the posterior border of the wound; the latter persisted for four weeks, and an incredible quantity of cerebro-spinal fluid was draining from it. The shirt of the patient and the beddings were continually and thoroughly soaked, and the bandages were wringing wet soon after their application. On account of our inability to keep the bandages dry, the original dressings, consisting of sterile materials, were permitted to remain at first for two and later for three days in succession; they were superimposed, however, by a number of thicknesses of iodoform gauze which were frequently renewed. On exposing the wound eleven days after the operation, a stream of cerebro-spinal fluid squirted forth. At each change of dressings a wide area of the skin, surrounding the wound, was thoroughly cleansed with sterile gauze sponges moistened with ether. No antiseptics at all were used. A slight diminution in the quantity of the fluid was noticed on the eleventh day after the operation, which was still continually trickling from the posterior opening.

The sunken-in bone flap has now risen to the level of the surface. Pressure applied to it with the finger caused a jet of fluid to squirt from the small posterior opening. The same state of affairs still existed on the 19th of May—twenty-four days after the operation. From that time on the secretion was markedly diminished and the bandages remained dry for twenty-four hours. On the 25th of May the fistulous opening was found closed by new epidermis; the bone-plate was only $\frac{1}{2}$ cm. deeper from its surroundings. Two days later, the bandages were again found slightly saturated; from that time on, however, they remained continually dry. Four days subsequently — June 1st — the wound appeared completely healed, and the valve not in the least depressed. Pressing on it with the finger did not per-

mit its advance toward the brain to any appreciable degree.

Very threatening symptoms followed the serious operation and the drainage of the large quantities of cerebro-spinal fluid. A strong spasming attack occurred (fortunately only once)—

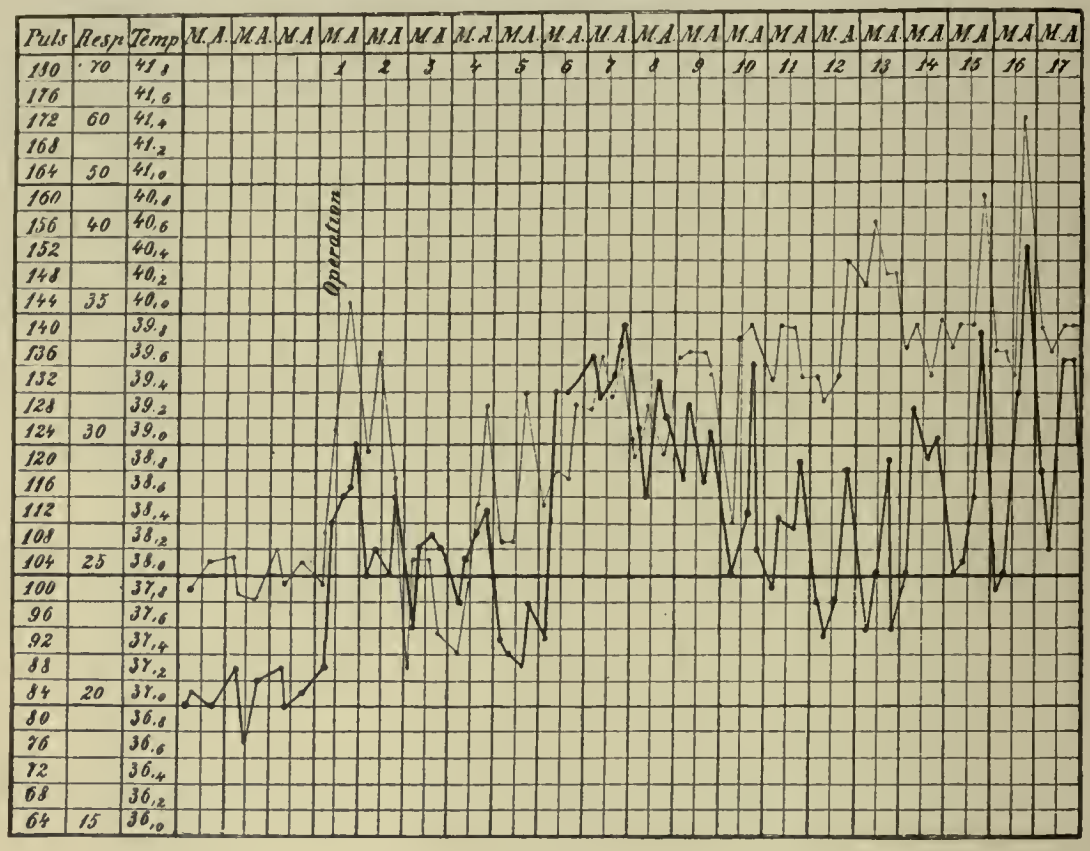


Fig. 82

Temperature, —— Pulse

nine days after the first time—and the grave condition of the patient caused us great anxiety for a very long period. The above pulse and temperature charts may be here consulted to great advantage.

While the pulse-rate was never conspicuously accelerated, in the first three days following the operation it became very frequently irregular, intermittent, and remarkably variable in

rhythm. The heart action would at times slow down, to about 60 beats per minute, when all of a sudden there would be a complete temporary interruption of pulsations, which was immediately succeeded by a few successive rapid beats and the pulse now quickly mounted to 140 beats per minute. This con-

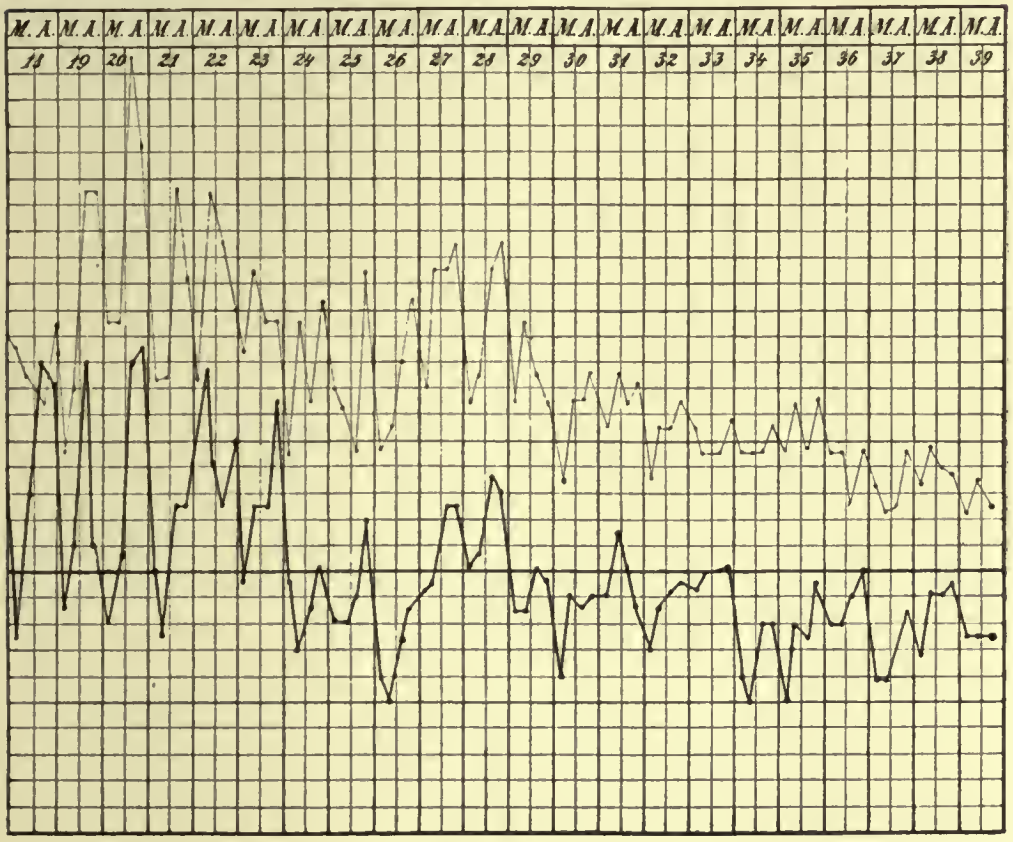


Fig. 82 (*Continued*)

Temperature, —— Pulse

dition repeated itself frequently and was accompanied by a corpselike pallidity of the child's face. From the fourth day on, the pulse became stronger and more regular, and there was a marked improvement in the general appearance of the patient.

In order to forestall the possible occurrence of epileptic seizures, which would undoubtedly kill the little patient—while she was in this precarious condition—she received from the time of

the operation, two to three times daily, at first a tablespoonful then a teaspoonful of mixtura nervina, administered per rectum. After the fourth day the medicine was taken by the patient by mouth, since at that time all inclinations to nausea and vomiting had disappeared. The patient drank much and partook also of some solid nourishment. The urinary and bowel functions were good throughout. On the other hand, the child complained of frontal headaches, which were almost constant until the 15th of May; they would usually disappear with the decline of the temperature, only to reappear when the fever became high again. They would at times also occur independent of temperature conditions. For the relief of these headaches we were frequently obliged to resort to the subcutaneous use of morphine. The child complained a few times of pain in the left limb, but we were unable to find anything of an objective nature in that member.

Despite the existing fever and headaches, the food assimilation soon became very good. The sleep was, as a rule, quiet and the tongue moist and not coated. After the 17th of May the appetite became voracious, and the child frequently asked for food during the night. From that time on there was a remarkable change in the patient's disposition; she became jovial and was frequently heard singing in bed.

It is evident that the secretion of such enormous quantities of fluid, as here seen, could only be perpetuated by some irritant, or that it—the fluid—in itself caused the continuation of the flow by acting as an irritant. While the appetite as well as the general condition of the patient were uniformly good, the abdomen never retracted, and outside of the headaches already alluded to, no other symptoms were noticed which would point to a meningeal irritation; there appeared, April 30th (five days after the operation), a slight stiffness of the head accompanied by a slight restriction of the movement of nodding; the active and passive movements of rotation remained unaffected. After a short time the head became normally movable again for a whole week. On the 2d of May the general condition of the patient was so improved that she was seen to play in her bed and displayed quite an interest in the other patients of the sanitarium. She was now able to turn over quickly in bed and keep her head

high. While after the 6th of May the head was freely movable, there appeared again a rigidity and flexion of the neck. On the 10th the whole length of the spinal column was concavely bent backward (opisthotonos), without being painful on touching. Three days later, attempts to straighten the head of the patient were only partially successful, and pain was complained of. During the following days the condition was improved, and on the 19th of the same month the head was not as conspicuously displaced, the nodding motion was freer and the child could place its head against the chest, unaided. The back was fairly straight. From the 21st on, the child could sit up in an easy chair for short periods daily. On the 23d the displacement of the head and a slight concaving of the back again recurred. On the 24th the child made successful efforts to sit up in bed. On the 27th the head and spine were freely movable, the patient did not complain of pain, discomfort, or any other inconvenience. The head was still thrown somewhat backward, however, and the lumbar region of the spine was somewhat in a position of lordosis (normal). The patient left her bed on the same day, and while unaided efforts at walking were during the first few days unsuccessful, yet a few days later she could walk, assisted by her sister.

There can be absolutely no doubt that the condition just described—moderate opisthotonos of the neck and spinal column—was the direct result of an existing transient irritation of the meninges.

During the first few days following the operation, no changes whatever were observed in the nervous status of the patient, but five days later—May 1st—the rigid flexion of the left hand (claw-hand) had mainly disappeared, the fingers were extended and she could elevate her arm at the shoulder-joint—which prior to the operation was impossible. A few days later—May 6th—the wrist-joint, which was until that time slightly flexed, again assumed its normal extended position. The spasm of the flexors of the fingers, the hand and the elbow, were markedly lessened; the same was also true of the adductors of the shoulder. The reflexes were no longer exaggerated, but there was a slight increase of the knee-jerk. Active movements of the hand and arm were very much better on the 27th of May than before the operation.

June the 1st, a slight tension was observed at attempts of supination. The flexors of the hand were also slightly tense, their resistance, however, was easily overcome. The child could now flex and extend its fingers, bring its hand to the mouth, elevate its left arm and bring it over to the right side and flex and extend the elbow. Active extension of the wrist was still wanting; the joint, however, did not assume a flexed position while at rest, as heretofore—it remained straight. The periosteal and tendon reflexes of the left arm were only slightly increased. The left leg was fully as active as the right. There were no more tensions. The patellar reflexes were slightly exaggerated on both sides. Pathologic reflexes (*Babinski, Oppenheim*) did not exist.

The child was now cheerful and perfectly well. She was sent back to her home on June 6th. While before the operation the slightest noise would cause the child to shrink with terror, soon followed by the occurrence of spasms, at the present no such fear exists and our patient is in an excellent condition. For the first few nights her sleep remained entirely uninterrupted. The last report of the girl's condition is dated September 11th, and it speaks of her complete physical and mental well-being. She is able to walk.

The microscopic examination alone could decide whether the outer cyst-wall consisted of thickened pia and arachnoid only, or whether altered brain-tissue also entered into its make-up. The latter proved to be true. The report of *Heinrich Vogt* follows:

The excised cyst-wall resembles in its histologic structure that of Case 6 (p. 317). There is a scar of moderate size consisting of indurated, fibro-glious tissue, which is characterized by a marked diminution in the number of the nuclei and an increase of the fibrous elements which are very numerous, thick, and long. The vascularity is only meagre. The vessels are convoluted and show a slight increase in the thickness of the vessel-walls, without qualitative changes within the construction of the latter. The overlying pia is also markedly indurated and in a number of places it is closely adherent to the surface of the brain. The vessels of the pia are numerous and dilated. In some places the nervous elements are only scarcely represented,

and in others they are entirely wanting; they are principally found in the deeper strata of the medullary part and consist of a few dark, sclerotic, and in the majority, pigmented ganglion cells. Toward the sides of the section we see a sudden transition from the pathologic wall to the normal cortical tissue. Neither of these can, however, be designated as normal, on account of the gliomatous proliferations found within them. A short distance away normal cortical cells and the usual arrangement of the brain strata, appear again.

The findings characterize the condition as one of meningo-encephalitic foci, which have become transformed into cicatricial tissue after the disappearance of the original disease, and which show no indications of a progressive tendency of the disorder.

This case, which on account of its importance has been thoroughly and fully gone into, was one of enormous hydrocephalus, restricted to the right lateral ventricle and which was not accompanied by the slightest symptoms of pressure. The condition was in all probability due to an extravasation of blood into the brain or into the lateral ventricle with the subsequent development of inflammatory changes. The extraordinarily large cavity, the result of the enormous dilatation of the lateral ventricle, covered only by a thin cyst-wall, is the result of a coalescence of a number of hemorrhagic cysts, the separating walls of which have become absorbed as a result of pressure and inflammatory changes. That inflammatory changes have existed, is established by the microscopic examination. I heartily regret that the collected fluid has been discarded through an oversight. An isolated hydrocephalus of a lateral ventricle—producing no pressure symptoms whatever—could not cause by itself such an extraordinary thinning of the lateral wall bordering on an almost total disappearance. That no such action from pressure existed is further corroborated by the conditions found in the interior of the ventricle, the tissues of which did not show the least form of flattening of its surface.

Healing of this enormous cavity could only result from obliteration. This was aimed at in the operation by implanting the three flaps of dura on the median wall of the lateral ventricle and by repositing the osteoplastic flap in such a manner that

certain parts of its inner surface were brought in direct contact with the nerve-tissue and the covering of the ventricle. The method thus employed actually brought about healing. Puncture and aspiration alone could have never accomplished a cure. If the latter methods be resorted to, how could we expect a coalition of the walls of that enormous cavity? It is certainly out of the question to think of a dead space within the closed cranial cavity.

## OBSERVATION I, 13

*Forceps Delivery. Jacksonian Epilepsy with Idiocy. Very Marked Cicatricial and Cystic Changes of the Central Region. Removal of the Cysts and Excision of the Centre. Cure Three Years Later.*

Ladislaus B., nine years old, comes from a perfectly healthy family. His birth lasted sixty hours, and it had to be terminated with forceps. Shortly after the delivery eclamptic spasms appeared which lasted for many hours, attacking the left side by preference, and which persisted for ten days. After that, the physical and mental development of the child were good; the left extremities, however, remained deficient in development and partially paralyzed.

One year before the operation—he was at that time eight years old—without known provocation, spasming seizures occurred again. The intervals between attacks were at times of longer, at others of shorter, duration. Lately, they would occur a number of times daily and last somewhere between one-half and five minutes. Some of these attacks would last fully twenty minutes. They would occur most frequently during the evening or at night. Not all the seizures ran the same course; most of them began, as a rule, with spasms of the extensors of the left lower extremity, and the eyes were turned to the left. Simultaneously the left arm began to quiver and then to contract. In attacks of short duration the spasms were confined to the left extremities and consciousness was retained. In those of greater severity consciousness was lost and there was frothing at the mouth. The severer spasms attacked the back and all extremities, and they were accompanied by involuntary urination. Fol-

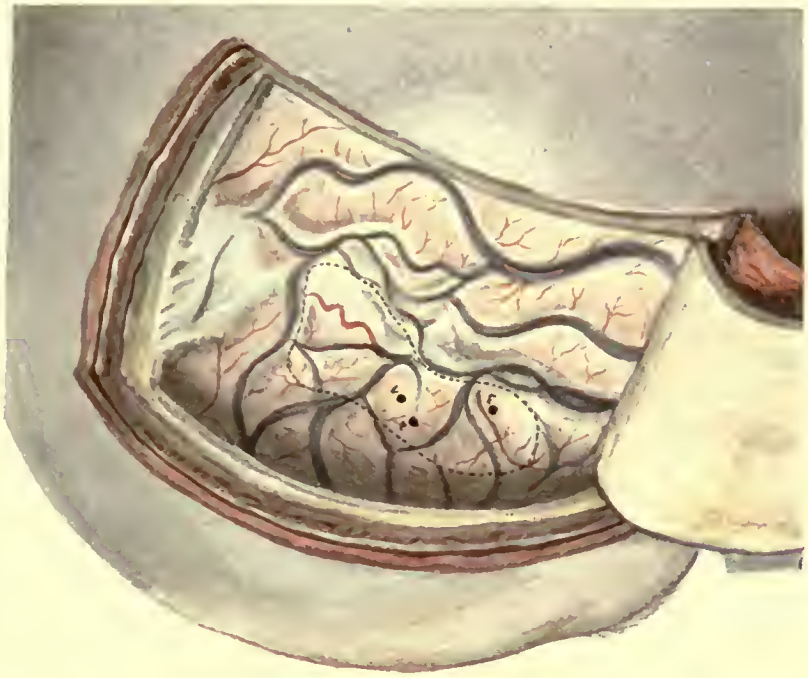

Fig. b.

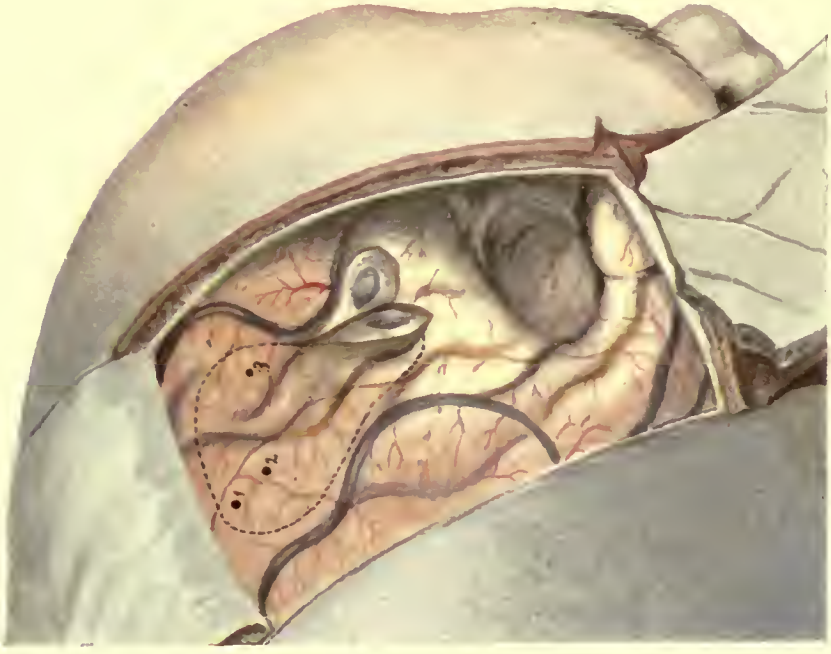

Fig. a.

lowing the seizures there usually existed a transient aphasia and marked asthenia of the left extremities.

As a result of the frequent seizures the mental development of the child suffered to a great extent in the last year. His memory was weakened out of all proportion, and his mental state could only be designated as one of beginning idiocy. The ophthalmoscopic examination proved negative. As a result of deficient development the left arm and leg were markedly diminished in size. The left lower limb was 3 cm. shorter than the right. The sole of the foot was much smaller than its opposite fellow. The circumference of the left thigh and leg were by far smaller than the right. Tests of resistance proved all movements of the lower limb below par. Real paralyses did not exist. The walk was clumsy. The patellar reflexes were very lively, much more so on the left than on the right side. *Babinski's* phenomenon was found on the left side only. There were no sensory disturbances on either side.

In development the upper extremity was much more behind than the lower. The left hand was pronated and could not be actively supinated. The fingers of the left hand were nearly paralyzed; their movements were weak and clumsy. The movements of the elbow and shoulder joints were also executed with much difficulty and with lessened power. All passive movements of the fingers, the hand, and the elbow-joint were more or less restricted as a result of the existing spasms. The periosteal and tendon reflexes of the left arm were moderately increased. Sensory conditions were normal. The stereognostic sense of the left side was very much decreased and it was almost impossible to prove its presence on account of the existing paralyses.

During an observation extending over a period of ten days, a number of spasms occurred. They commenced with twitchings of the left arm which soon became general. The severer attacks were characteristically epileptic. The head and eyes were turned to the left and consciousness was lost. There were injuries of the tongue from biting and involuntary evacuations of the bladder. A number of seizures were accompanied by vomiting. Attacks lasting for a considerable period were frequently accompanied by a rise of temperature to 39° C. While

a distinct aura did not exist, attacks of fear and terror were not infrequently noted shortly before the onset of the attack.

At the time of the first operation—October 9, 1907—an osteoplastic flap was trephined which measured 12 cm. in height, and 7 cm. in width. The 1½ cm. wide sinus longitudinalis was thereby completely exposed. On account of the weakened condition of the boy, the second operation was deferred until the 21st of October—twelve days after the first. After the usual blunt separation and downward reflection of the osteoplastic flap, the dura appeared to be normal and showed distinct pulsations. On account of the presence of the sinus longitudinalis the base of the flap was made to occupy an upward position; it measured 80 mm. in length, and it had an average width of about 50 mm. (See Plate XXX, Fig. a.)

Two veins crossing the sinus longitudinalis had to be ligated: one in the upper anterior angle of the wound, the other about the middle of the base of the dural flap. The first incision into the dura at once brought to view the jellylike, infiltrated, and bluish, transparent arachnoid. Reflection of the dural flap showed the arachnoid only slightly infiltrated in the upper half of the cleft; in the lower half the œdematous infiltration was very excessive. In this locality the pia contained a few whitish, dense spots. In the lower anterior angle of the wound a bluish, transparent subarachnoid cyst was found, partly hidden from view under cover of the bone, and which measured 30 mm. in width, 30 mm. in height, and, as later shown, 28 mm. in depth.

Immediately following the elevation of the dural flap, especially after the removal of the œdema of the arachnoid by scarification, a striking contrast between the colors of the exposed cerebral cortex was at once visible. The brain, contiguous to the arachnoid cyst, showed vascular deficiency for a distance of about 3 cm., after which it gradually resumed the reddish color of the normal brain. The anterior central convolution was located by means of the faradic current. It was considerably narrowed in its lower part. Its width varied somewhere between 6.5 and 14 mm. In one place it measured only 5 mm. A number of convolutions, situated in front of the anterior central, were also distinctly narrowed and atrophic.

Strong unipolar faradization had to be resorted to before

contractions could be obtained. The first contractions were observed at point 1, situated along the sinus longitudinalis. To get these contractions, complete covering of the coil (120 mm.) and simultaneous interpolation of the metal stopper to 78 mm. were required. At first, tonic backward movements of the arm (action of the latissimus dorsi), and flexory movements of the forearm (action of biceps and brachialis anticus muscles) were observed. Once these movements were accompanied by clonic contractions of the deltoid and slight lateral elevation of the arm as well as inward rotation of the left foot. Irritations of point 2 resulted in contractions of the deltoid and biceps as well as slight ulnar flexion of the hand. Besides the movements just mentioned, there occurred once, upon irritation of the same point, volar flexion of the left hand and adduction of the thumb. The flexory movements were of a tonic character. The strength of current used: coil-covering 120 mm. and interpolation of the metal stopper, 70 mm. Irritation of point 3 with the same strength of current resulted in an epileptic attack confined to the left side, without participation of the facialis. The interruption of the irritation caused an immediate suspension of the seizure, the last signs of which had completely gone after twenty seconds. The contractions began with slight volar flexion of the hand, extension of the index finger, extension and abduction of the thumb, and abduction of the arm to an almost horizontal position. At a second irritation with complete covering of the coil (120 mm.), there resulted extension of the index finger and abduction of the thumb only. No contractions were seen upon reducing the strength of the current. Faradic irritations of the other exposed parts of the brain were followed by no contractions whatever.

After completing the electric irritations the arachnoid cyst was opened and its contents evacuated. The floor of the cyst was composed of smooth cortical tissue which was covered by pia. In size it was larger than a walnut. After evacuating the cyst the entire portion of the brain, situated toward the base, was found to be markedly atrophic to a height of about 4 cm.; a space was thereby created, the breadth of about a finger, situated between the brain, toward the frontal pole, and the lamina vitrea. Higher up—toward the sagittal line—conditions

were normal, viz., the brain was separated from the dura by a small cleft. The *Sylvian* fissure and the upper temporal convolution could therefore clearly be seen under the bone. Irritations of the cyst-bed, with very strong faradic currents, were negative. A small strip of gauze was placed into the evacuated cyst.

After deligation of the veins of the pia a portion of brain of about 4 to 6 mm. in thickness, comprising the centres for the arm and hand, was excised. During the excision an intracortical cyst the size of a bean, located in the lower anterior section of the anterior central convolution, was discovered, opened and excised. The defect in the cortex measured from above downward 48 mm. in width; above 21 mm. below 16, and in its widest part, 28 mm. The slight hemorrhage in the wound of the brain was arrested by digital pressure, applied to the dura after replacing it over the defect. One end of the strip of gauze which had been placed in the bed of the cyst was brought to the surface in the anterior lower angle of the wound; the osteoplastic flap was then sutured into position without provision for drainage other than the strip just alluded to. The healing of the wound was uneventful.

The symptoms following the excision were slight, because the portions excised were markedly altered and as will be remembered the motility of the left arm and hand were considerably reduced for quite a period preceding the operation. Yet, there was a great reduction in the motility of both left extremities on the day after the operation, but a few weeks later the conditions existing before returned again. On the other hand, sensory disturbances could not be demonstrated. The child, who until the second operation was a daily sufferer from spasms, was discharged from our care November 13, 1907. Not a single attack has recurred since the excision of the cortex.

In this case there has in all probability resulted a hemorrhage over the right cerebral hemisphere and perhaps into the brain substance itself caused by the pressure of the forceps; because the child was free from inherited taints and no other cause could be discovered. The severe spasms noted in the first ten days after the delivery were undoubtedly due to the action

of the extravasated blood on the brain-tissue, and this was also responsible for the deficient development of the right cerebral hemisphere—especially in the region of the right central and frontal areas. With that, the deficient development, asthenia, and paralyses of the left extremities went hand in hand. After an interval of eight years, there suddenly occurred cortical spasms of the *Jacksonian* type. After the spasms had existed for about a year and the intellect had suffered to no small degree, the operation was undertaken. A distinct atrophy of the posterior section of the right frontal brain and a large part of the right central region, as well as severe inflammatory changes of the pia and arachnoid were found. The faradic irritation required uncommonly strong currents. During the irritations there occurred a transient seizure of spasms. The excision of the "primary spasming" centre disclosed in this locality the presence of severe structural damage—intracortical cyst formation—and farádic irritation again proved its great value.

Besides that, marked histologic changes were found (see Case 6, p. 317). The microscopic findings closely resembled those of the case of breech presentation described on p. 380.

The immediate results of the operation were highly satisfactory. The daily occurring spasms disappeared. The further course of the disease justifies the hope for a lasting recovery. At the present time (three years and four months after the operation) a definite opinion can, of course, not be expressed. Be this as it may, however, the boy did not have the slightest attack since the operation, and he has since that time developed mentally to a very satisfactory degree. I had the opportunity to examine him again, at the International Medical Congress held at Budapest, September 2, 1909.

The very large trepanation flap (12.8 cm.) showed complete and perfect osseous union. The paralyses of the left extremities were considerably improved, the musculature was well developed, and the left limb was scarcely weaker than the right. Prior to the operation the left lower limb was fully 2 cm. shorter than the right; now the shortening amounts to ½ cm. only. The walk has considerably improved. Slight contractures of the joints of the left upper extremity still existed. In the foot, there was a slight

contracture of the talo-navicular joint which was accompanied by an inconsiderable abduction of the foot.

Careful after-treatment with gymnastics, massage, baths, etc., were of distinct value in improving the patient's general condition. The improvement was so marked that in January, 1908, the boy could use his hand and fingers to grasp things, and in October of the same year the limping was considerably lessened. The genitalia were somewhat behind in development. The right testicle was situated above the external inguinal ring, the left in a normal position. The boy had daily erections.

Concerning the mental state of the patient, it is noteworthy that, while at the time of the operation he was an almost complete idiot, with great weakness of memory, frequently uttering unarticulated animal-like cries, he commenced to write while still in bed at Berlin. His further development progressed rapidly. His regular instruction could soon commence, and as early as January, 1908, the little Hungarian was able to write to me a German letter. From October, 1908, he studied at the gymnasium (high-school). He became a good scholar, and he reported to me his progress in the winter of 1910. He wrote to me in Latin. His mother describes him as somewhat headstrong and hasty—peculiarities he had inherited from his father. His memory is, according to her statement, "nothing short of marvellous." At that time my colleague at Budapest considered the boy completely cured. Meanwhile another year passed by. Attacks occurred no more and the mental as well as the physical development of our patient has made wonderful progress. According to a written statement, the young man, who is now twenty-one years old, is perfectly normal, remarkably strong, and wonderfully developed intellectually.

### Identity of the Changes in Infectious and Traumatic Encephalitis of Children

The macroscopic as well as the histologic changes of the central region, found in both forms of infantile cerebral paralysis—be they the result of infectious processes or consequent to trauma inflicted during parturition—are strikingly similar and we may therefore not wonder that both forms are seen to give rise to the

same kind of clinical manifestations. I shall cite the following case (Plate XXX, Fig. b) on account of its important bearing on the subject under consideration.

## OBSERVATION I, 14

*Encephalitis. Jacksonian Epilepsy. Cicatricial Changes in the Central Region. Excision of Centre. Improvement in the Last Two and a Half Years.*

This observation concerns a boy, almost twelve years of age, who until the end of the first half year of his life enjoyed perfect health, and developed normally. At that time there suddenly set in a high degree of temperature, accompanied by spasms that greatly endangered the life of the boy. He remained in that condition for fourteen days, after which he recuperated, but a complete right-sided paralysis remained with him. The latter condition improved, however, to a great extent, so that at the age of two years the boy was able to go about with the aid of splints. His general development progressed thenceforth favorably, and no disturbances of any sort were noticed. Intellectually, he remained far behind. Outside of a few babbling words his power of speech was *nil*. When he was about three years old, spasms occurred on the right side, which soon became general and attained a frequency of four to six per day; sometimes weeks elapsed between the attacks.

At the operations performed on the 11th and 24th of October, respectively, the dura was found extraordinarily thickened. The freely exposed arachnoid was markedly œdematous and showed, besides this condition, a number of other important changes. Dense, white connective-tissue strands were seen along the veins. Especially noteworthy was the presence of a fibrous band 2 cm. wide that was traversing the centre of the opening; it then passed from above downward over the brain, and thence to the upper anterior angle of the wound. Flattened adhesions between the cicatricially changed pia and arachnoid were also found and severed. The sinus longitudinalis was visible. Faradic irritation showed us that the anterior central convolution was situated in front of the cicatricial band of the pia. Points

1, 2, and 3 were foci of the deltoid, forearm, and hand. The irritations were soon followed by spasmodic attacks.

The veins of the pia in the vicinity of the primary spasming centres were ligated, and portions of cortical tissue belonging to the anterior central convolution, and containing the ascertained foci, were excised. The defect thus created measured 46 mm. from above downward. Above, it was 20, and in the middle and below, 18 mm. wide. The very slight bleeding was easily arrested by pressure with gauze sponges. The brain appeared greatly sunken in. The distance between the dura and the cerebral surface—measured at the anterior angle of the wound—was 15 mm. The dura was now replaced and the osteoplastic flap sutured into position without drainage. The child was discharged five weeks later. His wound had completely healed.

According to the report of the patient's father, dated June 29, 1910, the attacks occurring after the operation were very much lighter than those before, and for a number of weeks they had completely disappeared. The paralyses of the right arm and leg have materially diminished. There is also a marked improvement in the memory of the patient. He takes quite an interest in lively affairs. His speech, however, remains defective.

The microscopic findings of the excised portion of the brain are described on page 319 (Case 7).

## Jacksonian Epilepsy Without Microscopic Findings

While the cases thus far described have always shown distinct pathologico-anatomic conditions, which were directly responsible for the epilepsy, the group of cases of *Jacksonian* seizures to be presently described, show no changes at all, or, at best, only slight alterations of the cerebral cortex or the deeper strata of the brain substance. In these cases we are confronted with the important question, whether we should act in the sense of *Victor Horsley*, and excise the primary spasming centre or leave it alone. His advice was at that time received with exalted enthusiasm, which, however, soon died out and the procedure was finally completely abandoned—in my opinion unjustly. Looking through the literature, we find that the majority of surgeons were wont to locate the centres according to anatomic landmarks.

This method, as I have repeatedly emphasized before, is to be discarded as of no value. The results obtained in previous operations in which this method has been made use of, should be subjected to profound scrutiny and just criticism. In cases where even large openings were made in the skull, I have frequently had occasion to find the faradically irritable centre to be hidden under the bone; and in order to gain access to it, the bone had to be removed or another flap created.

The necessary details of technic are described on page 348.

According to my experiences, there can exist no doubt that the extirpation of the primary spasming centre of the cerebrocortical area may bring about a cure in *Jacksonian* epilepsy —it is therefore a justifiable and commendable method of intervention in these cases. A fact of great importance has been brought out by the early experimental labors of *Hitzig*, and that is, that too strong electrical irritations as well as the excision of a portion of the cortical motor area may give rise to recurrent spasms of an epileptic nature. Our prognostications should therefore carry with them a certain degree of scepticism right at the outset, and positive opinions as to whether operative interferences in the motor region of epileptics will be followed by the desired results should be expressed with great caution. In view of theoretical dissertations the question naturally forces itself upon us whether, in patients in whom the high state of irritability of the motor area is induced by the severe illness from which they are suffering, an operation on the central area would not produce a scar which by its presence alone would be capable of perpetuating the irritation, and thereby frustrate our attempts to cure the epilepsy.

Regardless of how strongly such theoretic conclusions may present themselves to us, their correctness or incorrectness can be established—in man—by practical experiences alone. My experiences in this respect have taught me that recurrences following scars remaining after an operation are by no means the rule.

You will remember, for instance, the case described as Observation I, 8, on p. 352, where the wounds remaining after the enucleation of the cyst and the wide scar surfaces resulting from the excision of the "primary spasming centre" of the forearm

could heal in one manner—the only way known to us—cicatrization. Yet, seventeen years have gone by since the patient had undergone the operation, and she remains completely cured from a severe form of epilepsy and from idiocy.

I have, furthermore, had occasion to see cases, quite a number of times, in which epileptic spasms that have existed for years and were of daily occurrence—in some instances occurring as often as eight times in one day—and which have never left the patient for more than a few days at the utmost, have completely and lastingly disappeared after excising normally appearing "primary spasming centres." The conclusion in these cases is certainly justifiable, that the aseptic scars which surely existed in the brains of these patients as a result of the excisions were not provocative of spasms nor symptoms of any nature or description.

Finally, I should like to object to the belief entertained in certain quarters, that only those cases are amenable to surgical intervention in which the pathologic process is situated in the cortex solely, that is, in an accessible position. This is certainly not the case. Even when epilepsy is occasioned by focal conditions, deeply seated within the brain substance, it may be favorably influenced or even permanently cured by an operation directed to that end. An example follows.

## OBSERVATION I, 15

*Acute Nephritis with Cerebral Hemorrhage, Hemiplegia and Hemianopsia. Jacksonian Epilepsy Originating from the Paretic Side. Excision of the Primary Spasming Arm Centre. Cure after Eight Years.*

Otto B., thirty years old, of Schwerin. His father died from locomotor ataxia at the age of sixty-three years. His mother and six sisters are healthy. He enjoyed good health until the age of sixteen years. No lues or other constitutional disease. About the beginning of April, 1888—he was at that time sixteen years old—he suddenly became ill with acute nephritis, accompanied by severe anasarca and ascites, the cause of which could not be ascertained. Fourteen days later, there suddenly

occurred (without spasms or disturbances of consciousness) a complete paralysis of the left arm and of the left lower extremity, accompanied by a reduction of sensibility. The articulations and the facialis did not participate in the paralysis. Upon protrusion the tongue deviated to the left. The motility of the limbs gradually returned, at first in the lower then in the upper extremity. About the beginning of June the patient was able to walk again. There nevertheless remained a slight weakness of the lower extremity and a paresis of the arm of permanent duration (the arm and leg are in the same condition at present as they were in 1890). The sensory functions on the other hand have completely recuperated. At the time when the paralysis first manifested itself, the intellect of the patient was very much weakened, and it regained its normal state, very gradually, about the end of 1890. Until 1894 the occupation of the young man was that of a painter of china. On account of the weakness of his left arm, he was compelled to give up his business and he has since been engaged as an agent. While copying accounts, in the winter of 1894–95, he discovered that he was afflicted with a left-sided hemianopsia, which persisted to the present date. The physician attending him at the time of the onset of the hemiplegia did not observe the existence of a hemianopsia. The patient, however, has observed that in the years preceding the onset of the hemiplegia prior to 1888—all the functions and motions performed with the left half of the face were in the highest degree clumsy and awkward. He could not find a cause for the existence of the condition just mentioned. The hemianopsia has evidently developed simultaneously with the hemiplegia.

On Easter of 1898, the first spasming attack occurred, without known cause or premonition. The patient was at that time twenty-six years old. While he was depositing a letter in the mail-box with the right hand, he became dizzy; he could carefully note that his left arm became flexed in a spastic manner at the elbow-joint, and it executed at the same time quivering motions. At the same moment he fell unconscious on the street. After the seizure, he walked home unassisted, prepared himself to take dinner, and while eating he was seized with the second attack—half an hour after the first. According to the description of his relatives, this, as well as all other following attacks

were very similar in nature. I shall describe them in detail later. At first the attacks would occur about once in every four or five weeks, followed by a marked increase in their frequency—since the summer of 1903 about three attacks daily. They were all of a severe nature. The aura consisted of a sensation of a cold shower ascending from the nape of his neck to the occiput on the right side. In the last few years he also noted specks of light in front of his eyes and he was unable to concentrate his mind. On the other hand, he has never perceived paræsthesias in the arm or the lower extremity preceding an attack or at any other time.

With reference to his psychic condition, he became more irritable and of an angry disposition. On one occasion (1898) he raved like a maniac. Lately his memory suffered to a very great extent. This gave him an enormous set-back in his business affairs. His mind was not as receptive as heretofore. All forms of therapy proved useless.

He was admitted on October 4, 1902. From that day on to the date of the operation (October 15th), a whole series of attacks were observed. They set in so unexpectedly and with such rapidity, that at one time it took all the efforts of his sister to remove the bread from his mouth with which it was filled at the time of the onset of the seizure, to save him from suffocation. To cite another instance: On his admission, while his history was being recorded, he sat quietly near me. Suddenly he exclaimed, "I am getting an attack," he then jumped up and advanced a few steps toward his bed. Before reaching it, however, and without uttering a cry he fell unconscious to the floor and he had to be picked up and carried to his bed. At the same moment, his left fingers, the left hand and forearm were flexed to the highest possible degree. It was a tonic contraction interrupted only by a few clonic spasms. Following this, his left lower facial region became spasmodically contracted, and the angle of his mouth was pulled downward to the strongest imaginable degree. Somewhat later the left leg, knee, and hip were slightly tonically contracted. Mild clonic contractions were also observed. Minor contractions were finally noticed in all other parts of the body. The head and upper part of the trunk were turned to the right in strong tonic tension. The pupils were

widely dilated and did not react to light. The corneal reflexes were absent. The respirations were snoring and they were accompanied by a marked degree of cyanosis. The entire attack lasted one minute—perhaps a little over. After awakening the entire musculature of the left arm was completely paralyzed; upon lifting it and permitting it to fall by its own gravity it behaved like a hemiplegic limb. Paresis was only found in the left lower extremity; it could only slightly be flexed actively at the hip and extended at the leg. The left lower facial was completely paralyzed. The weakness of the left lower limb regressed quite rapidly, that of the facialis somewhat slower, while that of the arm lasted about five minutes. The extremities of the right side were as strong immediately after as before the attack. The respirations remained labored and wheezing for about five minutes longer. Eight minutes from the commencement of the attack the patient was able to walk again, but was still dazed. The left arm remained weak for quite a long while. At times there would also remain a weakness of the left lower extremity which would last for a number of hours and it would mainly be perceptible while the patient was walking.

These post-epileptic paralyses and pareses were very characteristic indeed. The centres which mainly participated in the spasming seizure as that of the arm were so fatigued that for a certain length of time they did not functionate at all. Those less affected (lower facialis, leg) recuperated quicker. The aura preceding these attacks consisted of a sensation of whirling in the head and the patient could not think quickly.

We were therefore dealing with a typical case of *Jacksonian* epilepsy. The centres of the fingers, the hand, and the forearm were first thrown into irritation, followed by that of the lower facialis. The next problem to clear up was to connect the epileptic seizure with the hemiplegia. This was evidently the result of an extravasation of blood into the brain, brought about by the nephritis. The colleague who referred the case to me for operation—*Dr. Vollbrecht*, of Schwerin—was of the opinion that the condition was due to an encapsulated exudate or to a pathologic thickening of the cerebral membranes. Both of these assumptions were possibilities, the latter was actually the case

(as we shall see later on). It could also have been a cyst formation situated under the centres of the left forearm and the lower facial, as was the case, for instance, in Observation I, 8, p. 352. In considering such cases we must also think of the possible existence of other conditions which might have developed. As is well known, tumors may give rise to cortical epilepsy. Attacks may also ensue a long time prior to the development of the neoplasm. At any rate, symptoms indicating the presence of a tumor were wanting in this case, regardless of the fact that the illness existed for four and a half years. The internal organs were normal. The examination of the urine proved negative.

On the 15th of October, 1902, trepanation of the area overlying the right central convolutions was carried out. The dura was tightly stretched and showed no pulsations. A flap was formed and reflected downward. The œdematous, bluish-red-looking pia and arachnoid at once presented themselves through the opening made in the dura. After detaching the dura from the brain, pulsations were plainly visible. The veins of the pia were separated from each other by wide, grayish, diffuse connective-tissue bands (leptomeningitis chronica). Palpation of the presenting portion of the brain showed no abnormalities. Faradic irritation ascertained the position of the centres of the hand, the rest of the fingers and the forearm (area 2), and also that of the facialis (area 1). Somewhat prolonged irritation of the centre of the arm caused the beginning of an epileptic attack. After opposition and flexion of the thumb, flexion of the rest of the fingers, ulnar flexion of the hand, and pronation of the forearm, there followed flexion of the wrist and elbow joints with clonic contractions in the latter, which became extended and flexed alternately. The irritations were immediately interrupted, and the contractions ceased at once.

In order to expose also the centre of the arm, a section of bone measuring 15 mm. in height was removed from the upper border of the osseous cleft, by means of a pair of rongeur forceps. The dura was now incised in a vertical direction, about its middle, and reflected upward. Neither here could we detect pathologic conditions. After two negative punctures, the centres of the forearm, the hand, as well as that of the lower

facial were excised to an extent of 23 : 15 to 20 mm. in width, and to about 5 mm. in depth. The dural as well as the osteoplastic flaps were fixed in position by means of sutures. Disturbances resulting in complications in the healing of the wound as a result of a blood-clot has been detailed in Vol. I, pp. 103, 104.

On the 20th of December, 1902, the patient was permitted to return to his home. He at once resumed his business activi-

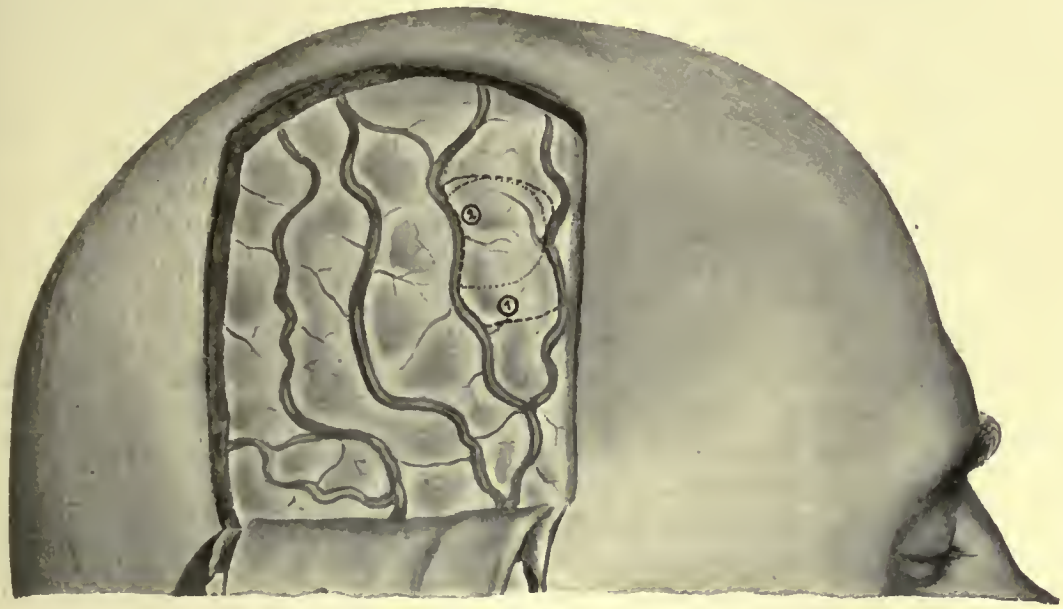

Fig. 83

For explanation compare p. 402

ties as an agent, and on the 9th of January, 1903, he reported that he is getting along well and that he is able to travel great distances. He can be on the road for three or four hours without becoming in the least fatigued. In his communication of March he goes on to say: "I am now looking much healthier than at any time before the operation. I am enjoying life to a full measure." In a letter dated July 31, 1903, the patient states that he has noticed a quivering in the left half of the face, especially the cheek, and a twitching of the left angle of the mouth which he first noticed on the morning of the 31st of March, while he was still in bed, and which repeated itself

on April 24th, May 5th, and on the 22d and 30th of July, respectively. The patient did not lose consciousness—even for a moment—he was therefore able to observe that the twitchings soon vanished, leaving no disturbances whatever behind.

In 1904 there would occur from time to time slight attacks without loss of consciousness. They consisted of spasmodic abductions of the left arm accompanied by quivering of the left lower extremity. In response to my inquiry the patient replied (February 15, 1905) that he was getting along very well. It is true that he still has from time to time—on the average of about once in every two to three months—after getting out of bed in the morning, slight contractions, but these are very insignificant and they are never accompanied by loss of consciousness. The twitchings occur only in the left arm and in the left lower extremity. At times in the left half of the face alone. He notices no untoward symptoms in the head, and his memory is very good. After the occurrence of the slight seizures just alluded to, he does not feel in the least fatigued, and half an hour later he is to be found busily engaged in some business deal or on the road. He concludes his letter by saying: "I am very happy and pleased with the result of the operation, and while I cannot say that I am completely cured, yet the improvement in my condition is so extraordinary that I shall never regret my decision to undergo the operation. I am attending to my business —which has extensively increased—without the slightest hindrance or disturbance."

Another report received from the patient on the 30th of December informs me that actual seizures have not recurred, and that the occasional stretchings and quiverings of the left arm and more infrequently of the lower limb of the same side were so insignificant that he would not dignify them as attacks, since they amounted only to a very little inconvenience, and he retained his full senses while they lasted. These phenomena would recur on the average of about once in four weeks. The patient believes himself perfectly well psychically. He carries on an exacting and strenuous business to great satisfaction (general agency).

In May of the same year he married, and on the following May he became a father. October, 1907, he writes again, that

slight spasmodic twitchings of the left arm, accompanied by a sensation of spasmodic contraction of his heart, appear about once in four to six weeks, when he is about to leave his bed. He adds, that these symptoms have more and more lessened in frequency as well as in intensity.

His report of October, 1910, reads: "My general condition is excellent. I am engaged in my strenuous business all day long. Only once in about every four to six weeks I still perceive upon awakening, in the morning, a spasmodic sensation which is confined to the heart; it lasts about half a minute. These sensations are getting to be rarer, however, and they are of milder character. My memory is good. My intellect is normal and not weakened. Since my operation (eight years ago) I have not used any form of treatment. I am happy over my recovery. My three years old little daughter is mentally as well as physically a perfectly well-developed child."

## Results of Cortical Excisions

### Disturbances of Motility and Sensibility

The primary spasming centres, that were located by means of electrical irritations and then excised, were of small dimensions only. My excisions rarely exceeded a width of 24, a length of 30, and a depth of from 5 to 8 mm.

After cortical excisions there usually appear certain manifestations the intensity of which increases for a time and then diminishes again. Where the excisions did not comprise large cortical sections, the paralyses and sensory disturbances adjust themselves more or less in the course of days, weeks, or perhaps months—some sooner, others later. They do not disappear, however, completely. In some instances there remain deficiencies in the execution of finer movements.

It is consoling to note that in cases of cerebral infantile paralysis, in which the cortical tissues are damaged to a greater or lesser extent, excisions of greater magnitude are, as a rule, not followed by lasting disturbances. We may therefore avail ourselves of this method in these cases with less fear of unpleasant consequences. However, in cases in which no macroscopic changes are found and the cortex appears to be normal, we must

act with double caution—excising only the smallest possible sections—because post-operative changes are most apt to occur in just such instances. This word of caution cannot be too strongly emphasized, especially in operating on the left hemisphere on account of the centre of speech and the importance of the right extremities.

Animal experiments have taught us that excisions of greater extent are followed by extraordinarily severe paralyses. This fact was established by physiologists. Fortunately, we need not resort to such extensive excisions in cases of epilepsy in men. In view of the fact that in cases of epilepsy in which the patient appears to be alarmingly ill, excisions of small portions of cortical tissue are quite frequently followed by remarkable improvement or even cure, this method should be more extensively made use of in properly selected cases.

The tests I have made, after cortical excisions, were always undertaken in the daytime, preferably in the morning, after the patient has been refreshed by sleep and they were never unduly prolonged. In order to obtain the best results, the tests were necessarily made at times when symptoms of exhaustion—usually more marked after cortical operations—could be eliminated as far as possible.

I have performed operations on the brain, in isolated instances, without resorting to the use of any anæsthetic. We may do this because the exposed brain—cerebrum and cerebellum alike—are almost completely insensitive. The brain may be cut, manipulated, and irritated without the patient experiencing the slightest sensation. On the other hand, the dura is extremely sensitive. This, of course, is not surprising, when we remember that all three branches of the trigeminus furnish its nerve-supply. Touching or pulling it will at once cause the patient to utter a cry.

I will illustrate this by an example. A patient in whom the centres of the hand and forearm of the right motor region were excised without the use of an anæsthetic was, two minutes later, requested to perform active movements with his left upper extremity, and his hand and fingers were found completely relaxed and paralyzed. He also was unable to actively extend his elbow-joint; on the other hand, the left biceps was at that time still

innervated. Two minutes later, the elbow-joint was also paralyzed. Even with the strongest impulses of the will (the patient executed very energetic movements with his right arm and head) he was unable to move his elbow-joint, even to the slightest extent. After an hour of the foregoing, however, he was still able to somewhat elevate and abduct his left arm. Only after the expiration of fully four hours the mobility of the left shoulder-joint was completely extinguished. Although the foci of the hip were left entirely unmolested, a distinct weakness of its movements was noted a few hours later. The knee-joint also shared in the very marked paresis. An hour later, the left foot and the toes were found limp and paralyzed.

As a rule, the paralytic phenomena disappear in the larger joints first, recuperation then follows in the smaller ones. Usually, but not always, active flexory movements reappear and regain their strength first.

Even though the paralyses of the extremities be of a slight degree only, distinct ataxic conditions and disturbances of coordination may be demonstrated in them; these also persist on the return to normal.

While with few exceptions I have strictly adhered to the anterior central convolution only, there occurred, in addition to motor phenomena, disturbances of the sensory sphere which accompanied the motor symptoms to a marked degree. The disturbances in this respect were so gross that there existed no room for an unintentional error.

For an example, I cite the case of a patient operated upon, in whom the sense of posture of the upper extremity was entirely lost. In the case of another, it was disturbed to such an extent that at the joints of the fingers nothing was felt, no matter what position they were placed in. In the wrist-joint, the perception was only slight; while at the elbow, flexions to an angle of 60 degrees were not perceived in the least. Pieces of ice placed against the skin of the patient yielded the same results; after the lapse of a long time following the application of the ice, the patient would say "pin-head or pin-point."

Other disturbances observed were muscular rigidities and a marked increase of the skin, tendon, and periosteal reflexes. In the beginning there exists, as a rule, complete hypotonia with

extinction of the reflexes. In most cases, however, there is a quick disappearance of this stage. Frequently the muscle-tonus reappears gradually after a few hours. That there remains a certain weakness lasting for a longer period is certain; but there is soon noted an increase of the tendon and periosteal reflexes and pathologic reflexes of the skin, and the *Oppenheim* and *Babinski* phenomena now make their appearance. The hypotonia then becomes transformed into hypertonia, rigidity, spasms, or even contractures.

The manifold qualities of sensation, i.e., sense of touch, pain, temperature (with delayed conduction), the sense of location, the sense of posture (muscle and joint sense) as well as the stereognostic sense, participate to a greater or lesser extent in individual cases. In hemianæsthesia, accompanying motor manifestations, it was observed that peripheral portions of limbs were preferably affected to the exclusion of others. They are the last of the sensory disturbances to disappear during retrogression. Even when all sensory manifestations have vanished, we could not find a complete restoration of the muscular sense, the sense of location and that of stereognosis. The last-named sense especially remained more or less damaged.

The explanation for these phenomena is offered by *v. Monakow*. He has shown that the representation of these qualities are in closest connection with the innervation foci of the finer movements in the *Rolandic* region; and that, in view of the close reciprocal conditions existing between the motor centres and the sensory end-portions, nothing but perverted or complete loss of sensory function may be expected after partial or complete destruction of either. The reappearance of the pain and temperature sense speaks for the existence of representations of these qualities by deeper centres, analogous to those situated subcortically and representing simple muscular movements.

The time consumed by the secondary disturbances in their regression is subject to extraordinary variation. Some cases requiring twenty-four hours to reach a certain stage of regression will, in other instances, require months to accomplish the same result.

Our findings corroborate also the well-known fact that the central region does not contain motor centres alone. The sen-

sory centres are here well represented. The relation of the anterior central convolution to the posterior is that of one twin to its fellow.

## OBSERVATION I, 15

The history of this case is given on p. 390.

Besides spasms, the quite strong-looking patient presented the following: The skull was small, brachycephalic in type and insensitve to pressure and percussion. The only deviation from the normal found in the areas occupied by the cerebral nerves was a complete left-sided hemianopsia. The pupils reacted to accommodation as well as convergence in a normal manner. No pupillary contractions could be obtained from the right half of the retina by irritating it with a beam of light from a ten-candle-power incandescent lamp; the left half, on the other hand, responded at once. This result was obtained at the beginning of the examination only, because exhaustion soon set in. The ophthalmoscopic examination was normal.

The musculature of the left forearm was atrophic—somewhat more so on the extensor than on the flexor side. The circumference of the left forearm was 2 cm.; that of the left arm $2\frac{1}{2}$ cm. less than that of the right. The hand-openers and outward-rotators of the left upper extremity were decidedly paretic; the coarse power of the left elbow-joint was also reduced at flexion and extension. Finer movements were executed with clumsiness in the left hand as compared with those of the right, yet there existed neither ataxia nor athetosis. There was no contracture of the left arm, the same being true of the left lower extremity. In the latter, the coarse power was somewhat reduced; the flexors of the knee on the left side were considerably weaker. The extensors of the foot and toes, however, were as strong as those of the right side. The circumference of the left thigh was 32 cm. to 35 cm. of that of the right. The musculature of the trunk showed no differences.

Sensory, trophic, as well as vasomotor disturbances were not present in the face nor in any other extremity; abnormalities in the sweat-excretion did not exist. The very slight change in the stereognostic sense still present could not be considered, since it ranged quite near the normal limits. The periosteal and ten-

don reflexes were increased in the extremities of the left side. To be more specific, the reflex of the left biceps was distinct, that of the right weak; the response of the triceps was completely wanting on the right side, while on the left it was pronounced and could be elicited with ease from the periosteum of the olecranon process. The supinator reflex was very distinct on the left side and it could also be obtained from the flexors and from the periosteum of the radius and ulna of the same side, which was not the case on the right. Forced volar flexion elicited clonus of both hands.

The knee-jerk was more pronounced on the left side. Displacement of the patella enabled us to obtain quadriceps-clonus in the last-named locality. It was impossible to produce this on the right side. The Achilles tendon-reflex was present on the left and very weak on the right side. Ankle-clonus was present in the left but not in the right foot. On attempting to stand on tiptoes, quivering of the left foot and other parts of the left lower extremity resulted; this was not the case on the right side.

Of the skin reflexes, the cremasteric and abdominal-wall reflex were present on the right side only; the reflexes of the soles of both feet were there (more marked on the right side). *Babinski's* sign did not exist. It was asserted that fourteen years ago the tongue deviated to the left upon protrusion; this condition, however, does not exist at present. The facialis remained equal on both sides.

After exposing the central region, unipolar faradization yielded (see Fig. 83, p. 395) at point 1 (representing the centre of the face), twitchings of the left angle of the mouth and the left portion of the upper lip. The focus for the hand and forearm was located 2 cm. above the last-mentioned centre (2), the irritation of which was followed by opposition and flexion of the thumb, flexion of the other fingers, together with pronation of the forearm with flexion and also ulnar flexion of the hand accompanied by simultaneous flexion of the wrist and elbow joints. The same results were obtained from bipolar faradizations.

The centres described were excised to an extent of 23 mm. in length, 15 to 20 mm. in width, and to a depth at least 5 mm., down to the white substance. Posteriorly, the excision was

bounded by a large vein, which presumably corresponded to the sulcus centralis.

So little did the operation affect the patient, that half an hour after its completion an examination could be undertaken. The sensorium was completely free. The lower facial was completely paretic; the angle of the mouth retracted while the patient was laughing and the exposure of the teeth caused the left upper lip to deviate. The upper facial evidently did not participate, except that at active and forcible closure of the eyes the left upper lid could be elevated with greater ease than that of the right eye. The entire left arm was completely paralyzed; it fell limp to the side, very much like a hemiplegic limb. He could actively extend the left leg, which was flexed at the knee. It was further ascertained on the same evening that the patient did not feel the touch of the examining finger in the entire extent of the left arm, up to the shoulder-joint. While pinching of the skin caused pain, yet, its location could not be stated by the patient. The same conditions were found in the leg, while the sensations of the trunk and the right extremities remained normal.

The left leg remained rigidly extended and its passive motion could only be accomplished by the use of force; it could not be moved actively at all. Placing the limb in a position of passive flexion, the patient could extend it with great force. The foot could also be brought into active plantar but not into dorsal flexion. During the further observation, the entire right half of the body presented perfectly normal conditions.

With reference to changes of individual functions, I shall speak of

*Motility*

first.

On the day following the operation, the paralysis in the left facial region was perhaps somewhat lessened and a distinct improvement in the left arm was noticeable. The patient could bring his extended left forearm to a right angle at the elbow-joint; this was accomplished at the expense of great exertion on the part of the patient. At the same time there were unintentional strong flexory movements of the left hip and knee joints as well as high elevation of the right shoulder—all accompany-

ing the aforementioned motions. The patient was further able to bring the passively extended four fingers to such a degree of flexion that in this position he was able to lightly grasp my index finger. This was, however, done slowly and with little power. This flexion of the fingers was manifest in all three joints, but it was least marked in the basal-joint. Here, also, unintended movements (flexion of hip and knee) accompanied the original motion. It required laborious effort on the part of the patient to flex the last joint of the left thumb to a right angle. Active extension of the elbow and wrist joints, as well as all active movements of the left shoulder-joint, were absolutely impossible. The examination described was undertaken exactly twenty-four hours after the operation, and the patient assured us that this was the first time he was able to execute the movements just detailed. Notwithstanding their trivial nature, they were sufficient to enable him to drink from a beaked cup unaided, when his head was supported. While he was executing these movements, a sensation of heat was perceived by him in the arm.

At the same time the patient was again able to actively flex his left knee, but with less power and with greater effort than before the operation. While he was well able to execute plantar flexion, he could neither actively nor passively bring his foot to a position of dorsal flexion, because the strong tension in the muscles of the calf prevented the execution of that movement. After passively relaxing the extensors, they appeared paralytic (see below). He could perform all movements of the hip well and with force.

Forty-eight hours later, the lower facial region showed only the angle of the mouth and the corresponding side of the jaw paralyzed. It was at the same time also observed that the tongue deviated to the left upon protrusion. This symptom remained unchanged until the eighth day after the operation, after which it gradually receded. It was, however, six weeks before it completely disappeared. Six days following the operation, the facial paresis was found to be slight; this disturbance, which in itself was very insignificant, persisted for five weeks longer. The soft palate never showed any abnormalities of movements. Its reflex was obtainable on either side.

The passively extended fingers could be distinctly flexed

three days after the operation, to such an extent that their tips touched the palm of the hand—this from one to two seconds after the request to perform that motion. On the same day, the patient could flex his elbow-joint to a right angle only, while on the day preceding, he could accomplish active flexion to an acute angle. This was, of course, performed slowly and without power. All other active movements were impossible.

Five days after the operation, the patient was able for the first time to horizontally extend his elbow-joint with a considerable degree of strength after flexing it to an acute angle. He could abduct, to a very slight degree, the passively adducted arm at the shoulder resting on the chest, but could not actively adduct it. On the following day, while the patient was actively flexing his fingers, a tension was noticed in the flexor carpi ulnaris. Besides that, there was noticeable progress in the movements of the arm. Asking the patient to extend the forearm, which was lying on the chest in pronation and right angular flexion, he was seen, for the first time, to execute rotatory outward movement, so that the pronated forearm was placed sideways on the bed. This, however, required great effort on the part of the patient. He said that he had to exert all of his effort to prevent the healthy arm from executing movements at the same time. Following this, the arm was actively flexed again—a rotation of the arm inward was hence executed—and a few seconds later the elbow-joint was extended to an obtuse angle. It was strange that these movements of extension were interrupted by three to four clonic twitchings for fully five days and again by another one four weeks following the operation. From a position of extension the patient was able to actively flex his elbow-joint to an acute angle.

The abduction and outward rotation of the arm improved in the following days; so did also the active flexion of the fingers, the tips of which could be strongly pressed into the hollow of the hand, but in the latter movement, however, there occurred a few distinct relapses. Fourteen days following the operation, flexion of the thumb could be executed with considerable force—patient could bring it in contact with the palm—active extension was still impossible. Fourteen days later, adduction was present.

At this time—one month after the operation—no important changes were observed, except that in addition to the abduction of the arm, it could also be actively adducted. The elbow-joint could be flexed to an acute angle and completely extended. Pronation and supination were still entirely absent. Eight days later, the patient could touch his chin with the left hand and adduct his arm to such a degree that his left hand reached to the right shoulder.

Two months after the operation, active abduction of the arm was possible to an extent of 30° while the patient was sitting; during this movement the scapula scarcely moved and adduction could be accomplished to such an extent that the internal condyle of the humerus touched the anterior axillary line. Flexion and extension of the elbow-joint were now normally executed; during the performance of these movements a few clonic twitchings occurred. Pronation and supination, as well as active extension of all fingers were still absent. Extending the fingers passively enabled the four last ones to be actively flexed in all joints with moderate strength; the thumb was evidently the strongest and it could also be opposed.

From time to time (in the left lower extremity, four days), following the operation, there appeared involuntary flexions of the knee-joint, which were accompanied by pain in the quadriceps extensor.

These spontaneous movements were most marked during the first night following the operation. The patient awoke frequently; the hip and knee joints assumed a flexed position and became spontaneously extended again. These phenomena gradually diminished, and after the fifth day they disappeared completely. In the arm, nothing of a similar nature was observed. Muscle contractures were also more marked in the lower than in the upper extremity. These conditions interfered with the active movements of the knee-joint, which could be moved freely as early as twenty-four hours after the operation. This condition appears to be quite singular. I shall refer to it again in greater detail farther on.

Nine days after the operation, the patient could for the first time bring his left foot into a position of dorsal flexion (with the same strength as before) and then flex it plantarward. It

took, however, five and a half weeks for the extensor communis digitorum and the hallucis longus to become properly innervated; at that time, the patient still had to exert himself and the foot remained in a position of middle plantar flexion.

*Contractures and Rigidities*

About twenty-four hours after the operation, a distinct resistance in the biceps was noticed by the patient when attempts were made to extend the flexed forearm; the triceps also showed resistance at flexion of the arm, but to a lesser degree. On the day following, some tension was noted in the flexors of the fingers; overcoming this position by passive extension, the fingers immediately returned to a position of semiflexion. On the following day, the muscles of the shoulder leading to the head of the humerus were also found contracted; the triceps as before—more so than the biceps. Passive stretching of the tense muscles caused the contractions to reappear after the lapse of some time; following the stretching active movements could be performed quicker and with greater ease. Spontaneous pain of slight degree was noted in the biceps only. Following active movements, the pain would persist for about fourteen days.

The contracture of the biceps was on the increase until the ninth day after the operation; at that time the arm was flexed to an acute angle at the elbow-joint and the fingers were also considerably flexed, so that their tips were touching the palm of the hand. The extensors of the fingers were always lax. Fourteen days after the operation, the rigidity of the flexors of the fingers was substantially gone. The tension in the biceps and triceps noted at passive movements of the elbow-joint persisted for two months after the operation, to a slight degree only. The pectoralis major and the abductors of the shoulder also showed slight rigidities which persisted for a few weeks.

As has already been stated above, the rigidities in the lower extremities were by far stronger than those of the upper. As early as six hours after the operation, the left knee was found in rigid extension. The quadriceps extensor was contracted; so were also the muscles of the calf; eighteen hours later the tension of the quadriceps, while still present (shown by passive flexion of the knee) was very much lessened, so that the patient

was now able to flex his knee-joint to an acute angle. On the other hand the muscles of the calf were under such marked tension, that after active plantar flexion of the foot it could not possibly be brought even into dorsal flexion. I could flex the foot to a right angle only after the knee-joint was brought to an acute angle and after relaxing the Achilles tendon. Otherwise, the contractures of the muscles of the calf behaved as those of the thigh.

In the following three days, the tension in the quadriceps increased to such an extent that on the day mentioned (third after the operation) the patient could not move his knee-joint at all. When we undertook to accomplish that motion passively (which of course required considerable force and during which the patient complained of marked pain in his quadriceps), he could actively extend and flex his knee-joint again. On the following day, the tension within the quadriceps was, at times, increased to a very high degree, during which pains of a burning character were complained of and these became intensified at attempts to move the knee-joint. Four days after the operation, the tenseness spread to the adductors, abductors, and the flexors of the thigh.

Two days later, an improvement in all muscles affected was again noted, at first manifest in the quadriceps which, nine days after the operation, showed no more rigidity, while the flexors, adductors, and the tensor fasciæ latæ were still moderately tense. Corresponding to the decrease in the contractures, the movements in the hip and knee joints became free; pain, however, was complained of for about a week longer. Fourteen days after the operation, active flexion and extension of the hip and knee could again be executed normally; yet tension of the muscles of the lower extremities would occasionally occur for about two months after the operation; clonic twitchings of the quadriceps would also occur at movements, now and then.

With reference to the

*Electrical Irritability of the Muscles*

numerous galvanic and faradic tests were undertaken preceding and following the operation at various times for a period of about two months. The direct and indirect results of faradic

irritation of the muscles of the extremities were equal on both sides. It should be especially noted that the application of electricity to the long muscles extending the fingers, at a time when they were still totally paralyzed (eight weeks after the operation) was followed by vigorous contractions. Galvanic irritation yielded the same results on the sound as on the affected side. The only difference noted was, that stimulation of the left arm would cause a few isolated muscle-bundles to contract more actively than the application of the same current to the same points on the opposite side. The An C C required weaker currents than the Ka C C; both were lightninglike in action. The same conditions existed prior to the operation. A number of muscle-groups suffered permanently as a result of the pre-existing hemiplegia.

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Since the discharge of the patient (December 20, 1902), I have received from him a number of written communications, in which he states that his left extremities were gradually but progressively improving. As early as January, 1903, he could walk considerable distances; he could descend the stairs and travel for three or four days without pronounced fatigue. His lower limb, however, was still dragging. The improvement in his left arm was not marked, yet with little effort he was able to bring it to a horizontal position or elevate it above his head. He could not as yet open and close the hand (the extensors were evidently still paralyzed). About December 30, 1906, his lower limb had greatly improved. He attended to a great many errands during the day; he had only three hours of rest, yet he did not feel fatigued after the day's work. The arm still remained behind; it did not improve as quickly as the lower extremity, but he could lift it to the head with exertion. The fingers could not grasp with power. The last report (June 30, 1910) speaks of no improvement in the arm; yet this condition does not influence the general well-being of the patient to any extent. His walk has shown greater improvement—so much so that even prolonged marches caused the lower limb to drag only very slightly—more so in the winter than in the summer.

*Reflex Irritability*

All periosteal and tendon reflexes which prior to the operation were exaggerated (more so on the left than on the right side), were found much more heightened twenty-four hours after the operation. We could by striking the tendons or periosteum of numerous places, elicit muscular contractions. Percussion of the tibia and both malleoli resulted in strong flexion of the hip and knee to nearly a right angle. Ankle clonus, on the contrary, was very weak or could not be demonstrated at all. This was evidently due to tension in the musculature of the calf, the abatement of which caused the former to appear again (nine days later). For weeks following the operation, there was ankle clonus which appeared at once upon passive dorsal flexion of the foot (active flexion was impossible). Reflex contractions were also brought about while testing for the sensation of cold.

Two days later, the *Babinski* phenomenon was present to a marked degree. Persistent testing for this also caused flexion of the hip and knee, and the patient complained of pain. Throughout the entire period of observation, the reflex of the right sole of the foot was normal.

While the increased reflex irritability of the arm persisted for a week and then gradually lessened to such an extent that the application of sensory tests by means of the hot and cold test-tubes (ten days following the operation) did not cause reflex reactions any more, the knee phenomenon was steadily on the increase from the third day on. A slight tap on the ligamentum patellæ created an entire series of clonic contractions of the quadriceps extensor muscle. On the tenth day after the operation, the reflex irritability of the lower limb was also found diminished. Testing for the *Babinski* sign on the twenty-fifth day after the operation, disclosed its presence, but unaccompanied by flexion of the hip or knee. There remained, at any rate, a decided increase in the reflexes of the skin, tendons, and periosteum, from the head of the humerus down to the tip of the fingers, which were still present on the day of the dismissal (nine weeks after the operation). At that time, the patellar and Achilles reflexes were still somewhat increased; the *Babinski* and ankle clonus were very distinct and, while irritation of

the periosteum of the tibia, the patella, and the epicondyles of the femur were followed by twitchings, they were not as marked as before.

During the entire period of observation, the cremasteric and abdominal wall reflexes were the same as before the operation.

*Sensation of Touch*

Twenty-four hours after the operation, the fingers, hand, and forearm were anæsthetic to the touch; this was also the case in the arm. On the anterior aspect of the latter only, contacts with the wooden handle of the percussion-hammer were said by the patient to be hot and painful; those of the blunt end of the instrument were felt by him as contacts with the point of a needle. This paræsthesia was more marked on the following day; while weak galvanic and faradic currents applied to both sides were, prior to the operation, unaccompanied by any unpleasant sensations, were now perceived on the volar side of the forearm by the patient as hot and very painful. These sensations, however, he was unable to locate. Galvanic irritation of the skin was at the same time felt on the wrong spot (he grabbed for his left hand). Equally so were applications of cold test-tubes to the inner surface of the arm and forearm; they were perceived as painful and hot. The first correct location of a pencil passed along the flexure of the elbow-joint was on the third day after the operation, yet heat was still complained of.

Pinching of the skin on the ninth day after the operation was located correctly; it was felt all along the arm, much more so on the left than on the right side and painful. While localizations in the region of the arm were in the main correct, in all other parts of the upper extremity they were utterly wrong.

Thirteen days after the operation, pinching of the skin of the left hand was not perceived by the patient; he noticed it first in this situation two days later (more so in the ulnar than in the radial and median regions). Localizations in the forearm and the inner aspect of the arm were fairly correct. Henceforth the improvement was gradually progressive, so that tests with the head and point of the needle, two months after the operation, were correctly noted in the entire extent of both arms. Localization was also correct, with the exception that at

times the patient would wrongly indicate the fingers (left) tested, or he would mistake the hand for the fingers, and *vice versa.*

Five days after the operation, touching and pinching of the skin of the shoulder and the cutaneous surface of the adjacent chest were not perceived by him correctly, and at times not at all. Three days later, the sensation reappeared in these parts again, but localization was incorrect. In the rest of the skin of the chest and abdomen correct location was the rule.

Tactile sense was markedly reduced twenty-four hours after the operation; two days later it was entirely extinguished in the leg and foot, and on the anterior surface of the thigh was mildly perceived. Pinching of the skin was here also only felt lightly. Pinching of the skin was painfully perceived on the sole and dorsum of the foot and in the region of the tibia, and correctly located nine days after the operation. This was not so in the leg and in the lower part of the thigh; higher up, localization was correct. An aggravation was noted in the foot four days later, which persisted for a week; during this time the sense of location was extinguished.

Pin-point and pin-head tests performed on the lower extremity two months later were properly located and normally perceived.

*The Temperature-Sense*

was, twenty-four hours after the operation, considerably disturbed. The patient could not distinguish between hot and cold applied to the forearm; in the arm heat alone was perceived upon the application of both test-tubes—principally so on the inner surfaces of the arm and forearm. Two seconds after touching the arm with the cold tube, there appeared acute flexion of the forearm, ulnar flexion of the hand, and slight flexion of the fingers. In the lower extremity, no differences of temperature were noticed by the patient; on the outer surface of the thigh and leg cold was felt as heat, and on the following day the same application was described as a sticking pain.

Two days after the operation, the disturbances of the temperature-sense were even more marked; the volar surface of the left forearm and the lower extremity were totally insensitive to the touch of a very hot test-glass. Sometimes the application

of an ice-cold tube was perceived by the patient as heat. The entire hand, the dorsal surface of the left forearm and the left foot were insensitive to the touch of either test-tube; on the right side, on the contrary, all answers were correct.

Six days after the operation, the hypersensitiveness to cold had somewhat decreased; four days subsequent thereto, the temperature-sense was located with a fair degree of accuracy in the arm as well as in the forearm, while applications of warmth were correctly identified (cold was still felt as heat).

Twenty-four hours after the operation, there was also, in the left half of the face up to the eyebrow, a decrease in the tactile and a disappearance of the temperature sense; the former also in the left side of the tongue. The left tip of the tongue was less sensitive to the touch of a pencil than the right.

On the volar and dorsal surfaces of the hand, the patient perceived ice cold as heat, and in the forearm the perception of temperature was entirely erroneous. While the arm and forearm showed, a month after the operation, no improvement whatever, the application of heat to the hand and fingers was perceived as heat, though not with certainty in every instance; cold, however, as heat. The localizations were as yet incorrect. On the thigh, both qualities were correctly located, but cold was at times perceived as heat.

Two months following the operation, the improvement was extraordinarily well marked. At that time, heat and cold as well as location were correctly perceived in the entire arm and lower limb; the fingers formed the only exception in which these qualities were at times mistaken and locations improperly described.

After the operation the patient could not distinguish the difference between heat and cold on the cutaneous surface of the shoulder and chest. Ten days later, the left shoulder and thorax were somewhat hypersensitive to the application of the test-tubes. On the thorax, cold was perceived as heat. Four weeks after the operation, heat and cold were alike normally located in the left pectoral region, but at times there would still be a perversion—cold for heat. One month later, sensation and location in the left shoulder were normal.

On the right side of the body, both thermal qualities as well

as location were properly perceived during all of our examinations.

The disturbances of

*The Sense of Position*

were strikingly marked. No trace of this sense was left five days after the operation. He knew nothing of the position of his fingers, the hand and that of the forearm to the arm, or whether the elbow-joint was flexed or extended. He was compelled, on account of his left-sided hemianopsia, to turn his head in the opposite direction, whenever he wished to make use of his facial sense. This created a most peculiar impression. The sense of position of the knee and hip was also suspended.

As late as a month after the operation, the sense of position in the elbow, hand, and finger-joints was still wanting. With the eyes closed, the patient was able to correctly locate all passive movements of the left shoulder-joint. The same sense was also present in the knee and hip joints, and in the ankle it continued uncertain for a week more.

Two months after the operation, the position-sense of the hand and finger-joints was still uncertain; only seldom were the passively produced positions correctly interpreted, while the patient had his eyes shut. The sense-position of the shoulder, elbow, and all joints of the lower extremity were normal.

*Trophic Disturbances*

of the skin and similar disturbances (anomalies of sweat-secretion) were not observed at any time. The upper extremity was, two months after the operation, somewhat smaller in circumference than before (the arm more so than the forearm), and the thigh was more wasted than the leg; this was undoubtedly the result of inactivity.

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The visual fields showed no changes following the operation.

In this case, the anæsthesias and paralyses, following the cortical excision, have lasted for a longer time than in the following observation. According to a written communication from the patient, the muscular weakness of the left hand appears to

be even more marked now than before the operation. The pre-existing conditions in this case offered a most unfavorable outlook, because, as a consequence of the old hemiplegia (cerebral hemorrhage following nephritis), all kinds of nerve-elements were evidently disorganized or destroyed. Had these tissues escaped injury, it would have materially influenced a favorable outcome following the cortical excision.

## OBSERVATION I, 10

The history of this case is detailed on p. 360. The nervous condition preceding the operation was as follows:

During observation, while the patient was at rest, a moderate inequality of both halves of the face was noticed, which became more apparent during movements. The folds produced at laughing, wrinkling of the forehead and by similar movements, were shallower on the right than on the left side. While there were no changes visible when the patient was moving his eyes upward, downward, and to the right, on looking to the left retardation of that motion, accompanied by nystagmus, were noted.

The left extremities performed their functions with regularity and with full strength. Upper and lower extremities of the right side were in every respect inferior to those of the left; the muscles on the right were weaker and somewhat atrophic, more marked in the arm than in the lower limb. The right arm was actively mobile at the shoulder-joint, in all directions, but the movements were clumsy. Extension of the right elbow-joint was possible to about 150°. Its strength was diminished. Flexion, on the contrary, could be performed normally but with lessened power. The forearm was in a position of semipronation, passively supinable to a very slight degree only—actively not at all. While it was impossible to perform stronger pronations actively, passively they could be accomplished effectually. In the right wrist, active movements were executed well—best on the ulnar side. The thumb was in a position of median adduction and its terminal phalanx could be actively flexed and extended. Flexions and extensions of the other fingers were weak; the power to execute isolated movements in the fingers was

wanting. The patient made use of his left hand in eating, because he was helpless with the right.

While walking, the right lower limb was seen to drag. No differences were noted in comparing the active movements of the hip and knee joints with those of the sound (left) side. Dorsal flexion of the ankle-joint was somewhat limited, this was noticeable when the patient was walking (point of foot directed downward). Plantar flexion was unrestricted. All toes were actively immobile. The power with which all movements were performed on the right side was less than that of the opposite side; their execution was also slow and hesitating. The latter remarks also hold good for the upper extremities. Here, also, there was no ataxia in the movements. On account of weakness, deficient exercise, and the restriction due to the condition in the elbow-joint, the right hand was clumsier in the performance of its movements.

The reflexes, sensibility, the temperature and position—senses as well as all sensory qualities in general, including the localization—presented no differences on both sides. Trophic disturbances on the right side were also absent. The right hand perspired more freely than the left, and it felt warmer to the patient.

Galvanic and faradic tests on the right side showed only slight deviations from those of the left; they corresponded to the degree of atrophy of the muscles.

The second operation (February 24, 1904) lasted exactly one hour and mainly consisted of faradic irritation of the exposed portion of the central convolution and in the excision of the corresponding part of the cortical centre. In view of the fact that no amount of blood was lost at the operation, the patient did not feel in the least affected by its performance, and on the same day he wanted to know when he could get up. The results obtained from the examination soon after its performance may be considered correct and reliable. Equally trustworthy were also the results of the examinations of the following days (till March 28th), since not the slightest disturbance in the healing of the wound was noticed.

An hour after the operation was completed, the patient was fully awake and perfectly clear, so that an examination could

be undertaken. On the right side, the fingers, hand, forearm, and arm were found completely paralyzed. During passive movements there occurred a distinct tension in the biceps and the flexors of the hand—this was not observed in any other muscles. The right angle of the mouth was somewhat drooping; the tongue protruded straight. The reflexes of the arm (triceps, biceps, supinator, and periosteum) were absent. Sensitiveness to superficial pricks of the needle in the regions of the arm and forearm were almost completely gone; only deep punctures were felt. The right lower extremity could be actively moved with force; sensation was here intact. The patellar reflex was as active as before the operation. Ankle-clonus was absent.

At subsequent examinations, great pains were taken to avoid exhaustion of the patient; the different qualities and functions were, therefore, tested at divers hours and times. I shall now speak of motility, contractures, reflexes, sensibility, and the sense of position, in rotation.

*Motility*

All disturbances antedating the operation are here, of course, omitted. Twenty-one hours after the operation, the complete paralysis of the right upper extremity had disappeared to such an extent, that the patient was able to perform the following active movements. He could bring his arm to a horizontal position; the forearm into its previous pronated state with moderate strength—he could also flex it. The hand which assumed the position as though afflicted with radial paralysis, could not be extended at the wrist-joint at all. Extension of all fingers was possible to a slight extent only; they could also be flexed moderately when dorsal extension of the wrist-joint took place. On the following day, elevation of the arm could be executed to a greater extent. Isolated movements of the thumb were totally impossible; when the other fingers performed their slight flexory movements, the thumb became adducted; its abduction was completely suspended. The other fingers could be opened to a very slight extent only.

Three days after the operation, flexion and extension of the elbow-joint, which was in a pronated position, were possible to

an almost normal degree, but the power was moderate. Isolated flexion of the index finger was totally absent; only when the last three fingers were flexed was this motion possible, to a very slight extent only. Adduction and opposition of the thumb were possible with moderate power. During the performance of these movements, a minimum extension of its terminal portion was noted. The patient was entirely unable to execute isolated movements with the 2—5 fingers. Simultaneous movements of the fingers caused the third, fourth, and fifth to form a unit, as it were, to which the second became

Fig. 84

This picture was taken twelve days after the second operation; it shows the wound healed by primary intention. The oblique line drawn with silver nitrate across the flap, marks the linea *Rolandi*. The paralysis of the extensors of the right hand is also shown.

joined at great exertion only; the thumb meanwhile took a position of opposition.

On the following day, the patient noticed that the paralyzed index finger performed involuntary movements of flexion and extension; at times only once, and at others a number of such contractions would follow in succession. These movements were not perceived by the patient at all; his attention was called to them by the facial sense.

On the fourth day after the operation, the paresis of the lower branch of the facialis had disappeared.

Four weeks after the operation, the movements of the shoul-

der-joint were normal; they were almost so with reference to flexion and extension of the elbow-joint, although their strength was apparently diminished. The wrist-joint could execute dorsal flexion. Synergic innervation of the extensors of the hand was also observed in clenching the fist, which movement was in the main performed without power. Isolated movements of the individual fingers were still impossible. Flexion of the last three fingers could be performed quite satisfactorily in all joints; extension, however, was deficient (index and thumb as before).

On May 29, 1903, the condition of the shoulder and elbow joints was the same as before the operation. Active extension of the wrist-joint was possible to a very slight extent only; during this time, marked dorsal flexion of the four fingers was noted at their basal joints. Flexion of the wrist was improved. The fingers could be flexed well and their grasp of my hand convinced me of their increased strength. Isolated movements of the index finger could be executed to a minor degree only. The thumb could be adducted with considerable strength; its opposition was *nil*, and it could only be extended slightly and, as a result, its metacarpus occupied a position of close proximity to the other metacarpal bones.

June 18, 1903. As far as could be determined, the ability to move the hand and arm has thus far not been materially improved. Especially the isolated motions of the fingers were the same as described above.

The active movements of the right upper extremity were, on the 10th of March, 1904, as follows: All movements of the shoulder-joint could, with slight restrictions and little exertion, be executed as well as those of the sound side. Flexion of the forearm was almost normal. During its performance, its volar surface touched the biceps. Extension was incomplete; it attained only an angle of approximately 75°. Pronation and supination were as before the operation—almost completely abolished. The wrist-joint could be flexed and extended to an extent of about half the normal. Opposition in the thumb was only slight; all of its other movements were entirely absent. The index finger was also immobile. Flexion and extension of the other three fingers were tolerably well executed. The ex-

tension was incomplete because the first interphalangeal joint persisted in slight flexion. At flexion, only the flexor sublimis was acting; the profundus not. The right lower extremity showed the same conditions as found prior to the operation; the same was true of the left limb.

In January, 1906, the patient asserted that the mobility of the extremities of the right side were the same as before the operation. At the examination of December 19, 1906, it was found that the right index finger could not be moved by itself; it partook, however, in the movements of the other fingers. The walk was more certain than before. The right limb did not drag any more. The point of the foot hung only slightly downward. According to the patient, exertion increased the disturbances of locomotion.

The

*Muscular Rigidities*

were as a general proposition not marked. Twenty-one hours after the operation they were greater and more extensive than immediately after. They affected to a slight degree the deltoid, triceps, and the flexors of the thumb; to a greater extent the flexors of the forearm and the extensors of the thumb, and to a still greater degree the biceps. All other muscles showed no increased rigidities. Three days after the operation, the contractures of the ball of the thumb were barely discernible—the others remained as before. Two days later, the biceps was much more contracted, so that the forearm was flexed at the elbow-joint to a right angle. The rigidities had noticeably diminished ten days after the operation; they persisted quite strongly in the biceps alone until the fifteenth day, after which they gradually diminished and finally disappeared. The same conditions were observed in all other muscles afflicted with rigidities. On the 18th of June, traces of contractures of the flexors of the hand and the extensors of the thumb, as well as a moderate degree of rigidity of the shoulder and elbow joints, were still present.

In June, 1904, no more contractures existed, except during extension of the fingers and the wrist-joint, slight rigidities were noted. During later examinations, these were also absent.

Twenty-one hours after the operation the

*Reflexes*

of the biceps and the triceps, as well as that of the periosteum of the bones of the forearm were found highly exaggerated. On the left side no differences were noted—they were the same as before. The patellar reflex was stronger on the right than on the left side. There was no ankle-clonus. On the following days, the reflexes of the arm were still increased—the supinator reflex very highly exaggerated. Ten days after the operation, the biceps and supinator reflexes were very marked compared with those of the other side, though not as much as before. Even slight contacts of the hand with the handle of the percussion hammer were followed by very active reflex movements in the right arm. The patient expressed surprise at his inability to voluntarily control these movements of the right side. Five days later, the patellar reflex was also found exaggerated on the right side; the *Babinski* phenomenon was also present on the same side; absent on the left side. Four weeks after the operation, the biceps, triceps, supinator, and periosteal reflexes of the right arm were still increased; the patellar reflex and the *Babinski* sign being still distinctly present. On the 29th of May, 1903, the periosteal reflex of the right upper extremity could hardly be elicited; the biceps and supinator reflexes were only moderately present, while the patellar reflex was stronger on the right than on the left side. Otherwise, the reflexes of the skin, periosteum, and tendons were exactly alike on both sides.

On the 10th of March, 1904, no differences existed between the reflexes of the lower extremities, yet those of the biceps, triceps, and the supinators were livelier on the right than on the left side. On October 9, 1904, February 18, 1905, and January 5, 1906, the condition of the reflexes was the same; on the 19th of December, 1906, the increase on the right side was only slight.

*Stereognostic and Tactile Sense*

Touching the entire right upper extremity lightly, the day after the operation, was not perceived by the patient at all. Contacts with the point and head of the needle were wrongly

perceived by him. Deep punctures were only slightly painful. All these tests were felt by the patient "infinitely more distinctly" on the left than on the right side. In the cutaneous region of the right shoulder, the sensation was normal. It was distinctly reduced in the back as far as the spine of the scapula; this was also the case in the right half of the face. In the right leg, especially on its inner surface, the sensibility was somewhat diminished. One day later, improvement was found in the arm only—mainly on the radial side of the hand and forearm. Localization of touch was wrongly interpreted in the entire territory of the hand and forearm; especially were contacts of the fingers referred to the dorsal surface above the wrist-joint. Touching of the arm was at times felt in the forearm.

On the right side, the sensitiveness of the tongue to pricks of the needle was somewhat lessened.

Three days after the operation, the *stereognostic sense* was found in the right hand extremely disturbed—almost wanting. For instance, a coin placed in the palm of his hand was not recognized as such at all, a key he mistook for a pocket-knife.

Four days after the operation, the disturbances of sensibility in the face and in the lower extremity had almost disappeared; in the dorsal region of the arm and forearm they were improved. The disturbances of sensation gradually increased toward the finger-tips, so much so that in order to elicit sensation at the tips proper, deep punctures with the needle had to be resorted to. One week after the operation, we found the sensibility—mainly that of localization—entirely unchanged. Two days later, however, both were improved; proper localization could, of course, not as yet be performed. The extent of improvement was such that contact with the patient's fingers was not misplaced farther than the metacarpus. Sensation of pain appeared weaker in the entire right arm than in the left.

Three weeks after the operation, the patient was decidedly more receptive to light contacts. One week later, the difference between blunt and sharp, while not completely restored, could be distinguished from each other with comparative ease. The intensity of the disturbances was noted to increase the nearer we approached the finger-tips. The localization of contacts was only slightly better than in the first days after the operation;

while this disturbance was most marked in the fingers, it was also markedly present in the arm and the forearm.

On the 29th of May, 1903, blunt and sharp contacts were almost regularly located. In the main, localization was also correct, with the exception that here and there a wrong interpretation was noted—this, to a short distance from the point of contact only. The stereognostic sense of the right hand was diminished.

On the 18th of June, 1903, the sensibility of the right arm was found improved. At that time, light touches with the test-brush were frequently not recognized. On the hand and forearm, sharp and blunt were perceived almost correctly. On the fingers, however, sharp was frequently mistaken for blunt, and *vice versa*. Localization was entirely erroneous. The inclination to wrongly locate contacts, in the region of the hand, still persisted. On the finger-tips, on the contrary, marked pain was complained of. Deep punctures caused the entire arm to retract in a reflex manner. On the trunk and lower extremities, sensation was normal.

In the further course of the disease, the remaining disturbances gradually disappeared, leaving only traces of their existence behind. Abnormalities of the sense of touch, pain and localization, remained longest in the terminal phalanges—(found as late as January 5, 1906).

In the right hand, the stereognostic sense showed marked disturbances (February 18, 1905). While metal objects placed in the palm of the hand of the patient were correctly recognized by him, he was unable to distinguish between a key, knife, coins, and other objects, by the sense of touch alone. On December 10, 1906, the disturbances were still present, but to a lesser degree.

*Temperature Sense*

On the day after the operation, the sensation of cold was very materially reduced in the entire right arm; heat was almost entirely not perceived. Both these sensations were normal in the tongue and lower extremity. Some differentiation between warm and cold was noted on the following day; the former was described as "pleasant." On the fingers, thermic qualities were

interchanged; warm was perceived as cold, the latter not as warm, however. On the fifth day after the operation, while testing the sensibility of the patient with the sharp and blunt ends of a pin, pieces of ice were placed against his arm; the sensations produced by the former were felt correctly. On the other hand, he was entirely unconscious of the application of the ice. Moderate warmth was perceived in the entire right arm as "pleasant." The application of heat caused pain and the arm retracted; this only after the irritant has acted for a much longer time than on the sound side (delayed pain conduction ?). Ten days after the operation, the temperature sense was only very slightly improved. At that time, the patient made the assertion that the sensation of cold (contact with a test-tube filled with ice-water) was perceived by him a number of seconds later than the same applied to the left side (delayed cold conduction). Higher temperature applications were felt by him as "warm," lower ones—say about 40° C.—as pleasant. To obtain these results, larger areas of skin had to be covered with the test-medium. The localization of the temperature sense was entirely reversed, and in comparison with the sensation of touch very much the worse.

Four weeks after the operation, cold was perceived by the right arm, with a fair degree of promptness. Warmth of moderate degree was still felt as "pleasant," while higher degrees were felt as warm for a considerable time before pain was complained of.

On May 29, 1903, warm and cold were only rarely mistaken; this was true in the entire arm.

On March 10, 1904, the temperature sense of both sides was the same.

### *Sense of Position*

Extremely striking was the sense of position (muscle-sense, joint-sense). On the day after the operation, the disturbances of the sense of position in the elbow, hand, and finger joints were enormous. In the fingers, the patient did not feel any movements of changes of position at all. In the shoulder-joint, on the other hand, if the abnormity was present at all, it was very slight indeed. While these disturbances were found on

the following day somewhat slighter, they were very marked in all joints, from the elbow toward the periphery. The patient stated that he found greater difficulty in performing active movements with his eyes closed subjectively—objectively, such movements were incomplete.

Four days after the operation, passive movements of the elbow-joint could be carried out to an angle of about 60°, without the patient perceiving the movement in the least. The wrist-joint was even still more insensitive. It appeared that dorsal flexion was better perceived after first stretching the slightly contracted flexors of the forearm than volar flexion (patient having his eyes closed, of course). The extensors of the hand were totally atonic.

The disturbances in the finger-joints were maximal. With his eyes closed, the patient was unable to tell the various positions of the fingers; he was also unable to distinguish them from one another.

Ten days after the operation, there was still no improvement. This was also the case three weeks later. In the course of the following week, slight improvement was noted, while the sense of touch was still very materially damaged.

On May 29, 1903, all passive positions of the right shoulder, elbow, and all finger-joints (also thumb and index finger), while the patient had his eyes closed, were correctly repeated. With the eyes open the patient performed active movements with the hand and fingers equally good. Neither objective nor subjective differences existed in their performance. On the 18th of June, the sense of position was again disturbed in the fingers, while in the elbow-joint, even slight movements were correctly perceived. A slight disturbance in the joint-sense was demonstrable in the finger-tips until January, 1906.

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Four and a half weeks after the operation, the galvanic and faradic irritability corresponded to the preexisting degree of muscular atrophy (somewhat diminished). Otherwise no other disturbances existed. There was no reaction of degeneration. The measurements, as well as the electrical tests, were the same as before the operation.

The pupils and visual-fields remained unchanged; the same was true of the ocular muscles.

### Disturbances of Aphasia and Agraphia

*Jacksonian* spasms usually begin, in the majority of cases, in the upper extremity—mainly in the fingers, hand, and forearm. It is for this reason that I have most frequently resorted to excisions of those portions of the cerebral cortex embracing these foci. If the left hemisphere was to be considered, it was not infrequently observed (in right-handed individuals) that, immediately following the cortical excision, disturbances of aphasia made their appearance. As has already been stated, a number of focal excisions were accomplished at the second operation without an anæsthetic, because the sensitive part is the dura and not the brain. We could consequently perform various tests a very short time after the operation, and in a number of cases motor aphasia was found immediately thereafter. In some instances, *Broca's* centre became functionally disturbed shortly after operations in the anterior central convolution. From an anatomic standpoint of view, the occurrence of the motor aphasia can in no other way be explained.

As is well known, *Broca* was first to show that in right-handed individuals, the centre of speech is contained in the posterior section of the inferior frontal convolution of the left hemisphere. The destruction of this portion of the cerebral cortex, including the medullary portion of the convolution, will give rise to loss of articulated speech (*word-dumbness, cortical motor aphasia*), that is, spontaneous speech as well as repetition is completely suspended (at best a very few word-remnants may remain). It is generally believed that it is the pars opercularis and triangularis of the third (lower) frontal convolution, which contains the cortical motor focus-field of speech of *Broca*. The original *Broca* place corresponds to the pars opercularis.

The centre of speech just described is not distinctly outlined by fissures, because fissures and convolutions in man generally, with the exception of the two main ones, the *Sylvian* and *Rolandic* fissures, present great variations and irregularities. At times, the centre of speech is known to reach backward as far as the anterior section of the anterior central convolution

and to its lower third, and is located here about the foci of the nerves of the tongue and face; it sometimes reaches upward to its lower border, always to about the middle of the second frontal convolution. The anterior portion of the cortex of the island may also enter into its composition.

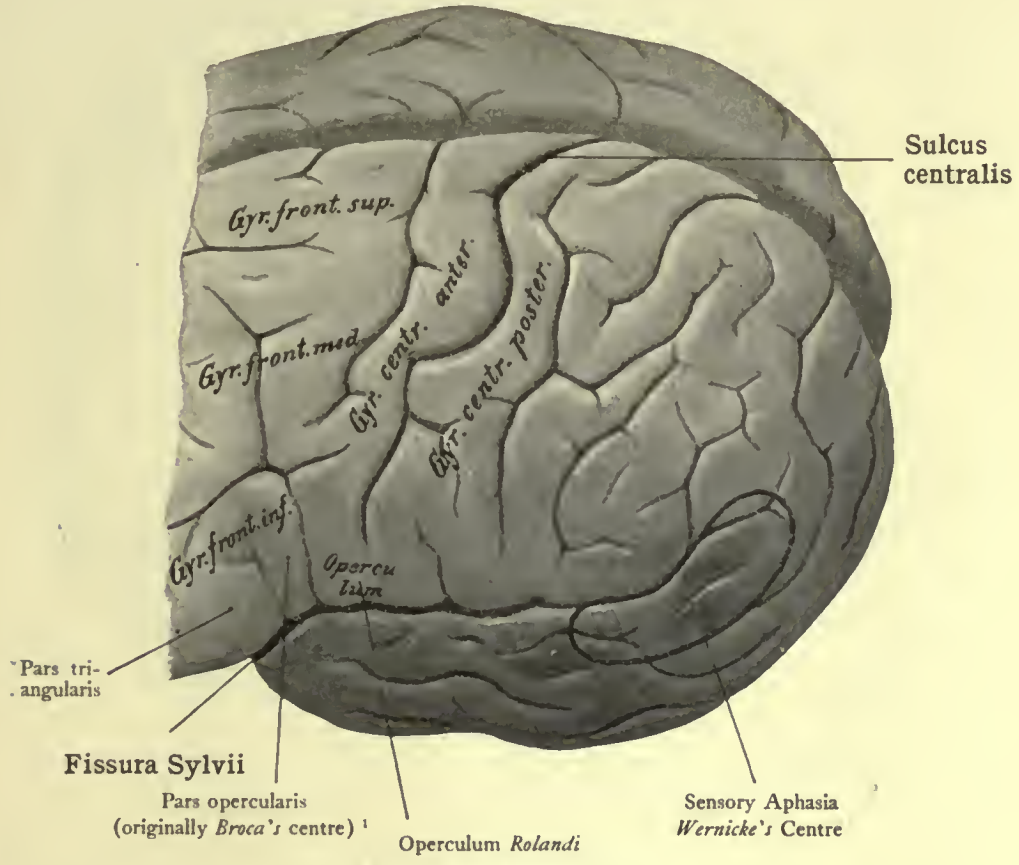



Fig. 85

*Broca's* and *Wernicke's* Centres. Compare this illustration with Fig. 66, p. 291.

To illustrate the disturbances of speech following cortical excisions, I shall cite the following instance: The patient was a young woman, twenty-four years old, who was suffering from *Jacksonian* epilepsy. The primary spasming centres of the right

[1] In this brain it is strikingly narrow. Forcing apart the lower fissura præcentralis, disclosed the presence of another small convolution, located underneath the surface and evidently belonging to the pars opercularis of the third frontal convolution.

facial territory and the hand were located by means of the faradic current. These were removed by excision to a length of 30 mm. and a width of 24 mm. The result was an almost complete motor aphasia

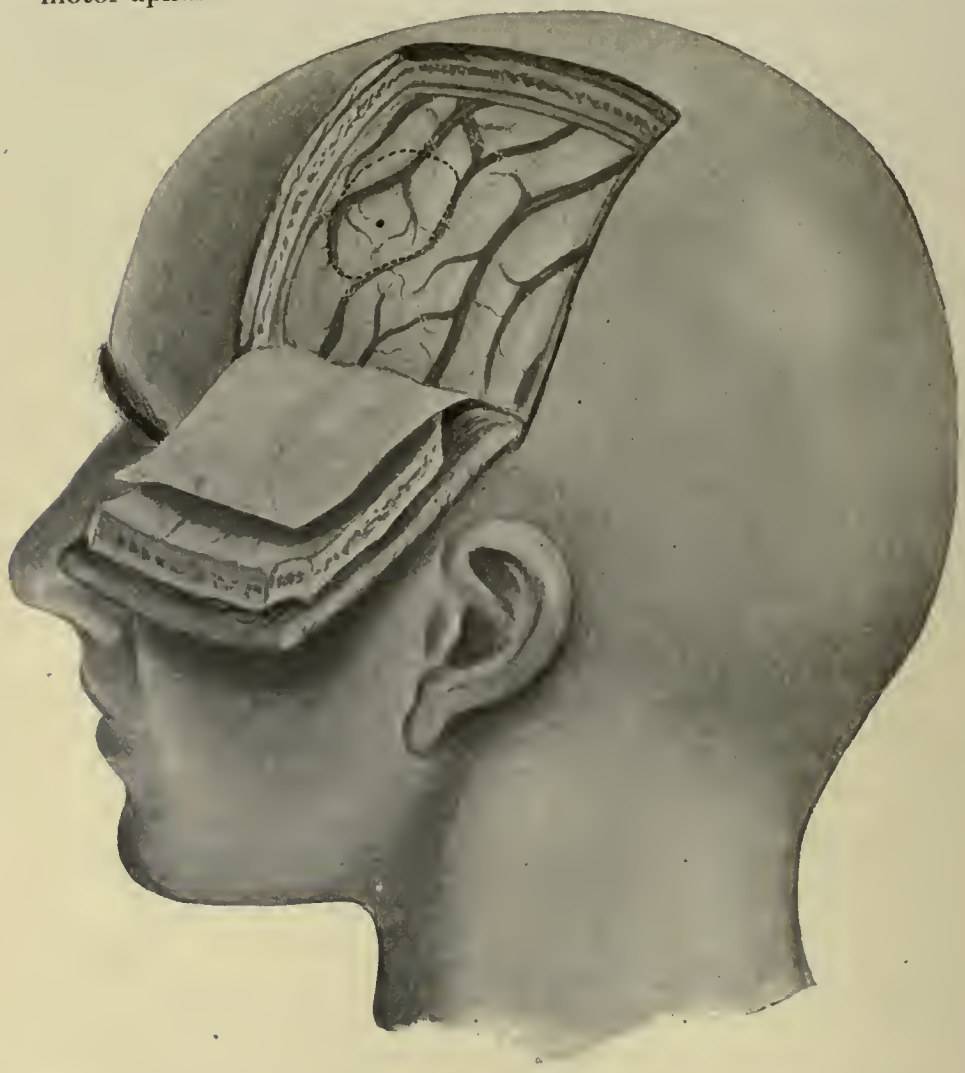


Fig. 86

The excised centrum is outlined by dashes. Unipolar faradic irritation at the point marked in the centre of the outlined area, resulted in an epileptic attack, which took its origin in the right facialis and hand.

On the day after the operation, the patient could only utter single words as "yes," "no," "oh," "God," and the following

day such expressions as "chair," "pot." During all that time, the patient showed marked irritability. After three days, simple words as "light," "cloth," etc., were correctly repeated and objects held in front of her correctly named. On the other hand, she could not speak combined words; for example, "handkerchief," "hand"; a series of words were furthermore repeated very indistinctly or babbling. The understanding of speech was preserved from the very beginning. With reference to reading, the conditions were analogous; asking her to repeat the parts she read, resulted in the repetition of the first word of the sentence only. In the following days her vocabulary increased, but in the first fourteen days after the operation, vowels were frequently interchanged; thus, instead of "oh," she would say "i" (brine instead of brown), etc. Three and a half weeks after the operation, disturbances of motor-aphasic nature were no longer observed during ordinary conversation, yet the speech was still drawling and the syllables somewhat drawn apart.

The disappearance of the aphasia proceeded hand in hand with the improvement of the pareses of the right hand and fingers resulting from the excision of the centres; so that on the sixteenth day after the operation, only the opponens, flexor brevis, and the extensor longus of the right hand, as well as the interossei, were found disturbed. At the discharge of the patient—eleven days later—the active movements of the 2—5 fingers were practically normal, those of the thumb still moderately decreased, and the speech as yet somewhat drawling. Two months later, the patient wrote that no disturbances of any consequence remained after the operation; the execution of the fingers of the right hand at piano-playing, however, had not as yet completely returned. Three months later, the fourth finger was noted to refuse on one occasion; besides this, she observed no other disturbances. Objectively, nothing could be discovered. She stated that at times while conversing, she would have difficulty in finding the proper words; yet during her conversation with me, she spoke fluently and entirely well.

Besides the centre of speech, we must also take cognizance of the centre of *Wernicke* (see Fig. 85, p. 427), the destruction of which causes complete *word-deafness, sensory aphasia.* This centre comprises the posterior third of the upper temporo-

sphenoidal convolution as well as the transverse-temporal convolution, besides the anterior portion of the gyrus supramarginalis. It will be remembered that in 1907, *Pierre Marie* upheld the belief that *Broca's* centre had absolutely nothing to do with motor aphasia; furthermore that *Broca's* aphasia is conditioned by a simultaneous affection of the centre of *Wernicke* and the left lenticular nucleus. In this he was ardently supported by his pupil, *Moutier*. I can hardly enter into a discussion of this controversy at this time.

Be this as it may, I should like to emphasize that, in my own cases, the condition depended upon superficial lesions of purely frontal location and that, during the excisions, neither the island nor the temporal-speech territory were in any manner encroached upon. My own observations of purely motor aphasia are certainly easier to explain than the clinical types of aphasic conditions due to emboli or diseases of the vessels. Both areas of speech are supplied by the a. fossæ *Sylvii;* consequently disturbances of circulation in this vessel and its branches not infrequently result in simultaneous morbid conditions of both motor and sensory regions of speech.

It must especially be mentioned that the disturbances of speech observed in my cases disappeared quite rapidly, leaving no trace behind them. Two to three weeks after the operation, the power of speech was, as a rule, in the main restored. In view of the fact that in cases of extensive focal involvement of the frontal convolutions, word-dumbness does not easily regress, the damage in the cases described by me must have been slight.

The clinical observation of a number of cases operated on by me invites the thought that, at least in the cases under our observation, we are dealing with functional disturbances resulting from some sort of inhibition. The *diaschisis action* of *C. v. Monakow* must be here considered. He gives the following definition:[1] "By diaschisis, I understand a condition of shock-like functional inhibition, in the primarily uninjured cortical parts, incited by acute focal lesions which, while distantly situated from the focus, are with it in anatomic connection. As a result of interruption of conductivity of the focus, numerous

[1] Neue Gesichtspunkte in der Frage nach der Lokalisation im Grosshirn. "Korrespondenzblatt für Schweizer Ärzte," 1909, No. 12.

excentrically located parts of the brain are deprived of their normal source of supply of stimuli and become partially isolated. Whereas, at each larger cortical focus, projection, association, and commissural fibres become interrupted, the isolation leading to diaschisis affects fibres belonging to all three categories, which, according to the locality of the focus are variously combined and exercise their deleterious effects on their end-stations in the gray matter. Diaschisic action may also be limited to one set of fibres, in which case the focus happens to be so located that only the fibres nearest to it become destroyed." Just as we have seen the onset of sudden regression of motor paralyses in quite a number of cases, the same was observed occasionally in instances of motor aphasia. The case of a patient, twenty years of age, was very interesting in this respect. The aphasia set in after the excision of the centre of the left hand, and total word-dumbness persisted in this instance for fully eight days. On the same day he suddenly greeted his nurse, who had left the room for a few minutes, with a loud "Good morning." A few hours later he could repeat difficult words, and in three days—according to the statement of his father—he could converse in his mother-tongue (Hungarian) in an almost normal manner. He spoke German fluently, but slower than before the operation. In cases of motor aphasia as well as paraphasia, occasioned by tumors or abscesses, the regression was always gradual and the disturbances of speech remained, as a rule, for months at a time.

### *Agraphia*

In diseases and injuries of the centre of *Broca*, besides disturbances of speech, the ability to write, frequently becomes deranged. Tests in this respect were in my cases generally impossible on account of the paralysis which set in, as a rule, to a lesser or greater extent in the right hand and fingers, following the cortical excisions. In these cases, the agraphia vanished with the abatement of the aphasia. I am able to cite, however, two instances selected from my material in which, in spite of the existing aphasia, no paralyses of the hand and fingers occurred. We were thereby enabled to examine the ability of the patient to write. In one of these cases (traumatic epi-

lepsy, Observation I, 16) I have, consequent to faradic determination, excised the centres of the arm and forearm and possibly a portion of the facial centre. Since we were dealing in this case with a cicatricially changed cerebral focus which existed for about two years, a substitution for the destroyed tracts, or at least an adjustment of their functions, had undoubtedly taken place, because prior to the operation, not the slightest disturbances existed of either motility or sensibility, nor that of speech and writing. Even after the cortical excision, which was by no means insignificant (18 : 30 mm.), the usual paralytic manifestations failed to appear. In their stead, however, aphasia and agraphia made their appearance; the latter could soon be examined on account of the absolute non-involvement of the right hand. It was perfectly useful.

## OBSERVATION I, 16

*Severe Injury of the Brain from Contrecoup. Jacksonian Epilepsy. Excision of a Scar of the Dura and the Brain in the Anterior Central Convolution. Aphasia and Agraphia. Cure of the Latter Condition; Marked Improvement of the Epilepsy.*

At the age of seventeen and a half years (June 29, 1907), this patient sustained a severe fracture of the skull. While sitting in a wagon during an automobile accident, she was violently thrown against a telegraph post, forcibly striking it with her right temple. Blood extravasation set in, and as a result the right temporal region and the parts immediately surrounding the eye, on the same side, became swollen to the size of a fist. Following the accident, there was complete loss of consciousness and vomiting, and hemorrhages from the nose, mouth, and right ear ensued. After the lapse of two years, the fissure of the ear-drum is still recognizable by a scar. The patient was unconscious for three days. On the fourth day, consciousness returned to some extent, but disturbances of speech, total paralysis of the right half of the body and of the musculature of the left half of the face were noted. On the afternoon of the same day, spasms set in. These mainly affected the right half of the body

and occasionally involved the left side to a slight extent. In the following four days, we observed from seventy to eighty of such seizures; after these, the injured girl regained her senses and, thereafter, the attacks were few and mild. The paralyses gradually vanished. Six weeks after the accident, the right leg was still dragging somewhat; the coarse power of the right arm was still reduced. The young lady remained under treatment at the hospital for six weeks, and then spent three weeks in bed at the home of her parents. At the end of that time she was very cheerful and did not pay any attention to her physical condition. According to the anamnesis by her relatives, she was, after the time just described, frequently afflicted with "rigors," which caused her to shiver all over the body; this was accompanied by great fear. During an incidental paternal exhortation, she developed a state of terror, which lasted for two days, and during the attack she shrieked and raved over things passed.

In the spring of 1908, there occurred occasional tremblings of the right hand, and in August, 1908, she had a severe attack with twitchings of the musculature of the right half of the body, which was probably brought on by excitement. Similar attacks were frequently observed in September of the same year. Prior to the accident, there were no indications of an existing epilepsy; it is to be noted, however, that the patient was known to be headstrong, crying for hours if her wishes were not complied with. She is the youngest of a family of five, and is very much spoiled.

*Dr. Weiler*, the Munich neurologist, to whom I am indebted for a large part of the following history of the patient, observed her from the beginning of November, 1908. The attacks varied in severity. The weaker ones recurred quite frequently—lately almost daily—and consisted of a sense of constriction of the muscles of the pharynx, and a feeling of heaviness of the tongue, accompanied by a sense of terror and palpitation of the heart. All the foregoing manifestations lasted a few seconds only.

Following intervals of from one to three or perhaps four weeks, the seizures occurred with greater severity, always commencing in the manner described above, and also engaging the muscles of the right side of the face. The muscles of the arm

finally became affected sympathetically. They were mainly limited to tonic contractions, lasting from one to two minutes. Attacks of greater severity, during which tonic-clonic contractions of the right half of the face, the right arm, and sometimes also the right lower extremity occurred, were observed less frequently. Contractions of the musculature of the left lower extremity were noted only twice. During attacks of light and medium severity, consciousness was always fully retained, and the patient soon felt perfectly well and was not somnolent. Only toward the end of seizures of greater severity, the sensorium became cloudy, leaving behind a slight grade of stupefaction which lasted for some time and which was accompanied by fear. Difficulty in speaking was also noted, following severer attacks. In the intervals between attacks, *Dr. Weiler* was able to detect, now and then, motor disturbances of speech of slight degree. Manifestations of a paralytic nature were, on the other hand, entirely wanting. In the intervals, peculiar crawling sensations of the right hand were, at times, complained of by the patient. The right arm and leg were noted by the patient to "easily go to sleep." Stereognostic and sensory disturbances existed at no time; involuntary losses of urine were not noted. The onset of an attack could easily be apprehended by the young lady, who, at the earliest premonition inserted a wooden spatula (which she always had at hand) between her teeth, to avoid biting her tongue.

In the beginning, *Dr. Weiler* entertained the belief that the manifestations of irritation were caused by some form of external influence (excitements of various sorts, etc.); he was soon compelled to abandon this view, however, because attacks were shown to occur frequently, without the slightest discoverable cause, and they occurred also at night. Preceding some attacks, there would at times be noted a certain irritability. This was erroneously ascribed to being the exciting cause of the seizure. There was just as little gained from various forms of bromide-therapy as from a change of climate. On account of the psychic suffering of the patient, as well as the physical deterioration consequent to the lack of appetite, and the existing general depression, the question of operation was considered by the doctor (*Weiler*).

In the opinion of *Dr. Wanner*, the Munich Privatdocent of otiatrics, there existed a distinct retrenchment of bone-conductivity, for a distance of from 2 to 3 cm., over the left middle meningeal artery. The sense of hearing was otherwise normal. X-ray examination showed changes in the left half of the skull and indistinct outlines of the contour of the inner bones. The fundus oculi was normal.

In the opinion of *Dr. Weiler* there resulted, from the accident, a left-sided hematoma from contrecoup; this gradually retrograded and left behind adhesions of the membranes of the brain and occasioned the symptoms of cerebral irritation.

At admission, July 22, 1909, the patellar reflexes were found exaggerated; *Babinski* present on the right side, indistinctly; *Oppenheim* absent. Percussion over the area of the left anterior central convolution toward the operculum and frontal bone proved distinctly painful.

Following the seizures, the stereognostic sense was somewhat lowered in the right hand. Otherwise, no changes could be demonstrated.

The first and second operations were performed under chloroform anæsthesia on the 27th of July and on the 3d of August, respectively. The trephined opening was made to overlie the anterior central convolution, and measured 60 mm. in width and 85 mm. in height. Upon the first incision made into the upper part of the dura, a conspicuously large quantity of clear fluid was evacuated, after which the flap was reflected downward. About the middle of the trephined opening, from above downward, entirely toward the posterior border of the cleft, the inner surface of the dura was found completely adherent to the underlying structures to a distance of about 18 mm. in width (from before backward) and 30 mm. in height (measured from above downward). Blunt dissection was only partly successful in separating the broad adhesion; the aid of the scissors was necessary to accomplish its complete ablation, during which two arteries and a vein were severed and ligated. After the arrest of all bleeding, the visible cortical defect presented the appearance of a flat trough, apparently covered by granulations. At a point perpendicular to and considerably above the focus, unipolar faradic irritation yielded inward rotation of the right lower

extremity; from the focus proper, no responses whatever were obtained. A puncture, having its point of entrance at healthy brain tissue, and thence continuing closely in front and underneath the focus to a depth of a number of centimetres, was entirely negative. The dura and cerebral cortex contiguous to the focus were normal.

We now proceeded to excise the entire diseased area. All vessels leading to it were ligated. The same method was pursued as in cases of *Jacksonian* epilepsy without anatomic findings; the only difference in this case was that the focus was macroscopically visible and corresponded in its lower part to the centre of the arm and possibly also in parts to that of the face (ascertained by faradism). The latter assumption may be looked upon as superfluous, since experience teaches us that intimate union of the dura with underlying structures (brain centres) may give rise to reflex irritation of contiguous centres (in this instance the facial). The entire area excised consisted of dense scar-tissue; the excision extended into the white substance. At the bottom of the defect, a spurting artery and a number of veins had to be ligated. After arresting the hemorrhage, the dural flap was thrown upward and firmly pressed against the surface of the defect, in order to prevent the formation of even the slightest hematoma between the opposed surfaces. The same object was aimed at during the closure of the wound, when a gauze tampon was firmly applied against the dura, one end of which was brought to the surface. The pressure of the tampon against dura and brain was continued until all stitches were tied, and before the last knot was made it was removed. Drainage was entirely dispensed with. To summarize: the operation consisted of the conversion of a cicatricial portion of the brain into normal cerebral tissue, minus cortex covered by normal dura.

On the afternoon of the operation fear was manifest, yet no paralyses nor disturbances of aphasia were noted immediately following it. Disturbances of speech—mainly of motor type—developed gradually late the same evening. To all questions put to the patient, she invariably answered "Mamma." She repeated words very badly. The power of verbal expression was practically limited to words; she always asked for water, change

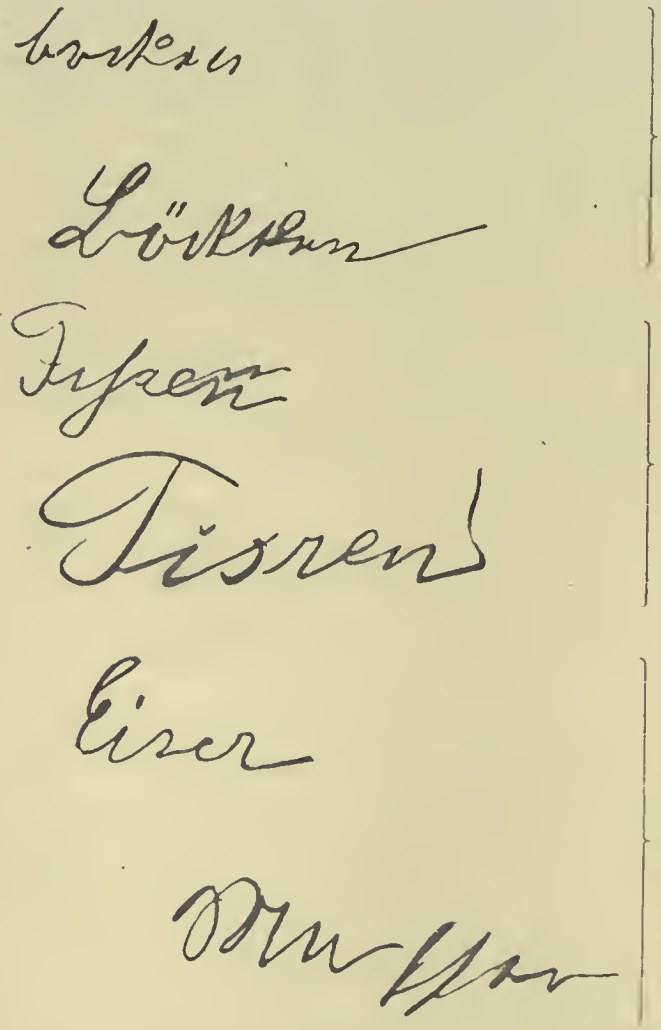
of bedding, etc., by saying "Mamma"; fear of approaching attacks were designated by the same word. She could further say "yes," "no," "here," "so," "oh," "God," "please." Symptoms of meningeal irritation were entirely absent. Two days after the operation (August 5th), after a night of refreshing sleep, the patient was heard to exclaim, the following morning, "That does not matter." The existing disturbances of the understanding of words were only slight. She could repeat simple words. While the movements with the right hand were more clumsy than those of the left, actual paralytic conditions did not exist in either right hand, fingers, or arm. To the question at dinner, "Which soup"? she replied, "It's all the same to me." In the afternoon she said, "I don't know," "go," "telephone," "I want it quick"; pointing to the side of the head operated upon and executing with the hand rotatory movements, she said, "I don't know," "It does so," "Mamma." She was further heard to spontaneously say, with a questioning expression, "Krause"? and in the evening, after the visit of her sister, "Adieu"; soon after that, "What time is it" ?

The uvula deviated somewhat to the right and the existing slight facial paresis was evidently regressing. On the afternoon of the 6th of August, the patient was heard to say, "I know that," "Now I can . . . . now I can"; she pointed to her tongue and continued: "Yet I cannot . . . . would you also . . . ."? When sensations of fright occurred, she would exclaim: "What are you doing"?

Toward evening she uttered a number of complete sentences, which dealt with occurrences of the previous day, as the operation, etc. She frequently asked for pencil and paper to write down the words she could not speak: this showed a *distinct paragraphia* (see next page). It should once more be distinctly emphasized that the right hand was in no way paretic, the joints of the fingers were movable, and the slight facial paresis which existed before had disappeared.

On the evening of August the 7th, about six o'clock, there suddenly developed a severe attack of terror, during which the face was not pallid nor was there palpitation of the heart. It lasted about three-quarters of an hour. After subsiding, the power of speech suddenly became strikingly improved; words

were brought forth with greater ease and the vocabulary was more extensive. On the following day still greater improvement was noted. The patient spoke more fluently and with greater ease of expression. There was a hyperæsthesia of the right arm and to a lesser extent of the right lower limb to light contacts;



Wants to write down some mineral water

She wanted to say Filser

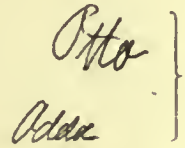
Wasser (water)

it was akin to touching an inflamed surface. In the afternoon, the patient complained of a crawling sensation in the right lower half of the face and of a feeling of furriness of the lips, especially

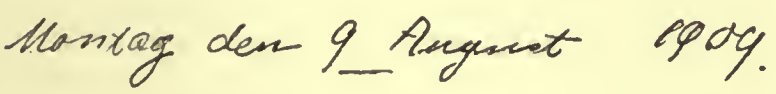
the lower one. She spoke of it as being "so swollen." Stereognostic disturbances of coarser grade in the right hand did evidently not exist. The patient could recognize coins correctly. There were no tactile disturbances in either hand.

On the 9th of August, the speech was more fluent; difficult words and those requiring repeated action of the lips were spoken quite well.

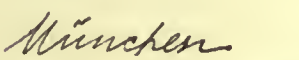
The hyperæsthesia of the skin of the right half of the face and arm persisted until August 13th, but it was very much diminished at this time. On the other hand, contacts of both lower extremities were equally well perceived. The velum palati could be better elevated on the left than on the right side; the tongue could be protruded without noticeable trembling. The paragraphia was, in a good many words, still very marked, as shown in the following specimens which were written to dictation:



= Otto

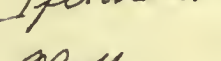


= Constantinople

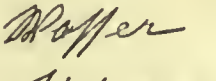


= Flower wreath

= Pferdebahn (street-car)



= Wasser (water)



= Drink glass

From now on, the power of speech improved more and more. On the 13th of August, only words used infrequently or those

very hard to speak were brought forth with difficulty; this was also the case in the presence of strangers.

On the 19th of August, the patient once more complained of crawling sensations in the hands. She described it as if electricity were applied to it. Formications travelled from the little to the middle finger; the index and thumb were, however, spared. These sensations were later on observed in the arm and especially around the elbow-joint. Sensations of similar nature were also noted in the right side of the face. Sensations of fear were especially noted while eating and swallowing. There apparently existed sensory disturbances of the œsophagus, which manifested themselves at deglutition, and thereby induced sensations of fear.

On August 22d, there were no more disturbances of writing after dictation; this, however, soon tired the patient. Writing spontaneously was accomplished with difficulty. She complained that thoughts did not occur to her and that she frequently wrote double.

At a subsequent examination (October 19, 1909), there existed no facial paresis nor disturbances of motion of the right arm, hand, and fingers of any kind. The power was normal. Stereognosis with reference to the recognition of all kinds of coins was perfect. The sense of position, as well as the sensibility of the fingers and hand were everywhere normal. Disturbances of speech were no longer present; she found it difficult, however, to speak in the presence of company, or if she knew she was under observation. At such times she found it difficult to utter certain words. Disturbances of writing no longer existed.

Privatdocent *Dr. v. Malaise*, of Munich, writes (November 2, 1910) that the general condition of the patient is good, and that an attack occurs and produces twitchings in the right arm and face on the average of about three to four weeks; consciousness is only seldom affected and paralyses do not exist. Generally the improvement is marked, since the attacks occur less frequently and with lessened intensity, and after their subsidence the general condition of the patient is good.

The second case of agraphia follows.

## OBSERVATION I, 17

*Jacksonian Epilepsy (Right). Careful Exposure of the Left Præcentral Fissure. Complete Motor Aphasia with Retention of Understanding of Word-Sense. Severe Agraphia. Gradual Regression of the Disturbances.*

B., forty-three years old, clergyman, no hereditary taints, suffered, in February, 1908, from a severe attack of influenza which, after subsiding for a brief period, recurred in a very severe form. He was delirious and confused. Soon after his recovery, for the first time, there occurred an attack at night, which was accompanied by rattling in the throat and unconsciousness. The patient was very much affected by the seizure. There are no data concerning its character. The attacks recurred for a few days in succession and then disappeared. Other seizures occurred which were observed from the 8th of April, 1909—the first day of consultation of *Dr. Fritz Kalberlah*, neurologist of Frankfort-on-the-Main. The attacks were described by him as follows: "The patient hesitated in his speech, gazed vacantly in front of him, after which distinct twitchings of the right half of the face and arm set in. Whether these twitchings also occurred in the right lower extremity, I cannot say. They lasted only a few seconds. The patient looked about confusedly and tried to speak without being able to utter a single word. While during the attack he could not be aroused, he now extended his hand on being asked to do so. He tried in vain to repeat words, after which he would say 'funny,' 'singular.' Three to four minutes later, he could speak well again. While in the first few minutes his speech was incoherent, this soon disappeared. He was now mentally clear and able to give intelligent information. Of the twitchings, there existed amnesia. An immediate physical examination of the patient did not reveal anything outside of a distinct right-sided facial paresis."

After severe attacks, the patient's foot was at times dragging. Now and then a weakness of the right hand would exist, which interfered with the use of the knife and fork while eating.

The continued use of bromides for months exerted no influence on the seizures whatsoever. On the contrary, they rendered

the patient dull and apathetic. There occurred at times, besides the attacks described, crawling sensations on the right side of the body, which were accompanied by giddiness. Complete loss of consciousness of longer duration occurred only once in the last year. The patient never complained of vertigo, headache, etc., not even immediately following the attacks.

Since three courses of inunctions and the exhibition of the iodides in massive doses were followed by transitory improvement only, and since *Kalberlah* assumed the existence of a cyst or a lepto-meningitic focus in the region of the left temporal lobe as a result of influenza, the patient was referred, June, 1910, to *Hermann Oppenheim* and myself. The attention of the relatives of the patient was called to the possible disturbances of speech, which may result consequent to the operation.

Besides a very slight asymmetry in the disfavor of the right half of the face, the examination of *Oppenheim* showed no pathologic findings. Two finger-breadths above the attachment of the left ear, or 7 cm. above the external auditory canal, a zone was found which was sensitive to pressure. In this area the patient perceived aberrant noises, as if water was trickling down from it. The diagnosis of *Oppenheim* was that of a morbid focus, of an irritative character with slight tendencies to spread in the region of the foot of the left anterior central convolution (meningitis serosa chronica circumscripta; possibly cysticercus; at any rate new formation).

The first operation was performed June 28, 1910; the second, July 7th. The left central region and the upper part of the temporal lobe were exposed through an opening 65 mm. wide and 80 mm. high. Immediately after reflecting the flap of dura downward, the brain presented at once; it was pulsating slightly. Unipolar faradic irritation (coil 80 mm. current barely perceptible by the moistened inner surface of the index finger as a crawling sensation) was followed by flexion of the index and middle fingers as well as the thumb (basal joints), accompanied by extension of the terminal joints. Repetition of the irritation three times in succession yielded the same result. The focus thus discovered (see Fig. 87, p. 443) lay in the posterior upper angle of the wound. Immediately in front and below it, toward the facial region, the brain was somewhat

more vaulted than contiguous portions. Puncture and aspiration of this area disclosed a cylinder of brain structure, consisting macroscopically of normal brain-tissue, devoid of fluid accumulation. The arachnoid in this locality corresponding to a vein, which faradic stimulations showed to belong to the præcentral fissure, was thickened longitudinally, to an extent of about 2 cm. and was whitish in color. In this situation, the

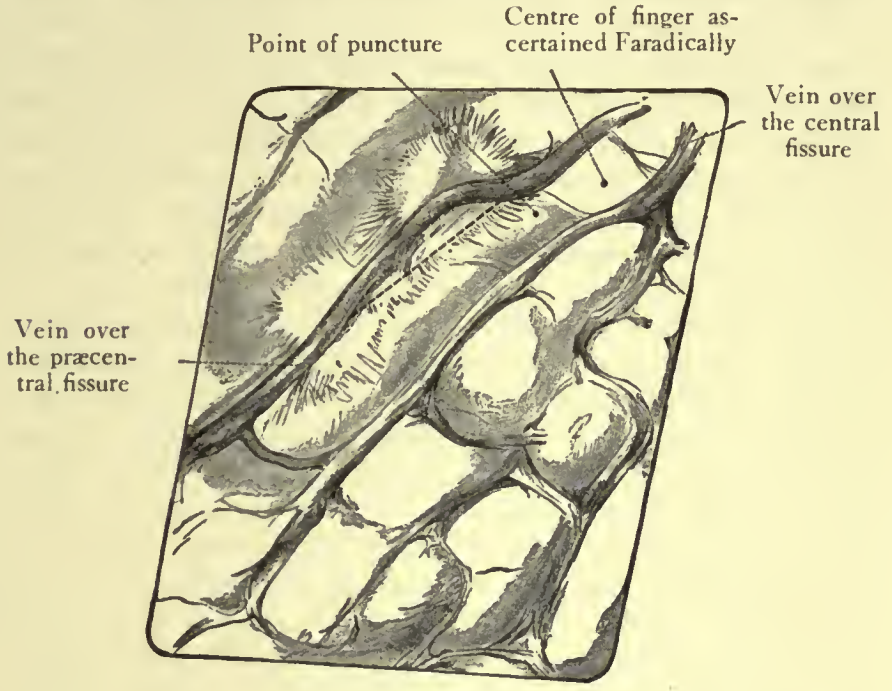



Fig. 87

Point of Division of the Arachnoid and Pia. The anterior central convolution and the frontal brain were in this situation forced apart to a depth of about 1 cm.

arachnoid was scarified, together with the pia, diagonally from above and behind, to the front below, with the fine point of a knife. The soft coverings were now carefully detached from the underlying cerebral surface for a distance of 1 to 2 mm. on either side. In this manner, a sulcus was uncovered, which, according to faradic irritation, was in all probability the præcentral fissure. Both convolutions immediately adjoining the fissure could be cautiously separated to a distance of more than

a centimetre, with the fingers, aided by gauze sponges. In the depth of the fissure nothing pathologic was discovered.

The brain in the trephined opening was now carefully examined, and no morbid conditions were found. As the area of speech was under consideration, an incision into it was not made on account of lasting and severe disturbances known to follow such procedures. After replacement of the dura and osteoplastic flap, the skin was exactly coapted without drainage.

The operation was completed at 10.30 A.M. On the afternoon of the operation, there was found a slight paresis of the right lower facial region (patient could not whistle). The tongue, on the contrary, could be protruded in every direction without restriction or lateral deviation. The grip of the right hand was not weaker than that of the left; its movements as well as those of the fingers were, however, somewhat clumsier. While the thumb, index, and middle fingers were somewhat paretic, the patient was, nevertheless, able to hold a pencil between the second and third fingers without trembling or effort. He executed movements of writing as before. Careful examination revealed neither ataxia nor adiadochokinesis. Apraxia, as well as optic-gnostic psychic disturbances were also absent, which was shown by the execution of correct movements in the use of a tooth-brush by the patient. The same results were obtained by applying tests of a similar nature. For instance, he recognized a watch shown to him and compared its dials with those of the watch of his nurse to assure himself that his timepiece was working. He drank tea from a cup handed to him, without hesitation, etc.

After the effects of the chloroform had passed (afternoon of the operation), he was perfectly clear mentally, and of a generally cheerful mood. This was noticed when the patient attempted to speak; he would get angry for a few moments and shake his head and smile over his miscarried attempts. If successful in writing a word correctly, his name for instance, he seemed satisfied with himself; if, on the other hand, a scrawling was the result, he evinced dissatisfaction. His judgment remained good throughout. For instance, thirty-four hours after the operation, the pencil he used became dull; he returned it to the nurse, intimating that he wished it sharpened. On such

occasions, action was instantaneous and without forethought. In this case, all tests could be undertaken to great advantage, because the general condition of the patient was excellent. To illustrate: As early as the afternoon of the operation, he was in a semirecumbent position, writing on a pad of paper with a pencil. In my examination, however, I did not take advantage of his generally good condition, because unduly prolonging them would undoubtedly fatigue him; this I carefully tried to avoid.

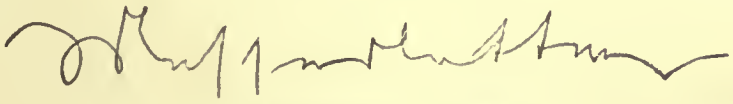
Besides the slight facial paresis on the afternoon of the operation, there was also a complete *word dumbness* and considerable *disturbance in the ability to write*. He could not utter a single word spontaneously; he was also unable to repeat any word or even the simplest syllables or vowels. When he tried to repeat any word or combination of words, nothing coherent could be obtained, except a continuous intonation of "da, da, da, da." It is hardly necessary to mention that he was unable to speak his own name or that of his wife whom he recognized immediately upon her arrival and greeted with a smile. When the nurse brought him warm tea, for a mouth wash, seven and one-half hours after the operation, he wrote the following:

(Warmer)

I doubt if he really wanted the tea to be warmer.

Testing his writing an hour later, the following was obtained:

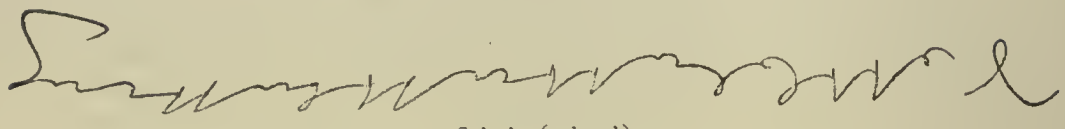
*Dictation-Writing*



He wanted a knife (messer)

Sonntag (Sunday)

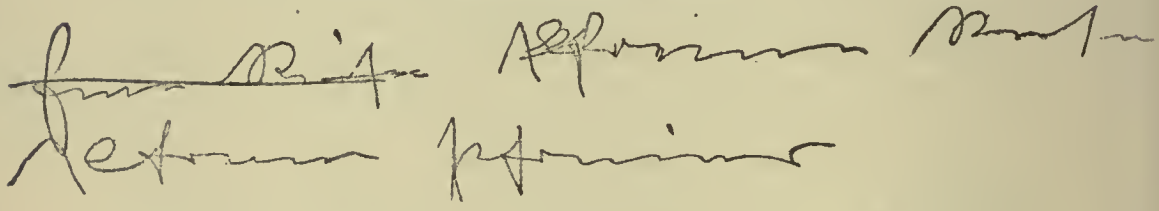
Kirche (church)



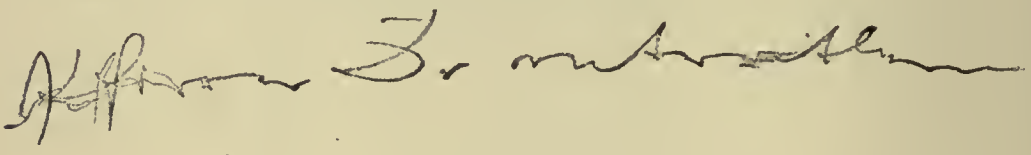
Schule (school)

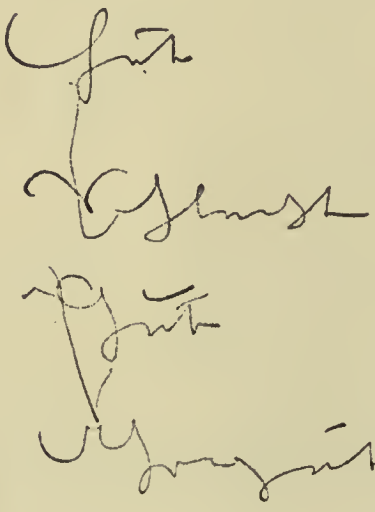
Five minutes later:

*Spontaneous-Writing*



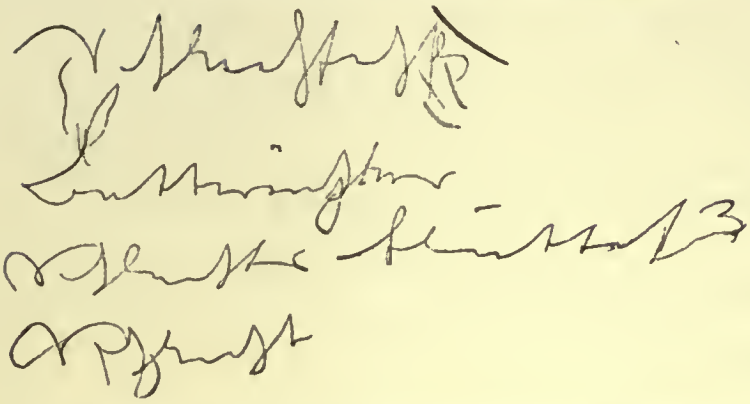
This should be "etwas zum trinken" (something to drink). The following line should be "schlecht" (bad).





After a pause of one minute he was asked to write the word "Gut," which was done correctly.

This should be "Uhr" (watch).



Finger

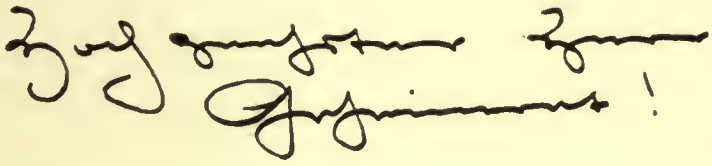
Bed

Auge (eye)

Nase (nose)

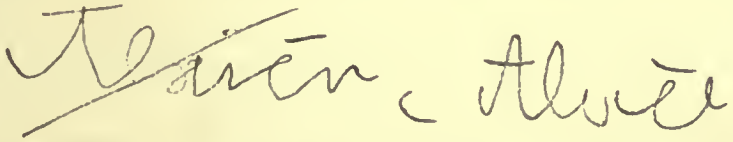
Note the well-executed letters, before patient became fatigued.

Following is a specimen of patient's handwriting before the operation:

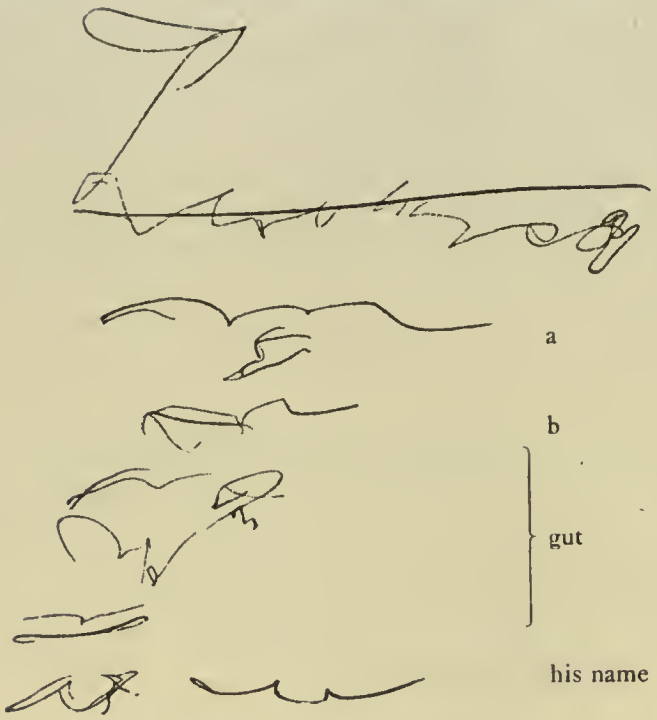


The marked determination of the patient to put down words and sentences in other specimens of writing is noteworthy. Compare this with the first case of apraxia (also of agraphia) of *Hugo Liepmann*, in his fundamental work: "Das Krankheitsbild der Apraxie." "Monatsschrift für Psychiatrie und Neurologie," 1900 and 1906.

The patient wrote the name of his wife, who sat near him, as follows:



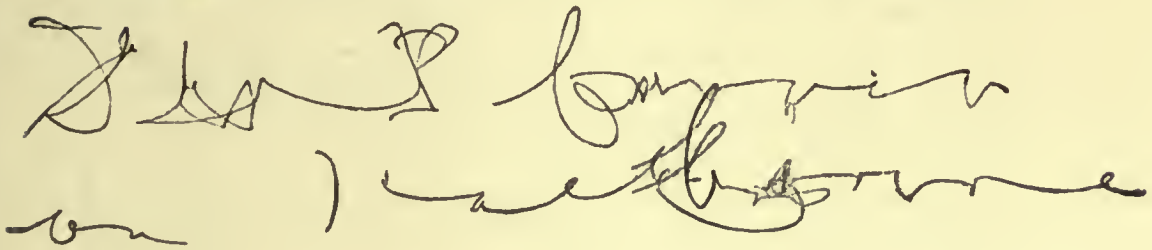
On July 8th, at 8 o'clock in the evening, the disturbances in writing became aggravated, and amounted to a complete agraphia. It was so marked that not even a single letter could be put down by the patient correctly. It should once more be stated, that up to that time his mental condition was entirely undisturbed. The writing was now as follows:



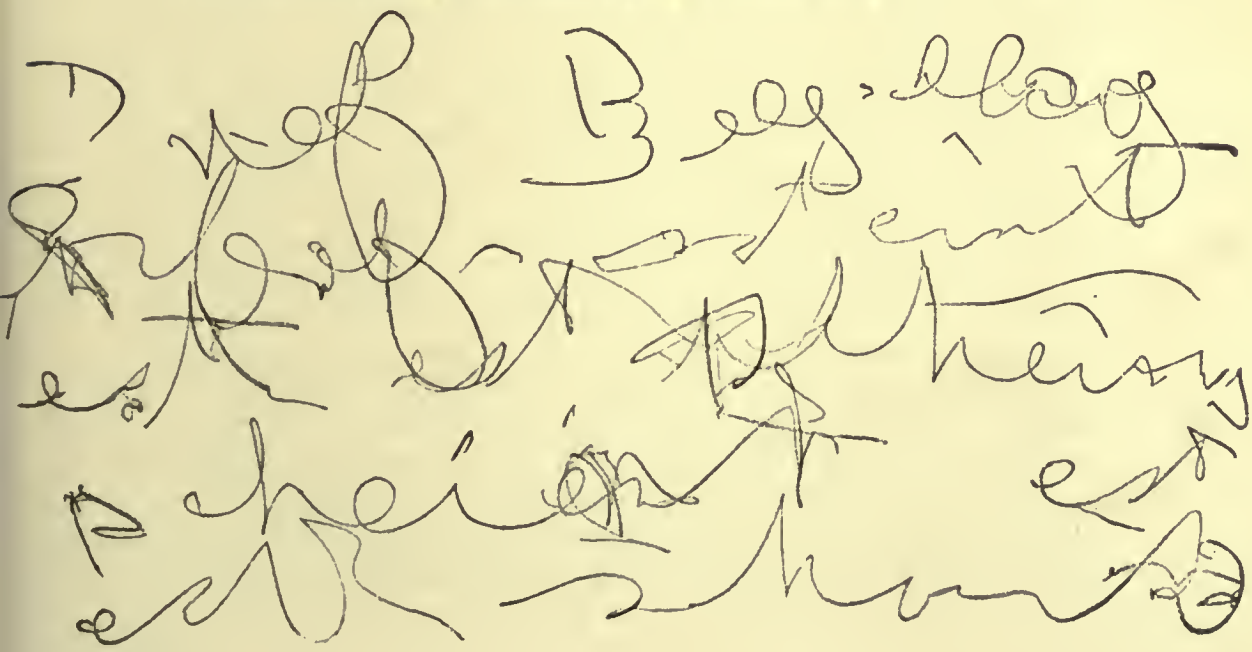

When requested to execute divers movements, he did so with precision. As an example, he would expose his knee, point at his nose, etc. He did, however, point to the nose again when asked to touch his chin. At 8.45 the following morning I wrote on paper, "knee," whereupon he thought for about half a minute and then exposed his left knee and tapped it with the left hand. To "right index finger," he responded correctly; to "left index finger," incorrectly. His understanding of words and sentences was good. He executed, with precision, the following verbal requests: "tapping the left forearm with the right hand"; touching the knee; grasping the nose with one hand, with the other, showing the tongue.

At that time (July 9th, noon) the facial paresis was improved to such an extent that the patient could whistle a little. Testing the power of the right hand, on the contrary, proved it to be weaker than on the preceding day. He was also unable to perform the finer movements in writing. The movements of the tongue were, until that time, normal. He made a knot in his handkerchief when asked to do so, without hesitation

(evening of July 9th). He winked and threatened at desire; showed his parts without any noticeable effort. Generally, he was able to correctly execute or imitate all movements on request. For the first time, the tongue was now seen to deviate somewhat to the right; its movements, however, were performed quickly and freely. Slight facial paresis still persisted; the right hand-grasp still somewhat diminished. The finer movements, especially of the fingers of the right hand, were not as adroit as those of the left. Word-dumbness (words and syllables), still existed to the fullest extent. Being asked to copy the heading of a newspaper: "The Parson of Kolbermoor," and other printed matter, the patient glanced at it and unhesitatingly wrote, as follows:



After this test, he motioned with his hand for the slate, and wrote the following—perhaps asking for something:



Out of this scribbling, only the name is recognizable. We conjectured that he wished some medicine, and showed him a bottle of syrup of figs, which he used occasionally prior to the operation; this, however, he energetically repulsed. On account of weakness of his right hand, he used his left hand for writing, from the 11th to the 20th of July. No changes were observed in existing conditions up to that time.

With reference to the further course of the disease, the patient gradually improved, so much so, that on the afternoon of July 10th, he sang correctly, of his own accord, the melody of the ballad "Precious Homestead be Greeted," during which he laughed very heartily. Of the words to the melody, he found none. On July 15th, the facial paresis had disappeared and the right hand was stronger.

The first word spoken by the patient was "ado," at the departure of his wife, July 20th. When he was asked to repeat the same word a few moments later, he was unable to do so. While, until now, the only manner of expression consisted, as stated above, in a continuous "da, da, da," the patient was, at this time, able to utter "da" singly as often as he was asked to do so; this made him very happy. Two days later, after preliminary babbling, he could repeat "baba." In the afternoon, he said once, spontaneously, "oh, no," but soon lapsed into his usual "da, da, da." The fingers of his right hand were now strong enough to write. On the following day (July 23d), after the words "papa" and "mamma" had been repeatedly uttered before him, he said "no" and, later on, "oh, oh." Two days subsequently he was able to protrude his tongue without the slightest deviation, as often as requested. He could also extend his hand without effort. The facial paresis was gone.

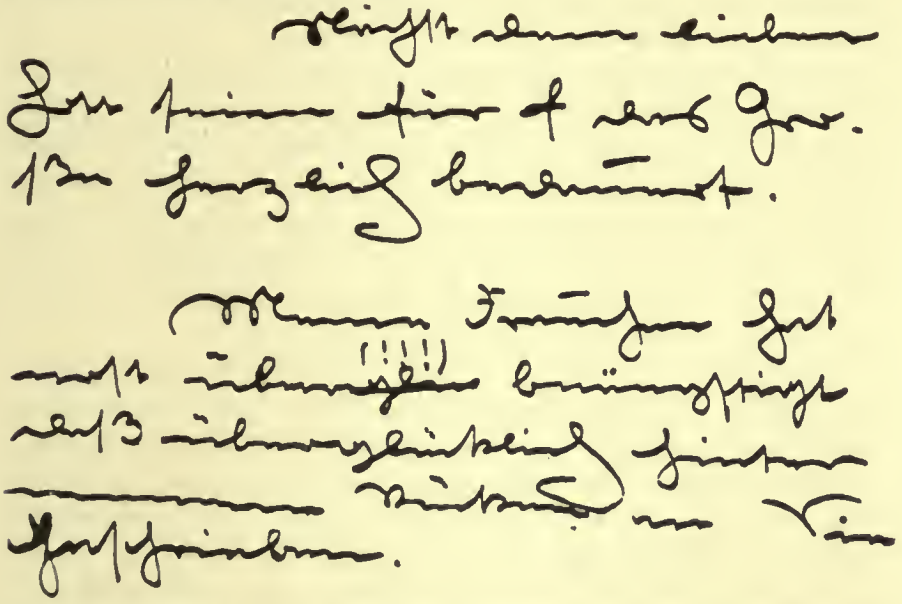
Besides his "da, da, da," two days later he was heard to say, "shada" and "ha, ha," and on the 28th of July, his favorite expression, "au wau." After the first of August, there was a marked improvement in his speech. In response to urging, he was able to repeat "yes" or "no" a number of times; also "the" and "sa." On the following day, he could spontaneously say "shame," "apron," and later on "mother." On August 4th, four weeks after the second operation, he greeted his wife with a clear and distinct "good-morning"; he was also able to count,

name the days of the week, tell my name, as well as to correctly speak simple sentences. All of this was, of course, accomplished slowly and indistinctly. The next day he spoke better; some things more clearly than others.

His writing was very much improved. On August 9th, it was to all appearances only slightly different from the normal, yet one would look upon smaller paragraphs as entangled, were he not to know that this was due to the inability of the patient to write down the proper terms.

In copying, he made only slight errors which he soon discovered and corrected. On August 15th, he returned home, a picture of health.

It is instructive to note that while his technic in writing has returned completely, written expression was still defective. On August the 18th, he wrote to me in his usual beautiful flourishing hand-writing, the following:



On September the 5th, the patient informed me that he made splendid progress in his speech, so that even the simplest people could understand him well; in the same letter only few errors were found. *Dr. Kalberlah* personally informed me that there still existed distinct disturbances of speech (beginning of October), which were of slight degree only.

The last letter from the patient (November 8, 1910), comprising eight pages, shows complete absence of any kind of error. His sister stated that he impressed one as a foreigner, who, while mastering the language, is yet speaking cautiously. The patient himself adds that while he speaks somewhat slower than before, he is able to utter any word or group of words he pleases, with the exception that now and then he must repeat a syllable accentuatedly. At that time, the patient was able to deliver a brief after-dinner speech in a circle of friends and relatives without the slightest difficulty. His four-year-old son is able to follow his lengthy conversations in detail.

His general physical and mental condition are otherwise excellent. The twitchings of the right side had disappeared. Isolated attacks, however, would occur from time to time, while the patient was asleep, or in the daytime. Some of the seizures were so mild and insignificant that the patient was walking up and down the room while they were lasting.

It is evident that the total dumbness and marked disturbances of writing in this case were the direct result of a slight injury at the border of the anterior central convolution, which extended to the second and third frontal convolutions. The disturbances did not depend upon a transient reflex activity, but were due to damaged states, requiring weeks for their disappearance. (Three months after the operation, distinct defects in speech were still demonstrable.)

Alexia did not exist; the patient responded to simple written requests. The understanding of spoken words, as well as written and printed matter, was completely retained. Essentially, euprexia existed. Retardation of comprehension was noted to a certain extent. When the patient was asked to write, he reflected thoughtfully before so doing. Accompanying the disturbances of writing, a senseless repetition of words made itself manifest (perseveration); this was noted at writing from dictation or spontaneously—especially in the latter. It was absent in imitating movements of the fingers. The technic of writing was mainly retained, except during the time of the existence of the paresis of the right hand, July 11th to 20th. This is shown by a number of well-written letters, in which the name especially

distinguished itself as flawless. The mode of writing peculiar to the individual also remained undisturbed. We were therefore dealing with a disturbance of verbal expression. Misplaced but correctly written letters were thrown confusedly between each other, and in the worst days of the disease the ability to write was completely checked for a certain period. That the name, title, etc., of the patient were correctly written is not at all singular, since this phenomenon is frequently observed in cases of agraphia.

The injury inflicted affected the site of articulated speech—the centre of *Broca;* the extent of the damage, however, was only slight. The assumption that the disturbances of speech and writing were due to deleterious influences affecting the general psychic conditions, must be abandoned, in view of the excellent mental state of the patient throughout the disease. Reflex action was also inoperative, since the centres adjoining the injured point (facial, arm, movements of the tongue) remained free or almost free from disturbances. Consequent to the traumatic intervention, between the 11th and 20th of July, there resulted a functional disturbance of the right hand, which interfered with its movements in writing. Tests of the left hand showed, besides awkwardness as a result of inactivity, no peculiarities in writing from dictation, spontaneously or copying from printed matter, as compared with tests of the right hand.

## General Genuine Epilepsy

According to the views now entertained, the cortex cerebri plays just as great a rôle in the production of attacks in general genuine epilepsy, as it does in cases of *Jacksonian* type. As stated above, spasms of an originally *Jacksonian* variety may, in the course of time, assume the type of general epilepsy. There are a few cases recorded [1] in which infantile cerebral paralysis has, in the course of years, entirely adjusted itself to such an extent that the existence of the slightest focal symptom could not be demonstrated; yet the epilepsy produced by the disease remained stationary and was of the general type. A faulty

[1] *Sachs* and *Peterson*, A Study of Cerebral Palsies, etc. "Journal of Nervous and Mental Diseases," May, 1890.

taking of the history would in this case undoubtedly have led to a diagnosis of genuine epilepsy.

On the other hand, there are cases of genuine epilepsy, in which the spasms begin in a certain circumscribed group of muscles or in one lateral half of the body,[1] in the first stage of the disease, and remain restricted to these parts. Consciousness is retained. Eliciting other important facts in the history of the case (heredity, etc.) will usually make a diagnosis possible.

It should furthermore be noted that epileptics in whom no focal symptoms existed in the beginning, may develop paralyses in the course of the disease. They may make their appearance periodically and immediately following individual seizures, and finally become permanent. The paralytic conditions, however, may suddenly set in after a long period of freedom from such symptoms, or they may develop from a beginning paresis. If, in cases of genuine epilepsy, focal conditions do exist, they are usually overshadowed by the general spasms and psychic manifestations of the clinical picture. In the genuine variety, there also occur symptoms of exhaustion, which are usually of lesser intensity and the result of the repeated attacks.

The surgeon should be thoroughly familiar with the clinical manifestations of these cases, because they may enable him to locate the seat of trouble even in cases of general epilepsy. *Redlich*[2] has pointed out the significance of the skin and tendon reflexes in these cases. The configuration of the skull, especially the X-ray examination as practiced by *Schüller*, may finally disclose deviations, and point to a circumscribed involvement of the brain—frequently one hemisphere. Such anatomic changes as extensive porencephalitis, microgyrism and sclerotic transformations were frequently encountered. To these must be added atrophic states of the hemispheres and hydrocephalus internus—more rarely externus.

The name of *Kocher*[3] has recently been connected with oper-

[1] *Emil Redlich*, Über die Beziehungen der genuinen zur symptomatischen Epilepsie, "Deutsche Zeitschr. f. Nervenheilkunde," 1909, Bd. 36.

[2] Über Halbseitenerscheinungen bei der genuinen Epilepsie, "A. f. Psych.," 1906, Bd. 41.

[3] *Th. Kocher*, Chirurgische Beiträge zur Physiologie des Gehirns und Rückenmarks, "Deutsche Zeitschr. f. Chirurgie," Bd. 36, und Über einige Bedingungen operativer Heilung der Epilepsie. "Verhandlungen der Deutschen Gesellschaft für Chirurgie," 1899.

ative intervention in cases of general epilepsy. He upholds the view that a sudden increase in the pressure of the cerebro-spinal fluid, which in these cases is, as a rule, increased in quantity as well as in pressure, may instantly rob the patient of his senses and be followed by general spasms. Local or general increase in the intracranial tension creates a predisposition to epileptic seizures. Besides this, fluctuation in pressure, another predisposing factor, is assumed to exist. In such patients, slight circulatory disturbances or pressure variations are sufficient to produce an epileptic attack. To quickly equalize the fluctuation of the pressure, *Kocher* advises the formation of a movable valve and, if deemed advisable, the repeated formation of a number of smaller valves.

Prior to *Kocher*, the increase in pressure was explained by *House* to result from an increase in the quantity of the cerebro-spinal fluid which, according to this author, precedes every epileptic attack. *Hitzig* is of the opinion that localized increase of pressure may irritate a circumscribed portion of the cerebral cortex, and thereby give rise to an attack of epilepsy of the *Jacksonian* type. The undoubted fact, that every epileptic attack enhances the occurrence of other seizures may therein find its explanation.

That the intracranial pressure is heightened during the epileptic attack is certain. The measurements of *Stadelman* have shown that the pressure in these cases may rise from the normal 35 mm., to the enormous height of 500 mm. While operating on some epileptics, during the attack, I have sometimes seen the brain protrude through the trephined opening in the form of a tensely and extremely stretched bag of dark blue-red color.

## OBSERVATION I, 18

### *Excision of the Facial Centre. Marked Protrusion of the Brain in the Status Epilepticus*

The patient in this case was a boy, eight years old, who, until his second year, developed extraordinarily well. At that time an acute attack of inflammatory encephalitis of short duration set in, which severely damaged the mental faculties of the

patient and resulted in severe and frequent epileptic seizures. They were only slightly influenced by very large doses of bromides. Whether paralyses existed at that time could not be ascertained. On admission of the patient to the hospital, however, the right lower branch of the facial was found paretic. Because the attacks were constantly increasing and no improvement in the mental state of the patient ensued; furthermore, and because the facial paresis was pointing to anatomic changes within its centre, and they, acting as lasting irritants, perpetuated the seizures, *Dr. Placzek* referred the boy to me for operation. Cerebral changes were not found upon its exposure. The facial centre was ascertained faradically and excised. (See Vol. I, Plate VII, Fig. b, and the dark-red area in Plate XXXI.)

On the evening of the day of the operation, the condition of the patient was satisfactory: pulse 95, temperature normal. At 11 o'clock of the following evening, spasmodic contractions of the right upper extremity were noted, which repeated themselves at greater intervals, but toward morning they became very frequent—almost continuous. Accompanying these contractions, tonic twitching of both lower extremities and the musculature of the diaphragm set in, so that the general condition of the patient became very alarming, indeed. Soon the status epilepticus developed. Since all therapeutic measures resorted to proved of no avail, I hoped to accomplish something by freely exposing the brain. This I did. After removing the stitches, the flap could easily be elevated, and after bluntly separating the slight adhesions and lifting the osteoplastic flap, the brain at once protruded into the trephined cleft, in the form of a tense bluish-violet pouch. No fluid drained off. The flap was now replaced and retained in position by a bandage. After this, the severe manifestations abated. In spite of all that, however, clonic and tonic spasms commenced again after a lapse of two hours, and, a few hours later, the boy died.

*Nawratzki* and *Arndt*[1] have further shown that the increased pressure which, in itself, is very significant, commences in the tonic stage, and ends when the clonic spasms cease. In their

[1] *Nawratzki* and *Arndt*, Über Druckschwankungen in der Schädel-Rückgrats-höhle bei Krampfanfällen. "Berliner klin. Wochenschr.," 1899.

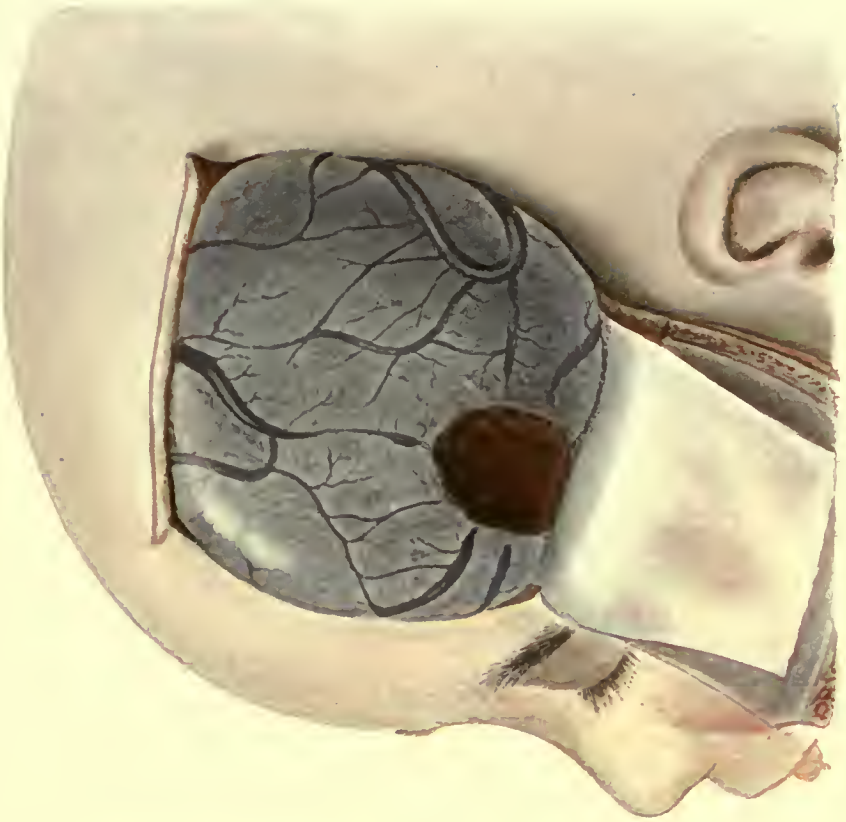


Fig. b.

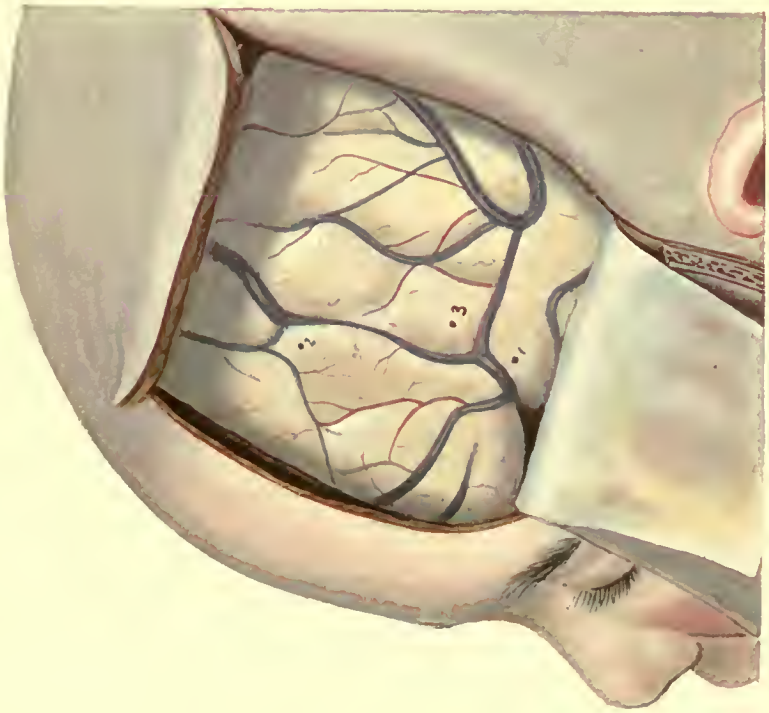



Fig. a.

opinion, the pressure is, therefore, a secondary manifestation. Their views are hence in direct conflict with the theory of *Kocher*.

*E. Redlich* and *O. Pötz*[1] have recently measured the pressure of epileptics—especially in the intervals between attacks—by lumbar puncture, with the patient in the lateral position and under all aseptic precautions. A continued elevation of liquor pressure could be demonstrated in some cases (maximum over 400 mm. of water), without regard to whether the attacks preceded or followed the lumbar puncture. In other instances, the tension was increased shortly before or after the attacks and also in the status epilepticus, while in the quiescent intervals, the lumbar pressure was normal. The examinations were so conducted that variations in the general blood-pressure as a cause of the elevated cerebro-spinal tension could be excluded with certainty. Subnormal pressures were repeatedly observed in patients with post-epileptic psychoses.

*August Bier*[2] has finally produced venous hyperæmia of the brain by means of a rubber band which encircled the neck and was tightened to a greater or lesser degree. An engorgement may, in this manner be produced, seldom seen in patients. It stands to reason that with heightened engorgement, there goes, hand in hand, increased cerebral pressure which may, in this manner be elevated to the highest possible point. Sudden constriction and release of the rubber band produce the most precipitous fluctuations of pressure within the skull and they should, in the sense of *Kocher*, produce epileptic seizures; yet, singular as it may seem, these experiments, the fundamental principle of which was the production of a marked increase of venous hyperæmia and intracranial pressure, were borne well by epileptics. On the contrary, the seizures in these cases were in no way increased in number or intensity, and the grossest possible intracranial fluctuations of plethora and tension were unable to produce an epileptic attack.

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[1] Untersuchungen über das Verhalten des Liquor cerebro-spinalis bei der Epilepsie, II. "Zeitschrift für die gesammte Neurologie und Psychiatrie," Bd. III, Heft 4, p. 492, 1910.

[2] *A. Bier*, Über den Einfluss künstlich erzeugter Hyperæmie des Gehirns und künstlich erhöhten Hirndrucks auf Epilepsie, Chorea und gewisse Formen von Kopfschmerzen. "Mittheilungen aus den Grenzgebieten der Medizin und Chirurgie," 1900, Band VII, S. 333.

These experiments were also carried out by *Bier* in patients with large trephine clefts and dural defects, in which the erect posture caused a humplike vaulting of these spaces and in whom the previously visible cerebral pulsations disappeared and were now only perceptible to the touch. Only one out of the ten cases thus experimented upon did not bear the procedure well. While in this case the attacks did not increase in number, they were prolonged and stronger, and the twitchings appeared more frequently and lasted longer than before. The patient felt worse after the application of the band and could not endure stasis to any extent. In the other nine epileptics, on the contrary, the attacks were diminished in number and lessened in intensity under the influence of stasis hyperæmia (six cases); three cases were uninfluenced one way or the other. A number of times the decrease in the frequency of the seizures was striking. At no time, however, did the favorable influence last long enough to cause a total disappearance of the seizures or at least a shortening of their duration.

These experiments have, at any rate, incontrovertibly proven that venous hyperæmia of the brain and increased intracranial pressure-tension do not produce epileptic seizures. The same is true with reference to sudden pressure fluctuations even in patients afflicted with the severest form of the disease or in those in whom psychic excitation alone is, under ordinary circumstances, sufficient to evoke a seizure.

In view of these facts, it was only after much forethought and reflection that I decided to make use of *Kocher's* method of valve formation in cases of genuine general epilepsy. My desires in this respect were checked, however, because my two first cases, in which I made use of this method, were complete failures. In spite of that, the favorable results obtained by other surgeons (*Kocher, Kümmel,* and *Friedrich*) induced me to take up the method again. Theoretically, at least, its use is out of the question, yet, while we possess in medicine so many old and valuable remedies, the modus operandi of which is until this date unexplained, and while we surgeons are in the habit of requiring definite and plausible indications for our procedures, we must not discard empiricism entirely; especially is this applicable in a disease where all remedies finally forsake us. There

is at present no room for doubt that valve formation is of distinct value in isolated cases of general genuine epilepsy. To this date, however, we are without a certain basis offering strict indications for its employment. We are still groping in the dark, as it were. Let us hope that we may soon be in a position to formulate definite indications for intervention in dealing with this disease.

Genuine epilepsy is not a uniform disease. It is represented by a number of varieties of morbid conditions. It should, therefore, be our aim henceforth to distinctly separate the individual forms from each other. The same state of uncertainty or limitation prevailed a number of decades ago, with reference to "rheumatism." As a result of close application and conscientious study, however, a number of morbid forms were evolved from the disorder (infectious conditions: acute articular rheumatism, acute infectious osteo-myelitis, bacterial endocarditis, etc.). If neurologic research be successful in the classification and in the establishment of certain types of the disease we now broadly term epilepsy, much benefit will be derived in a therapeutic sense. Only those forms of the disease will then come under surgical treatment, which, as a result of definite focal manifestations, have revealed morbid conditions amenable to surgical intervention. Since that time is as yet unfortunately distant, operative failures will necessarily be far too numerous.

And, let us reflect for a moment. How many malignant tumors do we actually cure permanently? Yet to get even these results, how frequently do we have to resort to severe mutilating operations! But, I should limit myself to surgery of the brain. We consider it a great success when we can effectually remove a cerebral tumor, notwithstanding the fact that in a considerable number of cases we get severe functional disturbances in the bargain, the result of the growth of the neoplasm or the operation. Yet I do not know of any surgeon who, in view of these facts, would advise against the extirpation of such neoplasms and not take advantage of the brilliant progress made in this particularly difficult branch of surgery.

Of one thing we are sure, and that is, the prognosis of the operation of valve formation, as far as life is concerned, is good. It must be remembered that this operative procedure exposes

the surface of the brain only and does not penetrate into the depths of the organ. Yes, we may even perform this operation without chloroform anæsthesia, substituting for it *Heinrich Braun's* method of adrenalin-suprarenin-infiltrations. This is of especial value in cases in which complicating cardiac and pulmonary disorders interdict the use of a general anæsthetic.

### Technic of Valve Formation

The area to be trephined is the one overlying the anterior central convolution in right-handed patients on the right side.


Fig. 88

If the spasms indicate a preponderating involvement of the left hemisphere, the operation is performed on that side. According to *Kocher* the trephined bone and dura mater are sacrificed. Osseous union of the cleft in the skull should be prevented.

The excised portion of bone need not be completely removed for that purpose; it is sufficient to snip off a strip of bone from one to two centimetres in width from all sides of the osseous flap.

After delineation of the central fissure and performing *Heidenhain's* deligations, a cutaneo-aponeurotic flap is formed, measuring about 35 mm. in width and 40 mm. in height (Fig. 88), care being taken not to injure the periosteum. An incision

Fig. 89

measuring 18 mm. in length, at an angle of about forty-five degrees, is now added to each angle of the principal flap and the three smaller flaps thus created are dissected. After this, the periosteum is divided at the bases of the flaps and at the edges of the three first incisions. The periosteal strips are now separated with the raspatory and permitted to remain hanging at the base below, to be removed, together with the bone flap, after its formation (Fig. 89). The bone is divided in the usual

manner, the osteoplastic flap well dissected down and removed with the periosteum below. The denuded sections of bone on all four sides are now broken off with the rongeur forceps.

The dura is so incised as to correspond with the skin incision, with the exception that the principal dural flap is made somewhat larger so as to project a little over the plate of bone. It thus overcomes the slight natural tendency to retraction. In this manner, besides the principal flap of dura, the base of which is directed downward, there result three smaller flaps, an anterior, superior, and posterior (compare Fig. 90), which are brought over the cut surfaces of the diploë, to prevent the contact of the exposed

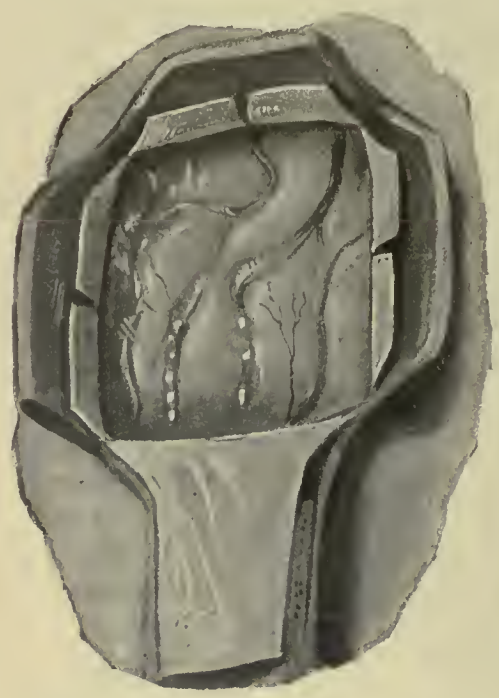

Fig. 90

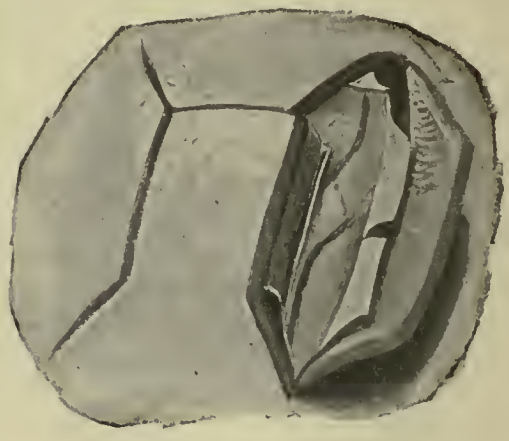

Fig. 91

brain and its soft membranes with the edges of the bone. A transverse incision in the middle of each of the smaller flaps greatly facilitates their application over the cut edges of the bone. In replacing the large dural flap, and after exact suturing of the osteoplastic flap into position (see Fig. 91), the lamina vitrea is brought to rest exactly on the principal flap, while above, in front and behind, the brain is covered by galea and skin only. In this manner a good valve formation results, and it obviates the necessity of the wearing of a shield by the patient

for the protection of that portion of the brain covered by soft structures only.

## Results of Operative Treatment of Epilepsy

Since we have seen that *Jacksonian* spasms not infrequently culminate in general epilepsy, I shall discuss, under one heading, the results obtained from surgical operations in both varieties. I shall limit myself to statistical data of my own cases exclusively for two reasons: First, I believe my own observations to be sufficiently numerous and reliable, since they extend over a period of seventeen years. Secondly, numerical results, the outcome of a particular place of labor, are generally more reliable than compilations from various sources; because in the former, results as well as failures are equally recorded.

In order to get results as accurate as possible, the following question-sheets were sent out (July, 1910).

We requested the exactest possible answers to the following questions:

1. How is your general condition?
2. Do you still have attacks?
3. If so, what kind are they?
4. How frequently do they occur?
5. Have your memory and intellectual faculties suffered in any manner?
6. Are there any paralyses present, or do they occur after attacks? How long do they last?
7. Are you under treatment; if so, how long since, and what kind?
8. Is your condition better, worse, or the same as before the operation?
9. What is your correct address?

These questions were sent to thirty-two patients, in whom valve formation had been performed for general genuine epilepsy, and to forty-five individuals operated on for the *Jacksonian* type of the disease.

To the former set, twenty-four, and to the latter, twenty-nine replies were received.

Of a total of thirty-four patients operated upon for general

genuine epilepsy, since 1906, the spasms were uninfluenced by the operation, except in two cases (two children, four and six years of age respectively, succumbed to general spasms in the status epilepticus on the day following the operation); on the other hand, a child, four years old, one five, and two seven years old recovered from the operation. The operation of valve formation, which in itself is in all respects a simple procedure, appears in small children to be a serious undertaking. We should, therefore, resort to it in these instances where the urgency of the condition requires it. In one more instance, in the case of a child three years old, the operation was performed upon urgent indications (October, 1910) in two sittings with very gratifying results. Besides the last case mentioned, four others were operated upon, so that until now, in a series of forty-one operations, only two children died.

As previously stated, I have adopted operative intervention in cases of general genuine epilepsy, only after much hesitation and indeed have expected little from it. The results obtained, therefore, did not disappoint me. Out of twenty-four answers, fifteen wrote that their condition is unimproved; four are aggravated, and five speak of a marked improvement. In three of these cases from three to four years have elapsed since the operation; we may, therefore, look upon them as permanently relieved. One of these patients uses a secret remedy. Of the other two patients, one, a man, at present twenty-seven years old, in the beginning of November, 1907, has undergone the operation of valve formation on the right side, in the manner described above. He was a daily sufferer from severe general seizures since he was nineteen years old. These rendered him, prior to the operation, totally incapable to work. Since he has undergone the operation, intervals of from seven to eleven months exist between attacks (last seizure, November, 1909). Momentary disturbances of consciousness (petit mal) that occurred previously as often as twenty-three times in a week, now appear on the average of about once in twelve to fourteen days. The patient speaks of an incomparable improvement in his condition since the operation, and he uses no remedies.

The other patient, a man, thirty-one years old, has in the last four years improved to such a remarkable degree that he

can now conduct his factory unaided to great satisfaction (prior to the operation he was totally disabled). He is on duty from 8 o'clock in the morning until 7 in the evening; does not take walks during the day; he desists from any form of extended relaxation; does not avoid alcohol altogether, and has not been using bromides for the last two years. Instead of three or four attacks daily, as before the operation, he now has one seizure in about four or six weeks. This is so insignificant that he continues at his work undisturbed while it lasts.

Finally, considerable improvement is to be noted in two other cases operated upon, and ten months after the respective operations.

It should be especially mentioned that in three cases in which simple valve formations were performed over the anterior central convolution, the hand of the opposite side became weak, and showed awkwardness in the movements of its fingers. We should, therefore, inform our patients that while motor disturbances after such operations are rare, they may, nevertheless, occur.

Whether the bone in valve formation should be removed entirely or in a manner described above, I shall refrain from deciding at present. Generally, however, I found no difference in the action of both methods. In one case in which the bone was retained in the valve formation, the aura, which until that time only preceded the attacks, was now almost continuous, so that the patient was prevented from leaving the house on account of it. The operation in this instance has, therefore, evidently proven harmful. Every time the patient stooped down, he became dizzy and had to keep to his chair most of the time. He occupied himself mentally as well as he could. The spasms, also, became more frequent, so that every hope for improvement vanished. His surgeon thought the cause of aggravation to be due to the pressure of the somewhat sunken bone plate, which, with my consent, he removed seven months later. Since that time a decided improvement is said to have occurred in the general condition of the patient. He was constantly using bromipin and substituted *Erlenmeyer's* bromide mixture for table-salt. The aura appeared now many hours before the attack, warning the patient of its approach. This enabled him to fre-

quent the streets, undertake journeys, and to do some scientific work, all of which he was previously unable to accomplish.

By far more encouraging are the results obtained in *Jacksonian* epilepsy. Neoplasms and other focal conditions should, of course, be carefully excluded from this category. My experiences with *Jacksonian* epilepsy date back to 1893. I have kept many patients under continuous observation and have later corresponded with them or their relatives with reference to their condition. Patients of the Berlin Hospital are frequently a travelling lot, from whom nothing more is heard after they are gone; consequently, I could not obtain any data from these people. I therefore felt obliged to mark all of that class as not cured. In tabulating my results, I strictly desisted from overenthusiasm; on the contrary, an element of pessimism was always before me.

Of a total of forty-nine cases operated on for *Jacksonian* epilepsy, only one died immediately following the operation (girl six years old; eight hours later, in collapse). In this case, I declined to operate from January till December on account of the weakened constitution of the patient. I decided to interfere only after repeated entreaties on the part of the parents and the house physician, but at that time the spasms were so severe that they encroached upon the pharyngeal muscles, making deglutition almost impossible. Inanition followed, and the involvement of the diaphragm threatened suffocation. To my regret, I performed the operation in one sitting and prolonged the Faradic irritation to excess. Three other patients, eight, twenty, and thirty-eight years of age, succumbed in the status epilepticus—three, five, and six days respectively after the operation. Death may ensue in any severe case of epilepsy, and it must be admitted that operative intervention may augment the number of the seizures. All other patients recovered.

Since the question-sheets were sent out, about the time of completing this book (October, 1910), I operated on six other cases for *Jacksonian* epilepsy. In this series, one patient was a boy six years old. All these cases recovered from the second operation. The mortality was consequently four out of fifty-five patients. Add to these the number of those of general genuine epilepsy makes six out of ninety-six patients.

Of the twenty-nine patients who answered, eleven find their condition the same as before the operation; three became aggravated, and in eight a marked improvement and amelioration of the symptoms and seizures has taken place; in two cases, nearly a year has passed since the operation, and in the others two to five years have gone by. Very good results were obtained in three cases, one of which deserves brief mention. When the boy, presently eleven years old, was just about completing his fourth year, I excised his primary spasming centre of the left hand. The epilepsy from which he was suffering developed in connection with a severe inflammation of the coverings of the brain at the age of ten months and was accompanied by complete interruption of the intellectual development. Before the operation, periods of tranquillity lasting three days, interchanged with seizures of great severity, giving rise to frothing at the mouth and loss of consciousness. This continued for days and recurred about every half hour. Such seizures occur now on the average of about once in six months, and in the intervals, short-lived twitchings of the left arm are observed about once in two to four weeks. Since the operation, no treatment whatever was made use of. The boy frequents a school for weak children, he reads and writes well, but his speech is defective.

It is noteworthy that while prior to the operation the seizures always commenced in the right arm, they now start in the left arm and remain confined to that side. This remarkable circumstance justifies, I believe, the exposure of the right central region, since the slight facial paresis of the right side existing prior to the first operation has disappeared after its performance without leaving a trace behind it. The parents of the boy are so pleased with the results, however, that they renounce the idea of a second operation.

I consider four cases completely cured. Of these, three date back seventeen, eighteen, and seven and a half years, respectively (Observations I, 8, p. 352, I, 15, p. 390, and I, 10, p. 360). To consider a case permanently cured, a number of years must elapse after the performance of the operation, because we not infrequently encounter cases of *Jacksonian* epilepsy, in which intervals of weeks or perhaps months are noted between the

seizures. In cases of epilepsy, following infantile focal conditions, the attacks are known to remit for a certain length of time, to return again in all their severity. Such intervals of apparent cure are not infrequently overrated. It, therefore, does not mean much in certain cases, when after trephining, exposure, and excision of a focus-field, the attacks fail to appear for a few months. Their recurrence after such lapses soon tells the tale. It should also be remembered that burns, injuries, operations of the most varied kind, and intercurrent acute affections, may check the spasms and cause the disappearance of the seizures for a very long time. I consider a case of epilepsy permanently cured after five years have elapsed, during which time the patient enjoyed perfect freedom from any symptoms. To illustrate my position in the matter, I recall the case of a girl, fifteen years and eight months of age, who was operated on for encephalitic cyst (Observation I, 8, p. 352). She has been cured now for seventeen years and I presented her case to the Hamburg Medical Society (*Deutsche Med. Wochenschr.*, 1900, Vereinsbeilage), only after the expiration of six years and four months, during which time no epileptic seizures of any description occurred and the mental development had returned to normal.

The prognosis is uncertain, even in typical cases of *Jacksonian* epilepsy. We cannot even promise an improvement with entire certainty. I invariably refuse to operate when some assurance or guaranty is wanted. How dare we even think of making definite promises in these cases when the extent and nature of the cortical changes are entirely unknown to us until the patient is operated upon? In spite of an earnest explanation, however, the relatives of the patient will not infrequently urge operative intervention.

However, numerical statistics alone cannot in these instances decide the question, as is the case with other operations. The value of the results must be looked upon from the psychic side of the question as well. Besides the spasms, I have seen idiocy disappear, following surgical operations.

1. In the case of the above-mentioned girl, seventeen years after the operation (Observation I, 8), the spasms lasted eleven years and eight months; the idiocy four years.

2. In a man thirty years old, eight years after the operation (Observation I, 15, he is at present general manager of a large life insurance company), the spasms lasted four years; the mental derangement two.

3. In a man twenty-two years of age, seven and a half years after the operation (Observation I, 10, patient studies in a business college and besides foreign languages, also takes as collateral studies mathematics, geography, and history) spasms existed twelve years; mental abnormality three years.

4. In the case of a boy, four years of age, six years and eight months after the operation, he became a good pupil.

5. In a boy of nine years, three years after the operation (Observation I, 13, p. 380), spasms and mental aberration lasted one and a half years. In the case of this boy, I make an exception to my five year limit, because prior to the operation he was a confirmed imbecile and he has since then learned, besides his mother-tongue (Hungarian), the German language so excellently that he writes very pretty letters to me from time to time informing me of his highly satisfactory condition. He now attends high-school (gymnasium) and is a good pupil in all branches. In mathematics, he is fifth in a total of sixty-eight students.

In a number of other patients, besides a decrease in the number and severity of the attacks, marked improvement of the memory was noted. In cases in which the imbecility disappears, it is certainly of a functional nature, secondary to circumscribed processes such as cysts, etc., after the removal of which the mental condition becomes entirely rectified or at least very much improved. Where marked anatomic changes exist in the cortex (encephalitis or meningo-encephalitis), as in paralysis for instance, their regression and, of course, the accompanying improvement in the psychic functions, will naturally be out of the question. Our aim should, therefore, be to diagnose the nature of the underlying condition from the clinical picture whenever possible. As long as this cannot be accomplished many useless operations will be performed. According to my experiences, whether a valve has been formed or not; furthermore, whether the resulting cleft after such valve formation is performing its function or has become obliterated, is of no mo-

ment as far as the results in *Jacksonian* epilepsy are concerned. Those of my own cases which were most successful, do not show a trace of the existence of valve formation (Observations I, 8, I, 10, and I, 15).

It should especially be emphasized that the primary spasming centre of the right hand should be excised with great caution. In four cases of the latter instance there remained a paresis of the hand and fingers with great impediment of movements. In one of these cases which concerned a boy sixteen years of age, in whom the operation was performed two years ago, there was observed an aggravation of the symptoms and the seizures and an almost complete loss of the stereognostic sense of the hand and fingers. *Broca's* cortical field is even more sensitive than the centre of the arm; great caution is, therefore, necessary in operating in the former area.

In those cases in which pareses and paralyses did not exist prior to the operation, and in which no macroscopic changes are to be found on the cortical surface, the excision of the primary spasming centres should only be performed in very small sections (15 to 20 mm. at the very utmost).

In cerebral infantile paralyses, on the other hand, the existing pareses and paralyses are frequently seen to improve, when the excisions in the altered central region amount to as much as 30 mm. in length and 24 mm. in width.

The immediate action of such excisions have been very slight in these instances. If, for instance, the centre of the hand was excised, the existing slowness, awkwardness, and limitation of motion were more marked after the operation. Of special value is the fact observed in the cases of two children (Observation I, 13, and I, 14), in which the paralyzed limbs improved after months and years. This is explained, of course, by the cessation of the spasms in certain muscle groups. The stronger the contractures that result from the encephalitic processes, the weaker, of course, are the antagonistic forces that result from inactivity; these regain their normal state after the abnormal tensions in the joints recede. This is mainly manifest in pronation and supination of the forearm, and in flexion and extension of the fingers. Under these circumstances I have seen even pes equinus improve.

In two other cases, one that of a child seven years of age (Observation I, 12, p. 368), and the other that of a young woman of twenty-seven years, in both of which large quantities of fluid were evacuated from the extremely distended lateral ventricles, marked improvement took place in the spasms and contractures, as well as in the paralysis of the antagonists of the extremities and trunk, a few weeks after the operation. The previously hyper-exaggerated reflexes were now considerably diminished. The evacuation of the hydrocephalus of the seven-year-old child was thorough; in the other patient only 50 cm. of fluid were obtained. Large quantities of fluid remaining after surgical evacuation may become absorbed; this, as is well known, is a matter of common occurrence in cases of pleuritic effusions and exudations. That no fluid remained or reaccumulated could, in the latter case, be corroborated with ease by information gained from the position of the trepanation valve. It was deep underneath the level of the surrounding surface of the skull.

The important question, whether the operation may by itself produce an aggravation of the disease, should now be discussed. It should be constantly kept in mind that the general tendency of all severe forms of epilepsy—all of our cases were of this type—is a progressive one, and that the intellectual faculties are very unfavorably influenced by it. In many cases it finally leads to idiocy. If the operation does not, in view of these facts, accomplish a cure or at least an improvement in the patient's condition, the epilepsy will run its usual course and the increase in the number and intensity of the spasms and the other untoward manifestations accompanying the malady, should not be attributed to the operation. From my observations, with the exception of one case described above, I am not justified to assume that the disease is aggravated by an operation.

## Indications for Operations

### General Genuine Epilepsy

Operative intervention in these cases has an established place. I must especially emphasize that besides cures we must also recognize improvements in the morbid conditions of epilepsy. *Ernst*

*v. Bergmann* asserted with unconditional exactness: "Epilepsy is either cured or not cured; improvement, I cannot acknowledge." I have retained this point of view on the authority of *Bergmann* for a long time, but was in the light of my own experiences prompted to abandon it. My experiences teach me that a complete cure in cases of general genuine epilepsy is, at all events, a very rare occurrence; improvements, on the other hand, are seen more frequently. It certainly will, as yet, require a great deal of labor to formulate definite and sharp indications for operative intervention in these cases. To be sure, failure frequently results; in such instances, it is needless to say, the individual was not a fit subject for the attempt, as for instance in cases where the cortical changes are extensive, involving one or sometimes both hemispheres. Unfortunately we are up to this date not yet in a position to diagnose these morbid states prior to the operation, for if this were possible, we undoubtedly would exclude them as improper subjects for surgical intervention. It is hoped, however, that the anatomic findings in these cases will contribute to our enlightening and advancement by newer discoveries, as in other branches of surgery. At the autopsy *in vivo*, we learn the peculiarities and frequent slight changes of the cerebral cortex, which in the cadaver can no longer be recognized. Just as the erythema of erysipelas disappears from the skin after death, so does the frequently alluded to slight discolorations and œdematous infiltrations of the soft coverings of the brain vanish post mortem beyond the point of recognition.

If it were possible to cure even a fractional number of these cases, it would no doubt be an inestimable gain. More than one highly cultured epileptic faces self-destruction, conscious of the dwindling of his memory and intellectual powers. If we are further cognizant how, through one epileptic, large circles are influenced and that not only his own happiness in life but also that of his family may be shattered by his infirmity, we at once become conscious of the gravity of the question we are called upon to decide. The higher the education of the individual, the worse the effects upon his relatives. How frequently have I been implored to operate on individuals of our own high rank, when not the slightest prospects of success existed.

In fact, we are dealing with a subject of social importance, because the number of these unfortunates is astounding. According to the courteous information of *Geheimrat Behla*, of the Prussian Official Bureau of Statistics, the number of male patients in the medical institutions of Prussia in 1907 were 9,058; females, 6,178; together, 15,236. There were 2,372 male patients and 1,601 females without mental abnormalities, making a total of 3,973 epileptics. A separation of the *Jacksonian* from the general genuine type of the disease was not attempted. If to these figures we add the number of patients in private families in Prussia, there would approximately be one patient to every thousand inhabitants (figures unofficial). In so many thousands of epileptics in Prussia (about 40,000) there certainly exists a number in which early operation would at least accomplish an improvement in the condition.

In cases in which the attacks are infrequent, the memory and intellectual faculties are disturbed but little or not at all; furthermore, if the patient is capable, in view of the moderate degree of his illness, to attend to his vocation even to a limited extent, operation should not be considered. If, on the contrary, as a sequence of the frequency of the attacks, the memory begins to suffer, we can never tell what the further course of the disease is going to be or whether it will ultimately lead to idiocy. In view of all that has been said, I strictly adhere to the principle to thoroughly explain to the relatives of the patient without reservation the various angles of the prognostic possibilities, and I leave them to decide whether or not an operation should be performed.

The improvement or cure of epilepsy may be decided solely by clinical observation of the patient. It will as yet require years of ardent and untiring effort to put us in a position wherein we are able to judge whether or not operative interventions will favorably influence the atrophic and sclerotic metamorphoses known to flourish in the cortices of so many epileptics (*Chaslin's* gliosis, sclérose névroglique) or arrest the unhindered progress of such anatomic abnormalities known by the clinical manifestations to exist. Pressure-equalizing operations hold out some hopes, particularly in the latter respect.

In these conditions, the joint action of surgeon and neurolo-

gist will undoubtedly lead to progress as exemplified by the invaluable fruit borne of the harmonious colaboration in general surgery of the brain and spinal cord.

### Jacksonian Epilepsy

The indications for operation in *Jacksonian* epilepsy may be formulated with somewhat greater precision than in the general genuine variety. If the basis of the disease be one of the intoxications, such as lead-poisoning, alcohol, or uræmia, or if it developed during the acute stage of some infectious disease, or perhaps from a hysteria, the patient should be considered unfit for an operation. It should be stated, that on the whole, cases of *Jacksonian* epilepsy that have lasted for a considerable period should be referred to the surgeon. I am fully aware that my view in the latter respect will at present still meet with disapproval, and that many of our leading neurologists will advocate the pursuance of a course diametrically opposed to the one advised by me. For that reason the great majority of my patients were referred to me, not by the neurologist, but by their relatives or family physicians.

In spite of that, however, a change of attitude has already begun in that respect, and labors in that direction are everywhere carried on and increased. When one stops to think how many whole groups of general diseases have in recent years, in a therapeutic sense, been transferred from internal medicine to surgery, one may with just anticipation look for the same to occur in this particularly difficult branch of surgery. It is far from my aim to advocate that all cases of *Jacksonian* epilepsy—except those indicated above—be assigned to the surgeon from the beginning; on the contrary, a rational preliminary course of general medication may be tried, and it is hoped that by so doing, a great many cases may be brought to recovery. Nevertheless, such treatment should not be unduly prolonged, because, by so doing, the favorable time for operation may be permitted to pass by. As such, I must describe that period at which the cortex has not as yet been involved in its entire extent, and the epileptic changes postulated by *Jolly* have not become diffuse or enrooted, also that period at which the intellectual faculties have suffered but little or not at all. The operative removal of

the focal pathology, causing the epilepsy, may lead to a successful issue only when the conditions responsible for the cortical symptoms are still reparable. The later we operate, the more apt are our efforts to be frustrated by the pernicious and damaging influences occasioning the trouble.

I have repeatedly removed quite large cysts (Observation I, 8, p. 352; Observation I, 10, p. 360, and in others) in older patients—one was thirty-six years of age, in which I have heartily regretted that they were not sent to me sooner, and the disease, which was at first of a purely *Jacksonian* type had, after many years culminated in the general genuine variety and affected the intellect to no small degree. In view of my further experiences, there cannot be entertained any doubt that a great many of these cases may be cured by a timely operation.

The anatomic changes previously described also speak for timely intervention in cases of *Jacksonian* epilepsy. The latter comprise, in a general sense, tumors, angiomata, cysts, etc. If the only clinical manifestation of the disease be spasms, we can never foretell if the condition is amenable to treatment or not. To cite another example: I have operated on two adult epileptics in whom operation has been strenuously advised against, after many months of observation, yet upon free exposure of the central region, angiomata of the soft parts and cortex were found. Both patients are cured. In these cases, not a single symptom existed to indicate the great extent of the serious organic changes found at the operation. I have had similar experiences in cases of genuine neoplasms.

All epilepsies resulting from infantile cerebral paralysis should be subjected to early surgical intervention, even if they be very extensive and involve an entire half of the body. To enhance the impeded cerebral development in these cases, valve formation comes under consideration. What *Lannelongue* aimed to accomplish in vain, by removing strips of bone in cases of idiocy, may be done with greater prospects of success in instances of premature ossification over the cerebral foci.

The relative freedom from danger of the operation should once more be recalled. The portion of the skull most easily accessible should be trephined; hemostasis should be perfect, and the loss of blood by the use of *Heidenhain's* deligations is,

as a rule, insignificant or practically *nil.* The asepsis, it is needless to say, should be faultless. The actual encroachment upon the cerebrum proper is generally superficial. If the operation is performed in two sittings, the untoward effects resulting from variations of pressure will be greatly minimized.

Once it is decided to operate, the surface of the brain should be widely exposed. In this manner alone may the presence of pathologic foci be ascertained and removed. The opinion that we should limit ourselves to trephining only in cases where the dura appears to be normal and pulsates, should be rejected.

My observations speak against it. In cases in which the dura appeared perfectly normal and distinctly pulsated after its opening, I have not infrequently found besides cysts, severe alterations of the brain; at other times again, the latter were insignificant in spite of complete absence or slight pulsations of the dura.

Too much faith should not be pinned to expectations in cases of primary spasming centre excisions in which the cortex shows no macroscopic deviations from the normal. Since this procedure has in some isolated cases of negative findings yielded satisfactory results, we find, at times, justification in its employment. If, however, changes be found severe enough to explain the symptom complexus—as, for instance, a tumor, the development of which may for a long time be preceded by epileptic seizures, or an encephalitic or porencephalitic cyst—the method to pursue becomes at once self-evident. We may hope to do away with the effects in these cases by eradicating the cause. In his work on Epilepsy, *Féré* has pointed out that only that method which attacks the cause may effect a cure of the disease.

Yet, causes so easily recognized are by no means frequent. At other times again, the diseased products are very insignificant as in some of our cases of leptomeningitis. We should in all these instances employ faradic irritation and find the primary spasming point, and if necessary look for subcortical processes (cysts, or hydrocephalic accumulations) by incision.

Anatomic alterations in the structure of the brain may be discovered in parts distant from the primary spasming centre. In that case, the question whether the morbid focus only should be excised, or in conjunction with it the primary spasming field

as well, must be left to the judgment of the surgeon. In a few instances I have adopted the latter plan with excellent results. You will recall, for instance, Observation I, 10, on p. 360, in which the porencephalitic cyst was situated below the centre of the face; since the latter was not included in the spasming area (arm centre very distantly located) besides removing the cyst, the primary spasming centre was also excised, proceeding exactly as in cases in which nothing pathologic is found.

## Course After the Operation

Following trepanation, the attacks may become very frequent, and coma epilepticum may even ensue. I have observed the latter condition to develop in a number of cases on the day following the operation. If this be the case, the patient does not regain consciousness, not even in the intervals between attacks. He is restless and tosses from side to side, or is in a tranquil coma. The pulse becomes markedly accelerated—150 or thereabouts. It is thready or it may even disappear at the radial and be perceptible as a faint wave in the carotid and femoral. As a result of involvement of the laryngeal muscles and cardiac inefficiency, the respirations become embarrassed. In cases of great severity, this may also be due to direct involvement of the diaphragm in the spasms. As a result of the respiratory impediment, the patient, besides being pallid, becomes cyanotic. This dangerous state may, as I have seen in five cases, end fatally immediately after the operation, or a few days following it. In other instances again, the timely use of enemata of chloral (at least 2.0) or morphin will subdue the spasms and exhausting restlessness and, supplemented by analeptica (camphor, caffein, digalen, infusions of salt solution, intravenous administration of adrenalin) will increase cardiac efficiency and may save the patient.

The status epilepticus may develop in patients afflicted with severe epilepsy after operations on other parts of the body. I recall such a case in an epileptic forty years of age, in whom the gall-bladder had to be extirpated and the hepatic duct drained. Two days after the operation, the status epilepticus developed which greatly jeopardized the life of the patient and

after active measures, in the form of medication with the drugs mentioned, we succeeded in tiding him over for forty-eight hours and finally bringing him to recovery. I believe that in the majority of cases, this condition is brought about by the irritation induced upon exposure of the motor area.

The epileptic state was observed to occur only in cases where the dura had been incised, regardless of whether the operation is performed in one sitting, as is practiced in cases of general genuine epilepsy—or in two sittings, as commonly employed in cases of *Jacksonian* type of the disease. Trepanation alone, as the first act, without incision into the dura, has in my cases never given rise to the status epilepticus. That this, however, may occur, is exemplified by the case of operation on the gall-passages just related.

This being the case, operations should be avoided on epileptics at a period when seizures are frequent. The assumption that, at such times, the cortex is in a state of hyperirritability is justified. If possible, a period for operation should, in these instances, be selected when the attacks are infrequent or do not occur at all. Up to the time of operation, the patient should receive the usual doses of bromides he is accustomed to take. While I am not allowing patients to take any drugs while they are under observation, the exhibition of bromides is resumed as soon as the decision to operate has been reached.

### After-Treatment

The patient is usually discharged from three to four weeks after the operation. He should remain under general treatment however for a considerable length of time. By so doing, the prospects for permanent cure are much enhanced. After the healing of his wound following an operation, the patient who had been the victim of epilepsy for a number of years can by no means be compared with an individual freed from a tumor or other condition by operative measures. Even when the focal conditions, which from their nature may be looked upon as the only disturbing factor in a given instance have been completely removed by the operation—the entire brain still remains in a state of hyperexcitation. This is shown by the frequent increase in the number of spasms that follow the removal of the discov-

ered focal states. Patients should, therefore, after such operations, remain under the supervision of a physician for a long time. They should, as far as possible, endeavor to avoid all influences which might prove injurious to their brains, such as mental and physical exertions, fatigue, etc. They should lead a life of moderation and properly care for the normal and undisturbed bodily functions; they should avoid alcohol in any form, as well as irritating and salty foodstuffs, indigestible meats and limit themselves preferably to a vegetarian diet in moderation.

Complete mental repose is essential. To diminish the state of hyperexcitement of the motor cortex induced by the operation, I use the bromides for some time, in the following combination:

| | |
|---|---|
| Potassii bromidi | 8.0 |
| Sodii bromidi, | |
| Ammonii bromidi āā | 4.0 |
| Aquæ ad | 200.0 |

S. A tablespoonful three times daily (adult dose).

The use of this preparation for eight to ten days is followed by a pause of equal duration. Should the attacks recur again, bromides, or a combination of opium and bromides, should be resumed, besides general treatment.

## Traumatic and Reflex Epilepsy

### Injuries to the Central Region

Any injury to the skull may bring on epileptic seizures. Whenever possible, X-ray examinations should be made. It frequently is a great aid in clearing up the diagnosis. Even in other forms of epilepsy, roentgenography is of urgent need. The simplest cases are those in which the central region is the primary seat of trouble and in which other portions of the cortex cerebri are secondarily involved by such agencies as: extravasations of blood, splinters of bone, depressions, inflammatory and suppurative processes, etc. Remembering what has been said before, it is but reasonable to assume that such factors may undoubtedly give rise to *Jacksonian* epilepsy. The action of

these mechanical irritations is similar to that of the electric current upon the anterior central convolution.

## OBSERVATION I, 19

*Injury to the Skull from the Kick of a Horse. Jacksonian Epilepsy. Cure without Intervention.*

Man, forty-one years of age. Never ill until the time of the accident. While unhitching a horse, April 23, 1906, he was so severely kicked in the right temple that he fell unconscious to the ground. After some time consciousness was regained, but the patient was so weak that he had to be taken home in a wagon. A physician sutured the scalp wounds he sustained. There was no vomiting and the following day the patient complained only of a slight headache. On the 25th day of April, he suddenly perceived a tingling sensation in the left hand, which lasted a few minutes. This was followed by involuntary clonic contractions of the left arm, which soon invaded the left half of the face, especially the region of the mouth, and finally affected the right arm. During the time the spasms lasted, consciousness remained unaffected. On account of the frequent repetition of the attacks on the following days, the patient was brought to the Augusta Hospital (April 30th).

A flat impression, moderately sensitive to pressure, was discovered in the bone on the right side of the skull, immediately above the auricle which, according to its position and cranio-cerebral localization, corresponded to the centre of the face. A smeary looking wound in the skin was found above the osseous depression, toward the sagittal suture. There were no unequalities in either half of the face, upon motion or at rest. The power of the left hand was moderately reduced. The sensation of touch as well as the senses of temperature and of pain were found reduced in the third, fourth, and fifth fingers of the left hand and in the forearm. The sense of position of the hands and fingers was retained; the stereognostic sense of the left hand, however, was uncertain. Temperature and pulse were normal and the patient placed under observation.

As early as May 10th, the power of the left hand was very

much improved. Sensory disturbances could no longer be demonstrated. *Jacksonian* spasms no longer occurred. Upon request of the patient, he was discharged on May the 16th.

On January 27, 1910, I was informed that the spasms did not recur. The patient, nevertheless, complained of pain in the head and back of the neck, in the first few months following his discharge. Sometimes when he stooped down, he became dizzy. He was also hypersensitive to noises. The condition gradually improved and the patient could resume his work again. He states that he cannot now exert himself as much as before the accident on account of becoming easily fatigued.

The course in these cases is by no means always as favorable as in the instance just related. There are cases, to be sure, where foreign bodies, such as splinters of bone, bullets, even knife-blades, remain encapsulated in the central area or its neighborhood for years, without occasioning *Jacksonian* epilepsy. I shall cite instances of this nature in the chapter on *Injuries to the Brain.* In other cases again, the spasms induced by the trauma continue, sympathetically affecting other parts of the body and finally terminating in general epilepsy. As is more frequently the case, however, immediately after the accident, a period of comparative or total freedom from symptoms ensues and during this time nothing is complained of by the patient. Months, years, or even decades may sometimes pass without the patient noting the slightest inconvenience, and then, as in cases following infantile cerebral paralysis, he will suddenly be surprised by the onset of a seizure. A boy patient of mine, fourteen years old, escaped with his life after shooting himself in the right temple. Six years after the injury, he was suddenly seized with left-sided *Jacksonian* spasms, immediately following an operation for appendicitis. During this time, the patient considered himself well and able to work, with the exception of slight headaches. The attacks now recurred on an average of about once in six to seven weeks, and persisted for four years, after which the patient came under our care, at the age of twenty-four. The projectile was shown by the X-ray to be imbedded in the right occipital pole, near the confluens sinuum. Outside of the spasms, no other focal symptoms were present. Trepana-

tion over the corresponding area and incision into the dura permitted the extraction of the bullet from the substance of the brain with the aid of a pair of forceps, from a depth of about 2 cm. In one place the bullet was surrounded by a kind of capsule, but for the most part, it rested in a cystlike cavity, which contained a small quantity of fluid. The patient was discharged cured. During the year and a half following the operation, the patient was free from attacks. After that time, I lost track of him.

Circumscribed injuries to the motor cortex may at once evoke spasms of a general character. More frequently, however, they commence with spasms of a *Jacksonian* nature. An intermediate type of the disease—between the epilepsies occasioned by infantile cerebral paralysis and those resulting from traumata in later life—may be found in the class of cases originating at birth, which while strictly speaking belong to this chapter, were, nevertheless, described under a separate caption for special reasons.

Hence, in epilepsies developing a long time after the injury was sustained, a new exciting cause is usually operative in precipitating the attack. As such may be mentioned new traumatization, psychic excitations, violent pains and, finally, intercurrent (febrile) affections. Whether, in the case just described the abdominal operation had something to do with the excitation of the seizures, I will leave undecided for the present. Once an attack has occurred, it usually is soon repeated, and becoming more frequent soon terminates in real epilepsy. If upon reflection, we find that persons who have sustained injuries to their brains early in life, not infrequently suffer in later years from no spasms whatever and, as I have stated above, foreign bodies may remain dormant in the central region for years without occasioning the slightest discomfort, not even a single fibrillary twitching—we cannot get away from the fact that there exists in these cases, a certain hypersensitiveness, a certain predisposition of the brain, if you please, that is analogous to the disposition spoken of in cases of epilepsy developing in connection with infantile cerebral paralysis. As hypothetical as this may sound, it is, nevertheless, an undebatable fact. *Féré* believes he has shown a hereditary predisposition to exist in 75

per cent. of his cases of traumatic epilepsy. *E. v. Bergmann* speaks of even a higher percentage, while others, *Tilman*, for instance, believe these figures to be much too high.

Not infrequently cases of well-developed traumatic epilepsy are ushered in by an aura. This may take on the form of motor or sensory symptoms of irritation that is perceived by the patient in the originally spasming limb before the attack sets in. At other times, again, the scar of the original injury may become sensitive and reddened immediately preceding the seizure. Cases are sometimes met with in which pressure on the scar is alone sufficient to evoke an attack.

With reference to the anatomic changes found at the operation, it should be stated that even when the skull is found uninjured, an existing extradural hematoma of the central region may be responsible for the occurrence of the epileptic seizures. The clot exercises its deleterious influences by an immediate irritation of the cerebral cortex—in recent cases and in instances of longer duration, it causes a pressure-anæmia of the structures underlying it. It is known to be an old-established fact (first shown by *Kussmaul*) that anæmia of the cerebral cortex bears an important relation to the origin of epileptic spasms. Other etiologic factors are: depressions in the bones of the skull, splintering or fragments of the lamina vitrea, and hemorrhages into the meshes of the arachnoid. All of these may occur with or without external, visible violence—even without laceration of the dura. The secondary inflammatory changes, however, are responsible for the chronic irritation of the cortex. The latter may even give rise to osseous metamorphoses of the dura and lead to hyperostoses.

In cases in which the brain substance has been crushed, complete resorption does not always take place. In such instances, foci of softening and cysts result, the blood-pigmented and firm cicatricial walls of which betray their traumatic origin. For instance, in the case of a man twenty-four years of age, a distended cyst was discovered in the posterior end of the middle parietal convolution immediately underneath the dura. The inner surface thereof disclosed yellowish-brown spots of pigment and roughenings. The wall of the cyst was composed of arachnoid, pia, and a thin layer of much altered cerebral cortex;

it was excised to a circumference the size of a quarter of a dollar, and we found our way into the cavity of the cyst, which was as large as a big walnut. There were a number of yellow, pigmented, and coarse cicatricial strands that were removed. In front of this large cyst and separated from it by a very thin layer of cicatricial tissue, another smaller cyst was found. It was as large as a cherry, resembled its fellow in every respect, and was dealt with in the same manner. After painstaking hemostasis the flap of dura was replaced into the remaining trough of brain-tissue.

The origin of this cystic transformation could be clearly traced to a blow from a lead pipe which felled the patient unconscious when he was sixteen years old. Six and one-half years later, he developed *Jacksonian* epilepsy. A scar the size of a cherry was found which was not united to the underlying structures and was located on the left side, lateral to the coronary suture and corresponding to the lower limb of the second frontal convolution. Not the slightest change in the bones of the skull was found at the operation. As a result of the violent blow of the pipe, the bone was evidently pressed inward, crushing the brain, but the elasticity of the young bones of the cranium rebounded without fracture or splintering. The cortico-arachnoid cysts just described developed in the course of time on the basis of the traumatized foci. The patient is cured.

Foreign bodies may also be the cause of cystic transformation.

If the dura is torn, adhesions with the arachnoid, pia, and the surface of the brain will always result. At the operation, we frequently find the arachnoid more or less œdematous. On many occasions I found the œdema to be very pronounced and closely resembling that shown in Plate II, Vol. I. In cases of traumatic epilepsy, this was frequently the only gross change discernible. The characteristic leptomeningitic white bands of cicatricial tissue along the vessels were also present in abundance.

Injuries to the skull by blunt force not infrequently lead to severe injuries of the brain opposite to the side traumatized—acting through contre-coup. This variety of crushing injury to the brain, of which a good example may be found in Observation I, 16, p. 432, may also lead to *Jacksonian* epilepsy.

### Other Injuries to the Brain

Epilepsy does not exclusively develop from injuries to the central region. Traumatization of any other part of the brain may also occasion the trouble. The farther away the injury from the central region, the less likely is epilepsy to follow. This is especially true in injuries to the frontal and parietal lobes. The following is a good example of an instance of the first category.

## OBSERVATION I, 20

*Fall on the Head, Followed, Two Years and Eight Months Later, by Epilepsy. Defect of the Frontal Brain. Thickening and Adhesions of the Dura. Removal of Indurations of the Scalp. Valve Formation. Very Marked Improvement.*

Patient twenty-eight years of age. No hereditary taint. Father committed suicide at the age of forty-two, for unknown reasons. Up to the time of the accident—Spring, 1903—the patient enjoyed excellent health. He was, at that time, twenty-three years old and got into trouble when one night he fell from a second-story window, and landed with the left side of his forehead on the pavement, sustaining a bleeding wound on that side and remaining unconscious for a number of hours. He was picked up in the morning and his wound dressed. While in bed, he regained consciousness a number of times but soon lapsed into deep coma, which lasted for about fourteen days. Gradually, his senses returned, accompanied by fever and delirium. He remained in bed for six weeks, during which time neither spasms nor twitchings occurred. After that he felt well.

Two and a half years after the foregoing—December, 1905—while the patient was unpacking a box, he suddenly lost consciousness while stooping forward; he fell backward and remained in that position for ten minutes; his whole body was, during that time, violently twitching. After awakening, he complained of headache and considerable weakness. Three days later, another attack of the same kind occurred. The seizures recurred now at least every second or third day, but soon increased in

frequency to two or more *pro diem.* Intervals of a few days were noted between seizures. The tongue was bitten occasionally.

The patient was admitted, February 20, 1906. Sensory and motor differences of both lateral halves of the body were not found upon examination. A flat impression, the size of a silver dollar, not covered by a scar in the overlying skin, was found in the left half of the forehead, near the border-line of the hairs. The attacks—observed by us day and night—were of the general epileptic kind. The face became cyanotic, the jaw snapped from left to right—a little saliva issued from the mouth, and the left lower limb and left arm executed violent spasmodic movements. On the right half of the body, only spasmodic contractions of the right hand were noted. Occasionally, the entire right side participated in the spasms. During all that time, the patient was conscious. The anamnesis and scar pointed to trouble in the left hemisphere; trepanation was performed on that side.

The first operation was performed February 28, 1906. The dura overlying the central region was exposed; it pulsated visibly and was not excessively tense. Anteriorly, at the site of the impression, it was united with the bone. For that reason, another, smaller, osseous flap was made the base of which was directed forward (compare Plate XXXII, Fig. a). A valve was formed by the removal of about 1 cm. of bone from the borders of the larger bony flap. The lamina vitrea of both osseous valves was perfectly smooth and did not show the slightest trace of an old fracture. The dura was sunken in to conform with the notch that resulted from the trephined cleft.

On March 16th, the second operation was performed. The dura could not be lifted off from the cerebral surface on account of adhesions between it and the arachnoid. It was incised (Plate XXXII, Fig. b). This difficulty was encountered in the area of the smaller notch only. Posteriorly—the region of the large cleft—no adhesions whatever existed. In front, the dura was extraordinarily thickened; it measured 5 mm. in diameter. The induration of the dura decreased somewhat posteriorly; on its inner side it was irregularly elevated, as seen in Fig. c. In this situation, the brain showed no abnormalities in color or on

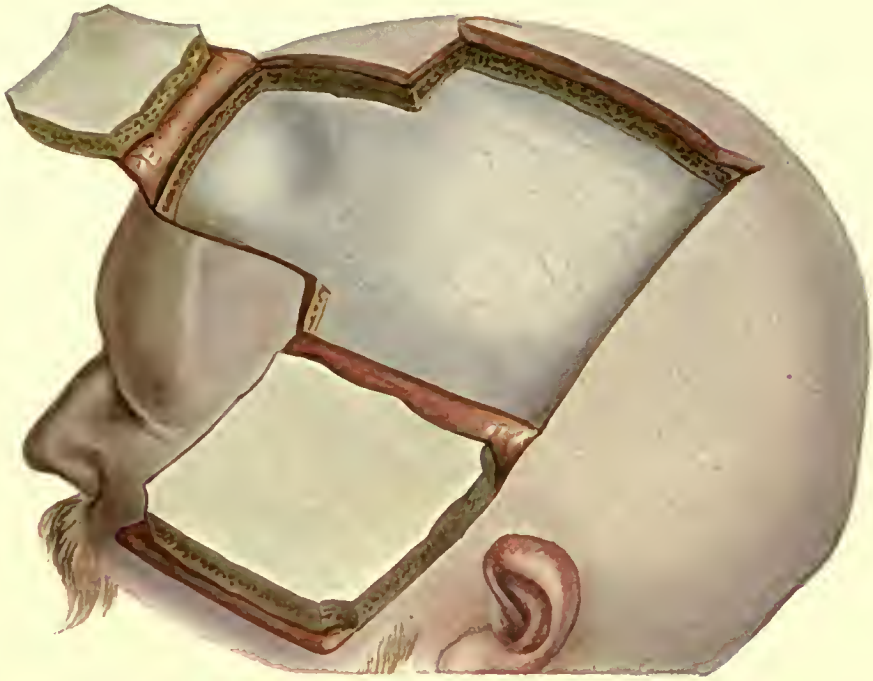

Fig. a.

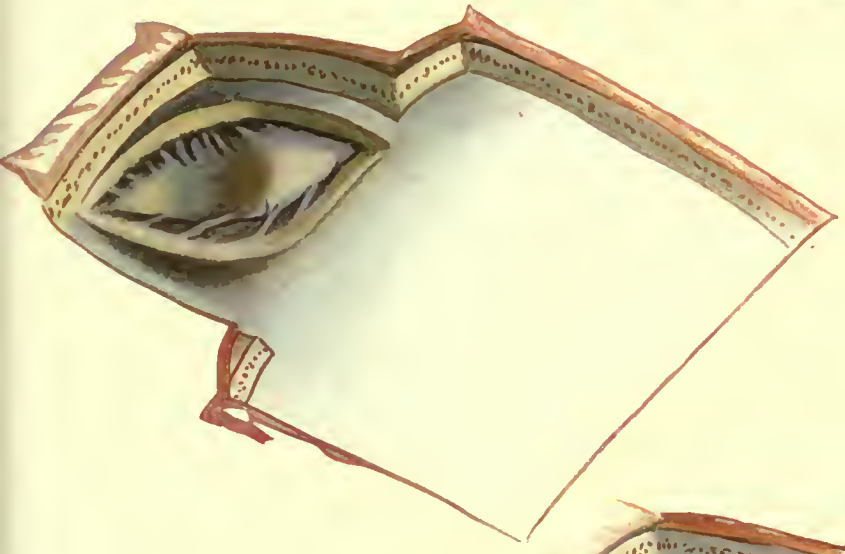

Fig. b.

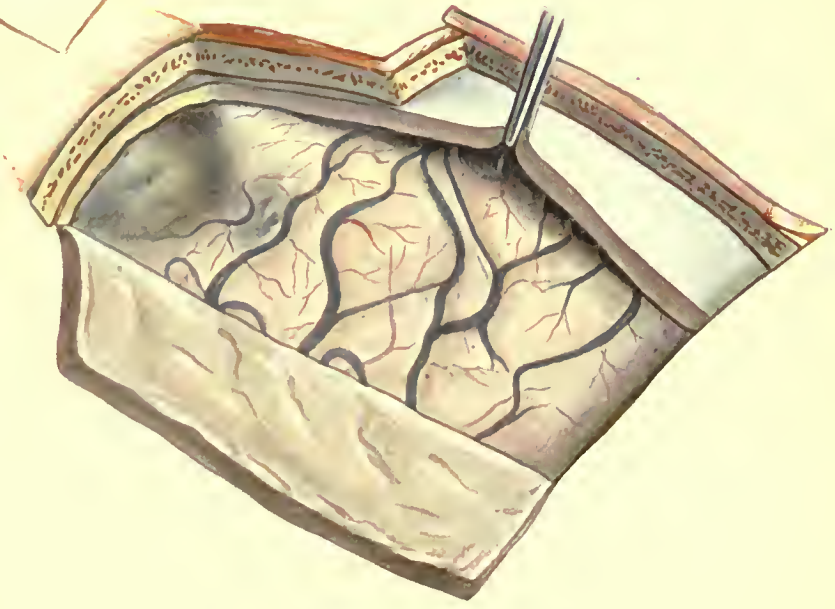

Fig. c.

Rebman Company, New-York.

its convolutions. A trough-shaped indentation was found on the surface of the brain that corresponded to the position of the depression of the dura; the former was about two digits long and about one wide. The color of the brain was, in this particular locality, grayish-violet. In order to successfully form a valve here, the markedly thickened dura superimposing the impression was completely removed. The microscopic examination disclosed a connective-tissue structure poor in nuclear elements and permeated by numerous thick-walled vessels that were especially numerous toward the arachnoid. This was very rich in cellular elements that contained many old foci of hemorrhagic extravasation in the process of resorption. There was also a chronic pachymeningitis and arachnitis (scar). The wounds in the skin were exactly coapted with sutures. Healing was uneventful.

During the first fourteen days following the second operation, the patient suffered from occasional twitchings in the left hand and sometimes in the left lower limb. These, however, passed off quickly. The right extremities did not participate in the twitchings. A certain awkwardness remained in the right hand. On the 15th day, post operationem (twenty-five days of freedom from seizures) a general epileptic attack suddenly set in. It began with twitchings in the right extremities, whence they jumped to the right facio-orbicular region, dragging the mouth from left to right, the right extremities then became involved while on the left side, a tonic spasm prevailed. The seizures lasted five minutes. It was typical (frothing at the mouth, biting of the tongue) and resulted in a total paralysis of the right half of the body. The recession of the latter commenced in the face. After two weeks, the paralysis of the lower extremity had completely disappeared. The arm finally recuperated with the exception of a slight weakness. The patient left his bed for the first time after the operation on the 16th of June, twenty-four days after the last operation. Twelve days later he was discharged from our care, with wounds completely healed.

I examined him three months later. Nowhere in his body could disturbances of sensation and motility be discovered. He did not complain of headaches. All told, three seizures recurred

since the time of his dismissal. They were all of the same character as those before. From the middle of May, 1906, the patient observed a gradual but steadily progressive improvement in his memory. He was well able to follow his very strenuous occupation (he was owner of a large merchandise business). He also undertook journeys. He had to rest sometimes on account of a "dazed feeling in the head." Taking a short walk, he would find relief. This sensory disturbance which occurred

Fig. 92

on the average of about once or twice in a week, became of late less frequent.

During an examination made in December, 1908, the patient stated that he felt much better than before the operation. He was physically well and worked hard and uninterruptedly, even not taking his usual walk. He smoked excessively and did not pay any particular attention to himself. The only untoward symptom he complained of was the occasional occurrence of seizures which, however, were far more infrequent than heretofore.

While before the operation they would occur as often as two or three in a day, they now recurred on the average of about once in four or six weeks. They set in without an aura; he became unconscious; his entire body would become rigid, his

eyes turned and he remained in a state of tonic rigidity for a few minutes. After awakening, he would complain of headaches from one-half to two hours. Mentally, he was perfectly normal; his intellect suffered at no time. His memory also was much better than before the operation. Insignificant lapses of memory occurred rarely. He did not use the bromides for more than a year.

The entire field of operation was sunken in. It was depressed to the depth of the breadth of a finger, from the rest of the surface of the skull. The anterior flap of bone, situated toward the forehead, measured, in both frontal and sagittal directions, forty-five mm., and appeared firmly united to the contiguous structures. It did not move on coughing nor on pressure. On the other hand, the flap of bone overlying the left central region (sagittal and vertical measurements 76 mm.) was distinctly raised on coughing (much more so on pressure), but never reached the level of the surface of the skull. A successful valve action was therefore obtained.

According to the last information—July 11, 1910—the general condition of the patient was excellent in spite of his strenuous business activity. The epileptic attacks occurred now about once in four or five months. Intellect and memory are normal. No more paralyses occurred after a few seizures. The patient received no medical attention of any kind since he has undergone the operation. In his own words: "I consider my condition decidedly and undoubtedly much better than before the operation, for which I am extremely thankful."

As may be learned from the case just described, the spasms that result from injuries to parts of the brain other than the central area, do not necessarily assume the *Jacksonian* type, but may be general from the beginning. In spite of that, however, it should be borne in mind that in injuries to the central area proper, the spasms are precipitated with greater ease than when other parts of the brain are involved.

The visible scars on the surface of the skin furnish no clue whatsoever to the actual location of the point of injury of the brain. The changes in the dura and the adhesions between it and the lamina vitrea or the brain may be found in entirely

different places than the actual site of injury to the brain itself. All factors brought into play by the marked elasticity of the vault of the cranium and the intracranial displacement of the brain, come here into consideration.

Every concussion of the brain may cause epilepsy. For its production, it is not essential to have focal diseases or hemorrhages, because every injury of the motor region is usually accompanied by more or less cerebral commotion. As a rule, it is hard or even impossible to decide which of the two factors —concussion or actual injury—in a given case, is responsible for the epilepsy.

In discussing traumatic epilepsies, it should also be stated that chronic suppurative processes of the bones of the skull that may lead even to hyperostoses and softenings of the brain, after lasting for years, may become the cause of epilepsy. Strictly speaking, however, these cases belong more properly in the chapter on reflex epilepsy (see p. 492) than in that of the traumatic variety.

## Indications for Operation

In view of the unfavorable prognosis with which we are brought face to face in every case of traumatic epilepsy, operative intervention is, as a rule, urgently indicated. If the spasms occur as an immediate sequence to an injury of the skull, and if after a reasonable time of observation they do not abate, the injured portion of the skull will have to be laid bare. If an external wound be found to exist, this mode of procedure will naturally have to be followed. There are enough cases, to be sure, which press the knife into the hand of the surgeon. My expectancy in the case described on p. 480 was justified by the rapid disappearance of the symptoms and the negative X-ray findings. If the bone discloses a depression of greater magnitude or if the X-ray plate shows the presence of splinters of bone or other foreign bodies in the depth of the cranium, the patient should be operated upon without hesitation; the sooner the better. If these foreign elements be found in or about the central area, they may be justly looked upon as the cause of the spasming seizures. Their removal should, therefore, be attempted at the earliest possible moment. If such conditions as

described be found in other parts of the skull, operation should be undertaken, even when the symptoms point to an injury of the brain itself.

In cases of longer standing, in which external wounds no longer exist, trepanation should be done at the site of the former injury and the dura opened, even when it appears to be normal. We frequently encounter underneath it, marked œdema of the arachnoid, which may be done away with by scarifications. The leptomeninges may be found in a condition of cicatricial transformation and united with the cerebral cortex; or, scars may even be discovered within the substance of the latter. Such conditions must be remedied by excisions which must extend to the healthy brain-tissue. The objection brought forward that after such excisions, the scar will recur during the process of healing, has no foundation. As shown above, our experiences teach us that scars resulting from aseptic operations will, in themselves, not give rise to irritations or epilepsy. In operating, the scars found in the soft and osseous coverings of the brain should be thoroughly removed. If abscesses, cystic transformations, or foci of softening be found at the site of the old injury, they should be freely laid open and dealt with in accordance with the principles laid down in Vol. I.

Cases of *Jacksonian* (traumatic) epilepsy of long duration may assume the general type, which is also true of epilepsies developing on the basis of infantile cerebral paralysis. In these cases, surgical intervention should be directed to the original point of injury of the skull. In the latter instances, of course, the prospects of recovery are greatly minimized. In such cases, *Kocher's* operation of valve formation should be considered. The latter procedure is, at the present day, the only method at our command that may be applied in the surgical treatment of cases of general traumatic epilepsy in which no local morbid focus can be discovered. The results correspond to those described in detail under the heading of General Genuine Epilepsy.

The question whether the defect in the skull created by the operation or by the injury itself, should be repaired by a plastic procedure has been variously answered by different observers. *Franz Koenig*, for instance, has cured a case of severe epilepsy by covering the defect by means of a plastic operation described

in detail in his work on the subject (Vol. I, p. 125 ff.). Such clefts must not necessarily be located in the central region to produce epilepsy. I have seen the occurrence of spasms in a case where the defect in the bone resulted from an extensive operation for suppurative mastoiditis. *E. v. Bergmann* advocates the closure of the cleft, while *Kocher* lauds his valve operation. It appears to me that the most rational course to pursue is to restore the structures to as nearly normal a state as possible, and for that reason I always resort to a plastic operation on the bone in aseptic cases wherever possible; otherwise I wait until the conditions in the field of operation have become favorable for the performance of such operation.

## Reflex Epilepsy

We shall here abstain from speaking of those cases of epilepsy that develop in connection with diseases of the internal organs because these cases do not belong to the domain of surgery. As we have seen above, chronic suppurative processes in the bones of the skull may occasion epileptic seizures. These may also be brought about—in predisposed individuals, of course, by old scars that result from operations on the skull and must not necessarily be located in the central region. These are cases of *post-operative epilepsy* which, considered in the broadest sense, should be looked upon as one of the forms of traumatic epilepsy. It should be noted that not only those mentioned, but scars in any other part of the body may be the starting-point for epileptic seizures. We are especially apprehensive of those scars that are in close connection with bone and nerves and that show marked sensitiveness to pressure. *Nothnagel* and *Jolly* were of the opinion that some scars of the brain or its membranes act in the same manner as those situated peripherally; hence they are looked upon by these authors as reflex epilepsies. An aura is sometimes felt by the patient to emanate from such scars. Even pressure alone upon them may precipitate the attack.

These facts are not new. Even *Dieffenbach* has already performed excision of such scars or carried out actual amputations of entire limbs in vain hopes to accomplish a cure of the epilepsy, only to be too often disappointed. While properly speak-

ing, these operations are not on the brain—hence outside of my theme, yet I cannot abstain from detailing the following interesting case.

## OBSERVATION I, 21

*Trigeminus Neuralgia with Epilepsy from a Scar. Extirpation of the Gasserian Ganglion. Cure.*

The patient was a man, forty-eight years old. His grandmother died in an insane asylum, but prior to becoming mentally deranged, had never suffered from any nervous disturbances. Otherwise his family history was negative. During Easter of 1897, he sustained an injury to his left supraorbital margin, as a result of which there developed a severe trigeminus neuralgia on the same side. The infraorbital nerve was resected in 1898; the second branch met the same fate in 1899 (operation of *Lücke;* at the base of the skull) and in 1900 the third branch was removed. All of these operations, however, did not effect a cure. The second operation was followed a few weeks after its performance by spasms that were accompanied by loss of consciousness. Sometimes they would occur a number of times daily, continuing for days in succession, at others, again, they would be absent for two weeks at a stretch. The continuous neuralgia and the reflex epilepsy accompanying it, rendered the man totally disabled from doing any kind of work and drove him, in January, 1901, to an attempt at suicide.

On the 13th of September, he was admitted to the Augusta Hospital. The neuralgia of the left side affected all three branches. Actual attacks with intervals of freedom from pain did not exist. He suffered continually for days in succession, and the pain would exacerbate to an almost intolerable degree.

In the last few weeks it was constant. Spasming seizures were repeatedly observed by us; they were of the following character: The patient lay unconscious on his back; the pupils were moderately dilated; they did not react to strong light. His fists were clenched. The lower extremities, which at first were in rigid spastic extension, were now executing clonic contractions. His body was bathed in profuse perspiration. The attack lasted about three minutes. After it had subsided the patient did not

react to calls nor to deep punctures with a needle. The respirations, which up to that time were whooping and stertorous, now became freer. Pressure on the scar of the zygomatic arch (site of second operation) caused an immediate repetition of the attack. Such pressure was sufficient to recall the declining clonic spasms again. The seizures were followed by unconsciousness, somnolence, and confusion. Some seizures would set in without psychic excitement and the spasms did not betray the slightest sign of voluntary effort.

The excision of the scar, which was very deep and closely adherent to the zygomatic arch and superior maxilla as well as reaching way down into the spheno-maxillary fossa, would in itself, besides being hazardous, be insufficient to effect a cure, because it is self-evident that such extensive dissection would undoubtedly lead to new and greater cicatrization extensively involving periosteum and bone alike. On the other hand, a favorable outcome could reasonably be expected from an extirpation of the *Gasserian* ganglion and its trigeminal branch, because, by so doing, the path of conduction between the central organ and the cicatrix would surely be interrupted. This would be especially true if the cerebral cortex had not as yet been permanently damaged. Such an operation would be justified much more since by its performance a favorable influence over the trigeminal neuralgia was expected, which was by no means typical.

The operation was consequently performed October 7th, 1901. The administration of chloroform had barely begun, while the zygoma was being prepared (scrubbed with soap) when an attack of the type described above suddenly set in which abated only after the anæsthesia became more profound. This was his last attack. Eight days after the ganglion was removed the patient left the bed. Ten days later, cicatrization was complete. The trigeminus neuralgia had now disappeared. While prior to the operation, the patient was despondent and irritable, he was now of happy frame of mind. Even strong pressure on the zygomatic arch was not followed by spasms.

One year and three months after the operation, the man was found in the best possible physical condition. He died, however, three years later from pneumonia. Spasms and pains have, since the operation, never recurred.

# Neoplasmata of the Brain

## General Symptoms of Cerebral Compression

Accumulations of pathologic masses within the cranial cavity of every possible nature, be they swellings, abscesses, cysts, collections of blood or hydrocephalic fluid (located in any portion of the brain or its contiguous structures) may give rise to symptoms of intracranial pressure as soon as they create a restriction of space within that cavity. Yet, it is surprising to note to what great extent the brain may occasionally become accustomed to the gradual diminution of its confines, without the production of the slightest symptoms whatever. I had occasion to extirpate a very large sarcoma originating in the membranes of the brain, in the case of a laborer forty-one years of age. The size of the tumor was so enormous that it broke through the thinned squamous portion of the temporal bone. After removing the temporal muscle, the zygomatic arch, the outer wall of the orbit, a portion of the skull-cap the size of the palm of the hand and the dura, the middle meningeal artery was ligated and the tumor extirpated. The cavity remaining in the frontal region was easily the size of a man's fist. The tumor had displaced the brain as far back as the foramen opticum. In spite of all that, however, not the slightest symptoms of cerebral compression were present—not even choked disc.

I have also operated on a woman (forty-five years of age) whose history is extremely interesting. She suffered from the severest form of trigeminal neuralgia. I extirpated the *Gasserian* ganglion, but the patient died six days after the operation. Wound healing was perfect. The necropsy disclosed an enormous cholesteatoma arachnoideæ cerebri, pontis, cerebelli. The mass had completely filled out the third ventricle; it displaced laterally the septum pellucidum and the thalamus opticus. The left lower frontal convolution was flattened by it to a nar-

row leaf and the convolutions of the left cerebellum thinned to transparent sheets. The tumor continued on to the medulla oblongata and had pressed aside the nerves at the base of the brain. In spite of the tremendous extent of the tumor not the slightest symptoms existed to hint at its presence (throughout the entire fifteen years of her suffering) outside of the severe neuralgia in the entire course of the left trigeminus. It should be stated that during that period a great many physicians had been consulted. Choked disc was at no time present. During the operation, the dura was in no way tenser than is usually the case in extirpations of the *Gasserian* ganglion. The same was found at the post mortem. The cause for the absence of symptoms in this instance may be found in the extremely slow development of the tumor and the consequent very gradual diminution of the intracranial space. I could not discover the existence of the tumor during the operation, because the procedure was an extradural one, while the cholesteatoma had an intradural location. The neuralgia was caused by compression of the *Gasserian* ganglion or the root of the trigeminus. With the removal of these nervous structures, the neuralgia ceased.

The manifestations of increased intracranial pressure are collectively spoken of as general symptoms of cerebral compression. Under these

### Headaches

are almost never absent. They may attain the highest grade, and in cases of cerebral tumor they are frequently vague. They may embrace the entire head or be perceived in the forehead and eyes, the vertex, or the back of the head only. If restricted to certain portions of the skull, they by no means always indicate those parts to be the locus of the neoplasm. To cite a few examples: In a case of large tumor of the right frontal brain, the headaches were perceived by the patient in both temples; they would commence on the right side and end in the nape of the neck. In other cases of tumor, the pain was felt in the back of the head exclusively. Conversely, tumors of the pons will frequently give rise to pains on the opposite side of the head. In a case in which a tumor was compressing the tentorium cerebelli and in another one in which an abscess of the

posterior surface of the petrous portion of the temporal bone was exercising pressure, the only symptom complained of by both patients was excruciating headaches on the same side. Headaches must, therefore, be classified as a general symptom. As a local phenomenon, they are of value only when they are invariably perceived (spontaneously, on pressure or on percussion) on the same side of the skull. In my experiences, the latter is not frequently the case in cerebral tumor. In cases in which the dura is also involved, the pains are more frequently found localized, corresponding to the site of the neoplasm.

Headaches are occasionally accompanied by nausea and vomiting. These, it must be borne in mind, may occur in cerebral tumor, unaccompanied by other manifestations. It is characteristic of **cerebral vomiting** that it also sets in without retching on the empty stomach; it frequently occurs without provocation, and is projectile in nature.

### Psychic Disturbances

All processes tending to diminish the space within the skull may lead to severe psychic disturbances, such as weakness of memory or stupefaction. The latter may increase to a point of unconsciousness or culminate in lethargy. That the increased cerebral pressure may be the cause of these conditions, at least in a number of instances, is proven by the disappearance of symptoms which is known to follow the release of the intracranial pressure after trepanation and opening the dura. If we are successful in removing the diseased focus, and if the soporific state has not as yet continued for too long a time, a regression of the untoward symptoms and a return of the psychic faculties is frequently noted to take place in a surprisingly short time; in some instances even in the course of twenty-four hours. It is needless to reiterate that in the latter instances no gross anatomic changes have as yet taken place. It is generally conceded that the cerebral cortex is the organ of psychic activity, of conscious sensation, of thinking and of the will. Whether the higher functions of the brain are performed by the entire cortical surface or is restricted to certain portions of it only, is a matter which we need not discuss here. There are differences of opinion in that respect, to be sure. *Hitzig*, who sees in the

frontal brain the centre for abstract thinking, credits other parts of the cerebrum with psychic functions as well. To cite him verbally: "In my opinion, the intelligence, in other words the wealth of imaginative power, is to be looked for in all parts of the brain." The occurrence of psychic phenomena resulting from marked increase of cerebral pressure should, therefore, not surprise us.

General spasms may also be produced by the same causes. Finally, vertigo also plays an important rôle here. General dizziness manifests itself in a loss of equilibrium. Compare this chapter with p. 683 for circular vertigo, characteristic of processes tending to diminish the space in the posterior fossa of the skull.

### Choked Disc

Choked disc is a symptom of greatest value, with reference to general cerebral pressure. In these conditions it is, as a rule, so characteristic a diagnostic phenomenon, that its presence or absence may decide the problem before us. Of course, it is not present in all cases. It may be present in small tumors and missing in large ones. Its intensity bears no proportion to the size of the tumor. The site of the neoplasm plays an important part for its occurrence; it is most frequently found in cases in which the larger veins are subjected to pressure and in those instances of cerebellar tumor where the return of blood is interfered with from a decrease of space in the posterior fossa of the skull, between the tentorium cerebelli and the osseous capsule. In the latter instances, choked disc is quite frequently bilateral. As stated, the disc conditions are by no means constant; not even in cases in which the sinus rectus is directly interfered with. Let me cite an instance. In a man, twenty-five years of age, under our observation, the necropsy disclosed the presence of a solitary tubercle, the size of a plum (4 : 3 : 2–5) of the right cerebellar hemisphere, located on its tentorial surface, to which it was closely attached to an extent of about the size of a quarter of a dollar. Its median posterior two-thirds were in direct proximity with the lower side of the sinus rectus to an extent of about 2 cm. In spite of that the changes found on transverse section of the optic nerve were extremely slight. The median

borders of the papilla only were indistinct; the lateral contour, on both sides, was clear and sharp. On the left side (free from tumor) the upper border was blurred. Differences of level could not be found.

In unilateral sinus compression, the choked disc frequently remains limited to one side, as seen in cases in which the cavernous sinus and the veins emptying into it are compressed from neoplasmata of one of the frontal lobes. In cases in which there exists a rapidly increasing venous stasis, extravasations of blood into the retina go hand in hand with the papillary changes.

While, in neoplasmata of the posterior fossa of the skull and the frontal lobe, choked disc is quite a constant and early phenomenon, in a considerable number of cases, tumors of the cerebrum, especially of the motor area, show no characteristic changes in the fundus oculi. In tumors of the pons and corpus quadrigeminum, choked disc is, as a rule, absent.

Unilateral or unequal choked disc is by no means a certain and infallible diagnostic sign, and its practical application in diagnosing the hemisphere supposed to contain the tumor, is problematical. I have seen choked disc on the unaffected side in two instances of occipital tumor. In one instance it followed retinal hemorrhage and was more pronounced on the sound side. Fourteen days after the tumor had been extirpated it still persisted, while at that time the affected side showed no trace of its existence. According to *Victor Horsley*,[1] the extent of the papillary œdema, from a diagnostic standpoint of view, is not as important as are the fine degenerative processes (neuritis with white and hemorrhagic exudations) that he believes occur in 70 per cent. of all cases of growing tumors, and that are mainly found on the side corresponding to the tumor. He considers papillary œdema accompanied by inflammatory changes to be the surest indicator of the seat of the intracranial pathology in conditions of raised pressure states. Papillœdema always commences in the upper nasal quadrant. *Kuhnt* was first to demonstrate that in cases of neuritis the œdema is more marked on the nasal side; he showed the loose connective tissue to be mainly developed on the nasal half, and less so on the macular side of

[1] *Victor Horsley*, Optic Neuritis, Choked Disc or Papillœdema. "British Medical Journal," March 5, 1910.

the papilla. This was in 1879. According to *Gowers*, the white points indicative of degenerative processes, commence in the nasal half of the papilla. The œdema extends from above downward, and affects first the nasal and then the temporal half. The externo-inferior quadrant is consequently the last to be affected. Strange as it may appear, *Horsley* has frequently known the choked disc changes to progress exactly the reverse of the manner just described.

In 80 per cent. of the cases of neoplasm observed by *Cushing*, in which choked disc was not present in the beginning of the observation, he noted its appearance on the affected side first.

With reference to the pathogenesis of choked disc, the mechanical theory of *Manz* and *Schmidt-Rimpler* coincide, in my opinion, with clinical experiences. This view is opposed by the inflammation theory of *Leber*. I have frequently observed that as long as a tumor was exercising intracranial pressure, choked disc persisted; as soon as the pressure was diminished the choked disc abated with it (compare Observation IV, 1). It should also be borne in mind that neuritic changes in the papillæ also occur in processes of softening of the brain. In Observation IV, 4, the autopsy showed a greater softening of the right occipital pole than its fellow; the right papilla was found here completely blurred, while on the left side the temporal border was tolerably well discernible.

*Bordley* and *Cushing*[1] described a shifting of the outlines between red and blue in the visual field as a pathognomonic symptom of heightened cerebral pressure. While the outlines for white remained normal, the visual field appears smaller for blue than for red—the reverse of what is normally the case. *Cushing* has seen the outlines for blue and red return to normal after decompression-trephining. He also found that the shifting of colors in the visual field, which is a recognized characteristic phenomenon of hysteria, to be a fairly constant symptom in the early stages of cerebral tumor.

One of the most important symptoms of increased cerebral pressure is a **slow pulse.** I have seen it reduced to 36 beats per minute. Its volume is usually full and its tension strong.

[1] *Harvey Cushing*, Some Aspects of the Pathological Physiology of Intracranial Tumors, "Boston Medical and Surgical Journal," July 15, 1909, pp. 71–80.

General cerebral compression may lead to death by its **paralyzing influence over the centre of respiration,** before the slightest focal symptoms that would give us a clue to the diagnosis have appeared. Such deaths are unfortunately not uncommon. Patients received in fairly good condition, have not infrequently perished in a very short time with symptoms of acute cerebral compression. In these instances death is brought about by a rapidly developing œdema of the brain.

## Introduction to Focal Symptomatology

A collective study of all the cerebral manifestations hitherto described may enable us to make a presumptive diagnosis of tumor of the brain; its location, however, can be ascertained with some degree of certainty only when concussion, pressure and percussion of a particular circumscribed area of the skull invariably causes pain. Cracked-pot resonance obtained upon percussing the tumor area, so highly lauded by *L. Bruns*, is only seldom developed to a degree to be of real diagnostic value. Dulness on percussion, diminished resonance or tympany, with or without cracked-pot feature, are only rarely demonstrable.

With the consideration of these symptoms we have about reached a point where the reviewed focal symptomatology directly points to the seat of the trouble. In order to describe these local symptoms clearly, minutely, and as accurately as possible, I shall treat of neoplasmata of the brain in the following paragraphs, and accord each respective portion of the cerebrum in which they occur a symptomatic preludium. It should be kept in mind that it is an almost impossible task to distinctly group and classify the symptoms in these cases, because as is well known there are no sharp lines of demarcation between the individual parts composing the brain and the lack of respect neoplasms, as a rule, have for these border-lines. If, for instance, in a given case the tumor affects the posterior section of the frontal convolution, the central region will also add its share to the general symptomatology of the case and so on. Fully cognizant of the limitations and restrictions of the symptomatology, I still consider my classification of these cases, at least from a surgical point of view, to answer the purpose. It should be

emphatically stated that in order to arrive at a definite conclusion as to the nature of the morbid state, the study of a single focal symptom means little, and that in order to establish a correct focal diagnosis the symptoms will have to be weighed, studied, and scrutinized one by one and also collectively.

Just as the manifestations of general cerebral pressure are not always the same, but frequently tend to considerable change in their severity, so do also the local symptoms at times appear paroxysmally, or evince tendencies to periodic exacerbations and remissions. These changes are occasionally noted in all the focal symptoms to be described in the following chapters. Alternating symptoms, such as hemipareses, etc., may also be observed.

There are certain cerebral areas that when affected do not show any characteristic focal symptoms whatsoever. If tumors develop in these localities, symptoms of general cerebral compression only are manifest. We are accustomed to designate such cerebral areas as **silent territories.** These comprise the anterior portion of both frontal lobes, the posterior section of the right frontal lobe, and large portions of the right temporal and parietal lobes. Of course, all of these are in the normal right-handed individual. In this class, as is well known, the centres of speech are situated on the left side and in left-handed persons on the right. We rarely meet with exceptions to this rule. Originally there exists an embryonal rudiment on both sides. In the course of development, however, only one side matures in a particular hemisphere. If, in young individuals, disturbances of speech remain consequent to lesions of the left half of the brain, the function of the left lobe may gradually be assumed by the right and a partial disappearance of the symptoms of aphasia may take place. Disturbances in reading and writing are exclusively the result of newgrowths of the left hemisphere. In these instances it concerns the gyrus angularis in particular. The left hemisphere in right-handed individuals also plays the leading rôle in explaining the symptoms of praxia, and of recollections of form and color as well as for the higher association connections of simple memories and their spontaneous incitation. It should be stated that the number of left-handed individuals is not as small as may be thought. According to *M. Schaefer,*

of a total of 17,074 children of the Berliner Gemeindeschulen (8,401 boys; 8,673 girls), 4.06 per cent. were left-handed. Of these 5.15 per cent. were boys and 2.98 per cent. were girls; 0.21 per cent. were ambidextrous (0.28 per cent. boys, 0.15 per cent. girls); 95.73 per cent. were right-handed (94.59 per cent. boys, 96.86 per cent. girls).

While the focal manifestations that in the clinical picture occupy a central position, as a rule, correspond to the main location of the neoplasm, the growth of the tumor exercises a constantly increasing morbid influence over the contiguous sections of brain structure and the neighboring nerve-trunks. Aside from the immediate pressure exercised by the tumor proper, the œdema and softenings and hemorrhages, usually accompanying it in its vicinity, also play an important rôle. The resulting manifestations are collectively spoken of as *neighborhood or vicinity symptoms.* The latter may stand in a decidedly important relation to the silent cerebral territories. As *distant symptoms* we designate those morbid manifestations known to affect sections of the brain and cerebral nerves distant from the seat of the tumor. For instance, symptoms of the frontal brain and olfactory nerve may result from tumors of the posterior fossa of the skull or the occipital lobe of the cerebrum.

## Scheme of Localization

As a result of the destruction of certain portions of the cortex cerebri and its medulla there are produced certain characteristic focal symptoms that bear a decided relation to focal diagnosis. They coincide so strikingly with results obtained by faradic irritation of the central region (see Fig. 66, p. 291) that both methods may be happily combined in ascertaining its function.

In operating it is therefore of the utmost importance to the surgeon to always know the exact relation of neoplasmata and other focal pathology of the brain to the bony skull, if he wishes to make use of the cranium as a guide in his operative interventions. Figs. 93 and 94 have been executed by the artist, at my request, in the following manner.

The lines of *Kocher's* and *Kroenlein's* constructions were

drawn on the skull of a cadaver, sixty years old (see Vol. I, Fig. 51). For reasons of better representation only the heavier lines of the latter construction (Fig. 45) were used. The perspective

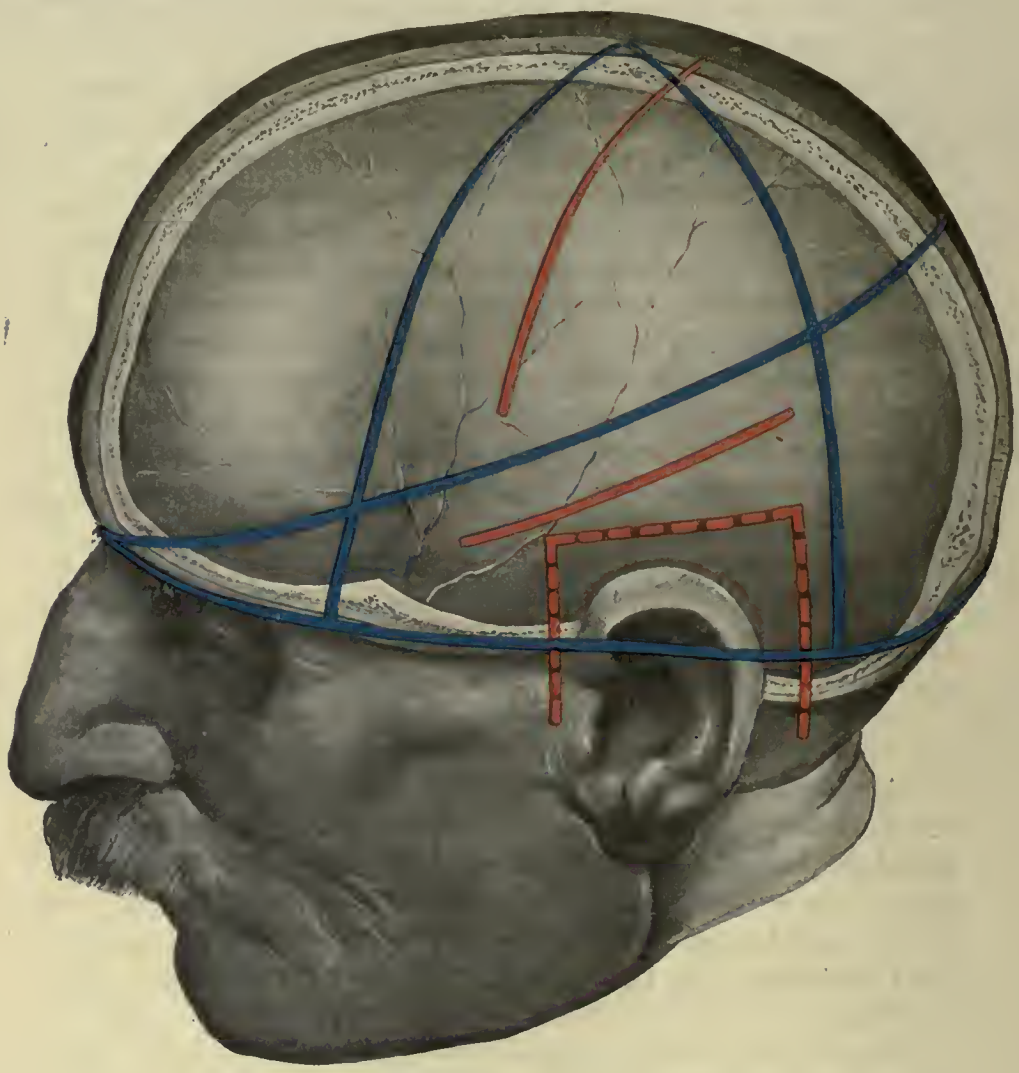

Fig. 93.—*Kocher's* Construction, Blue; *Kroenlein's*, Red

the artist utilized in this work was such that he looked at the head exactly from the median point of the left side and also somewhat from above; that enabled him to see the sagittal line as well. For that reason *Kroenlein's* square, ABK¹M, appears in the

drawing somewhat deep and in a lower situation. The marking of important points of the dura and in the brain are accomplished with the bone-drill.

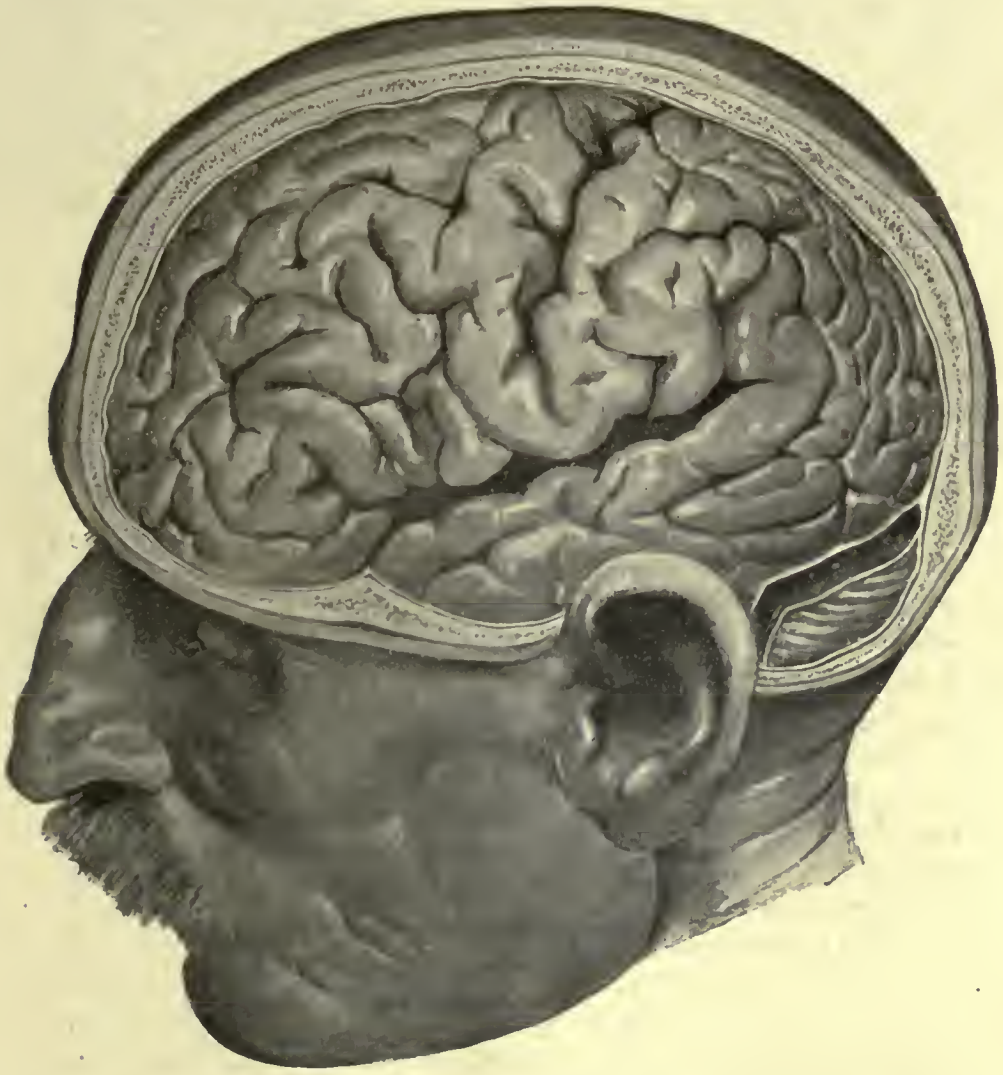

Fig. 94

In order to retain the brain in its normal position as much as possible, the left half of the vault of the cranium was now removed and the right half left *in situ*. This exposed to view the middle meningeal artery and its two branches on the left

surface of the dura. A few millimetres of the trunk of the vessel were also visible below. It at once became evident that *Kroenlein's* points for the ligation of both branches of the meningea media were, at least in this skull, erroneously constructed; i.e., the anterior point corresponded to the posterior branch of the vessel.

The dura of the left half of the base of the skull was now severed transversely and reflected upward. The sinuses (sinus longitudinalis, transversus, and sigmoideus) were incised in order to gain a better view, and the pia was ablated in order to ascertain the position of the various sulci and convolutions of the brain. To render the fissura *Sylvii* and the sulcus of *Rolando* distinct they were strongly forced apart by the interposition of absorbent cotton.

The reflected flap of skin showed *Kroenlein's* outline of the *Sylvian* fissure (previously marked on the surface of the skull) to be entirely correct. The construction of the sulcus *Rolandi* was correct in its lower half only; its upper half was drawn about 1 cm. too far to the front (linea *Rolandi*). *Kocher's* line for the *Sylvian* fissure was about a finger's breadth above that cleft. The linea præcentralis was fully 1 cm. in front of the sulcus præcentralis. On the other hand, the posterior line of *Kocher's* SH was more exact than the anterior, and answered the purpose for which it was designed fairly well.

The pars opercularis of the III frontal convolution (old centre of *Broca*) was in this case remarkably small. Forcing the præcentral fissure asunder, however, revealed in its depth the existence of another convolution which evidently also belonged to the pars opercularis.

After the dura was removed the eye of the artist was directed exactly to the fissure of *Rolando*—1 cm. above the operculum *Rolandi*. As a result of this, the portions of brain contiguous to it are depicted in their natural size and position. The farther away from that point the smaller appear the cerebral sections on the convex surface of the hemisphere. In the drawing therefore, the anterior part of the frontal brain and the entire occipital brain appear as the shortest, but to a somewhat lesser extent than the portions of brain tissue contiguous to the sinus longitudinalis.

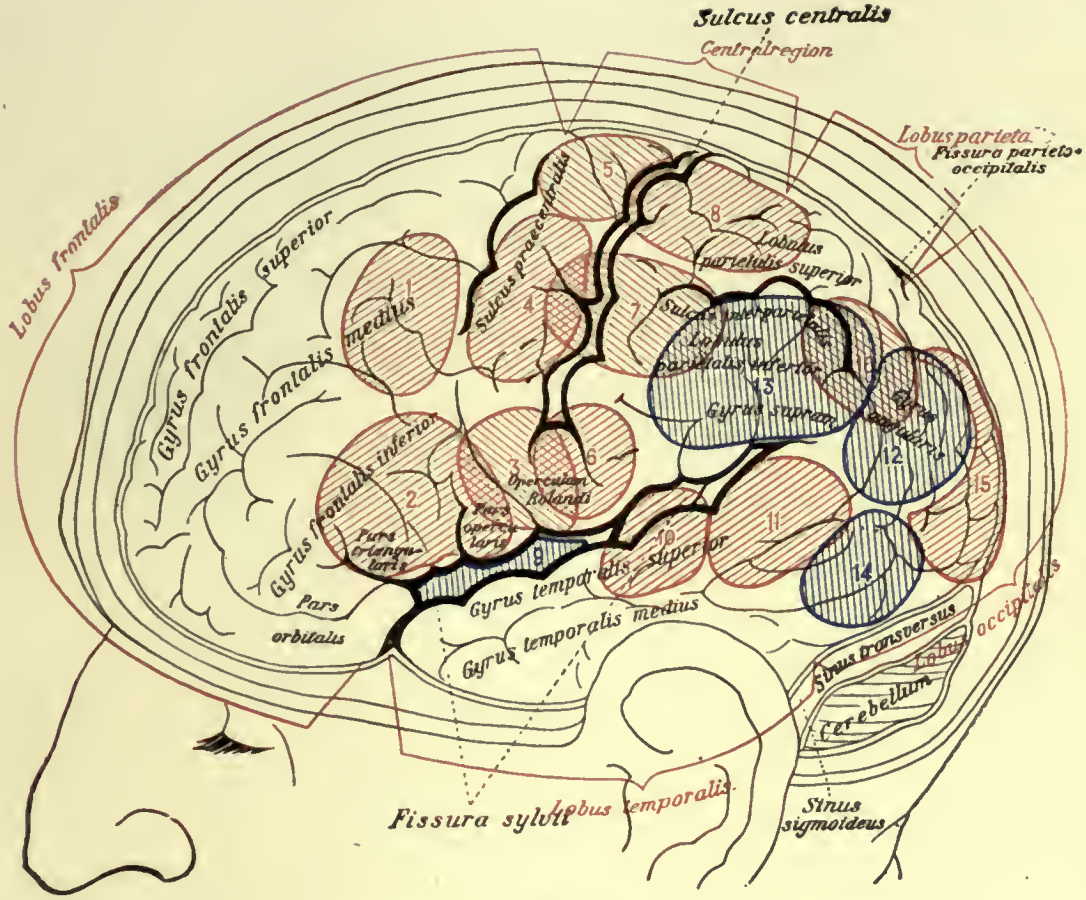


Fig. 95

External View of Left Hemisphere

Schematic representation of Fig. 94, p. 505. The red outlines depict the cortical, the blue ones the subcortically located foci

1. Rotation of the head toward the opposite side.
2. Motor aphasia. Since the third frontal convolution has been drawn from a direct view (unshortened) the frontal area of speech appears greatly magnified.
3. Paralysis of the striated muscles of the tongue, face, œsophagus and larynx (with the exception of the tongue, mainly transitory).
4. Paralysis of the arm and hand.
5. Paralysis of the leg and foot.
6. Sensory disturbances of the face.
7. Sensory disturbances of the arm and the sensation of touch.
8. Sensory disturbances of leg.
9. Island-aphasia. This focus could only be marked in its width; i.e., in its frontal diameter. The cause for this being the deep position of the island in the depth of the *Sylvian* fissure.
10. Is situated in the upper temporal convolution and in the gyrus temporalis transversus (*Heschl's* convolution). Since it is to be found in the upper surface of the temporal convolution, its location could only be indicated on the sketch, Fig. 95.
    If space 10 be destroyed on both sides total cortical deafness will in all probability be the result. According to *Flechsig, Heschl's* convolution contains the centre of hearing.
    It is asserted that in left-sided destruction of this space word-deafness alone will result. This is uncertain.
11. Sensory aphasia.
12. Near the convexity: Alexia and agraphia. In the depth, near the median surface, pure alexia.
13. Next to it: Amnesic aphasia; in the depth, apraxia.
14. Amnesic aphasia and optic-tactile aphasia.
15. In bilateral destruction: Loss of psychological perception of visual objects. This may also be produced by the destruction of other foci; amnesic (special optic) aphasia. The occipital brain appears shortened in the drawing.
16. Déviation conjuguée.

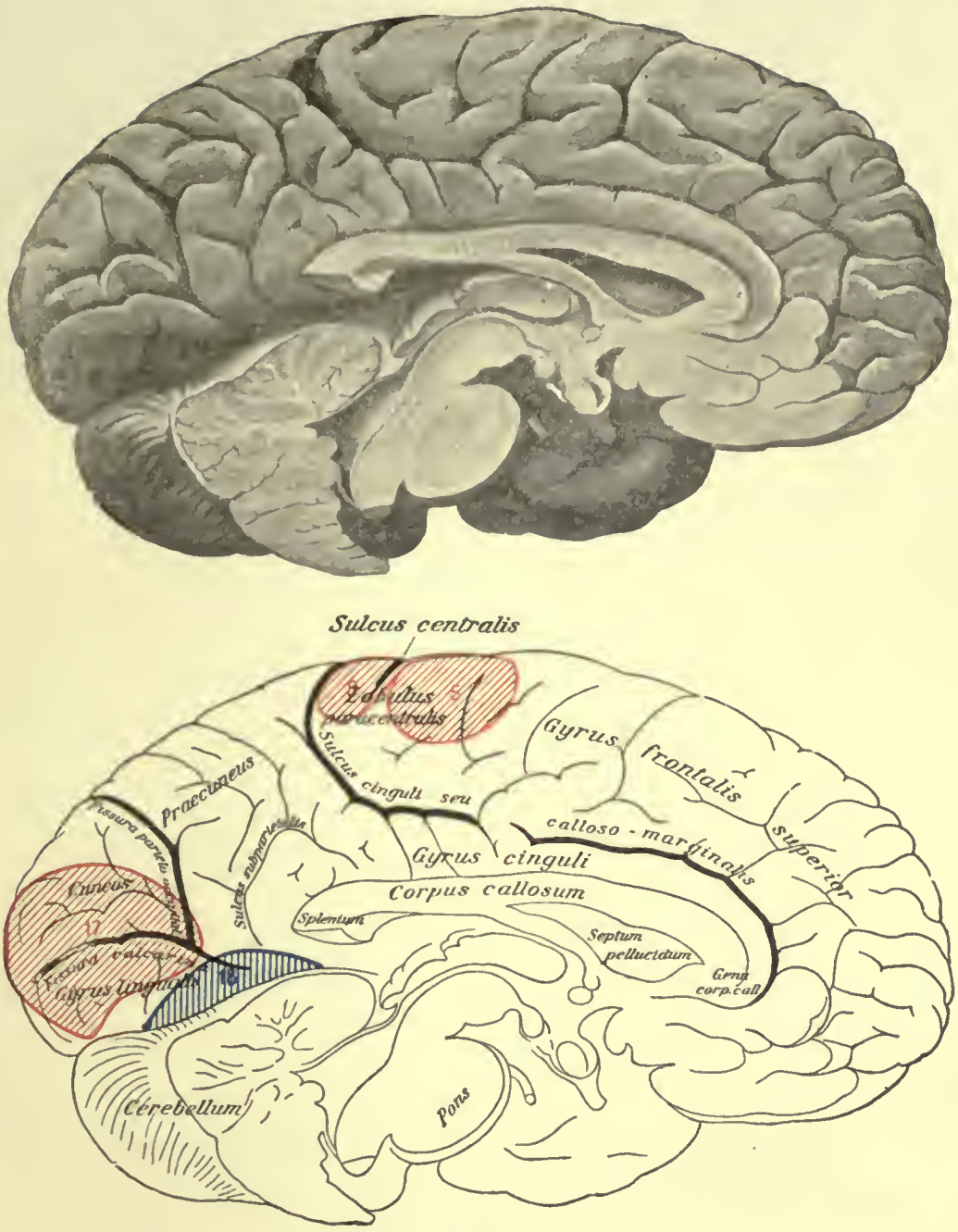


Fig. 96

Left Hemisphere Viewed from the Median Fissure

The brain had to be removed from the skull and appears, on account of its soft consistency, somewhat flattened

5. Paralysis of the lower extremity.
8. Sensory disturbances of the lower limb.
17. Right hemianopsia.
18. (In the medulla subcortically) amnesic aphasia.

In Figs. 95 and 96 I am giving the localization of functions as much as they could be ascertained from clinical manifestations up to this time. These, of course, are only approximate determinations. While sketching, I have frequently consulted Figs. 161 and 162 of *Hugo Liepmann*, in *Hans Curschmann's* "Treatise on Nervous Diseases," Berlin, 1909.

# Neoplasmata of the Frontal Brain

The frontal brain comprises the convolutions of the cerebrum situated in front of the præcentral fissure (see Fig. 94). Three gyri are distinguished, i.e., the gyrus frontalis superior (I), medius (II), and the inferior (III). The base of the frontal lobe rests on the superior surface of the orbit and extends backward to the border of the lesser wing of the sphenoid bone. It, therefore, occupies the anterior cranial fossa. From its anatomic location, the frontal brain is quite easily accessible. Larger portions of its substance may be removed than it would be prudent to attempt in any other part of the brain. This is clinically proven by the extirpation of very large sections in right-handed individuals, who, as is well known, have not the motor centre of speech developed on that side. I recall the case of a man, thirty-eight years of age, who applied to me three months after an unsuccessful attempt at operation. He presented a semisolid sarcoma the size of a fist of a child. I was obliged in this case to extirpate the entire left frontal pole at one sitting. At the conclusion of the extirpation the roof of the orbit, the falx cerebri, and the sinus longitudinalis lay widely exposed. While the frontal pole was being delivered through the extensive opening in the skull, the arteria corporis callosi, the median surface of the right hemisphere and the corpus callosum were brought into view. Wound-healing progressed without mishap and, after a two months' stay at the hospital, the patient was discharged. Not only was there a decided improvement in his general condition, but the severe symptoms also regressed to quite a considerable degree. Only a suggestion of choked disc persisted, and the paresis of the right oro-facialis was barely noticeable. The severe headaches from which he previously suffered ceased, and he feels very well, indeed. The speech, while still somewhat slow, was much better than before the operation. He answers questions without much hesitation. The impression he creates

is that of greater activity and greater intellectual brightness. While before the operation he lay listlessly in bed, taking interest in nothing, he now busied himself all day long by reading extensively and entertaining the other patients.

## The Use of Suction in the Removal of Cerebral Tumors

### Supplement to the Technic

Since the appearance of the first volume which contains the technic of operations of the brain, I have made use of suction to steady and deliver the tumor, in quite a number of cases.

Of cerebral tumors that can be located, only the encapsulated ones may be totally extirpated with certainty. In a given case of diffuse glioma, it is well nigh impossible to tell where the pathologic tissues end, and the sound structures begin. The autopsy, nay even the microscopic examination, may render it difficult or even impossible for the pathologic anatomist to ascertain those border-lines.

The extirpation of even encapsulated tumors is not infrequently rendered extremely difficult because they have to be enucleated from the cerebral substance. With the exercise of even the greatest possible care it is frequently impossible to accomplish the desired result by means of the scoop or other rigid instrument. The difference in the consistency of the tissues is so slight that during the operative manipulations one either enters the brain, or if not bold enough limits himself to the neoplasm, in which event tumor-rests will surely remain behind. Until now we usually did our enucleations in the time-honored way—with the fingers. It stands to reason that with this method a great many nerve-fibres are destroyed that should have been preserved. In the cerebrum this may yet be tolerated, because here the post-operative manifestations are, as a rule, not very marked, provided no important centres have been interfered with; not so in the cerebellum, especially in the posterior fossa. Enucleation with the fingers in these areas may at times lead to a fatal issue. You have perhaps succeeded in enucleating the tumor with the aid of the finger easily enough, and have returned your patient from the operating table in a toler-

ably good condition when, as I have seen it frequently happen, after five or six hours the respirations commence to be bad and the patient dies with all symptoms of respiratory failure, while the heart continues to beat for a time regularly and with force. This state of affairs is due to disturbances in the fourth ventricle which are, in a great measure, brought on by the operation.

Now, from what has been said, it is quite obvious that it would be a great advantage to possess an instrument that would enable us to drag the tumor out of its bed prior to its enucleation. Unfortunately, the consistency of tumors renders such attempts futile by ordinary means. By the use of hooks, *Muzeux* forceps and other contrivances, they usually tear, because, as stated, they are, as a rule, soft or semisolid.

For that reason I am using, since December, 1908, a suction apparatus which is applied around the exposed tumor. In my first experiments I availed myself of *Klapp's* models. It occurred to me that to obtain a better hold on the split and rigid surface of the tumor, with the suction attachment, the use of quite a thick not easily collapsible rubber tube would be a great advantage. This I have tried with great satisfaction. To insure greater pliability, the distal end of the tube was given a conical shape and so constructed that it terminated in a thin membrane. With this simple apparatus I was successful in removing a tumor of the acusticus without any difficulty. To accomplish this procedure no special preparations are required. François Fonrobert's Rubber Factory, Friedrich Strasse 77, has supplied me with rigid-walled rubber tubing having a lumen of 45 mm. The connections with the suction balloon are made by means of a perforated rubber stopper, through which a glass tube is inserted.

During a joint operation with *Professor Dr. Schuster*, Privatdocent of Neurology, of Berlin, he told me that physiologists have for a long time been using pointed glass cannulæ for the removal of very small bits of tissue from the cortical and subcortical regions. The tissue from which a specimen is desired, is selected, the pointed cannula is inserted, and the air exhausted from it. In this manner a circumscribed piece of cerebral tissue is removed by suction. To obtain the necessary suction action, which must be strong, physiologists make use of a water-pump

on the principle of a water jet vacuum pump, or an air-pump driven by an electro-motor. Since I did not aim at a sucking out of the tumor, as it were, but to gain a good hold for its better manipulation, the communication of my colleague *Schuster* was of great value to me. I am using a water-pump because it furnishes me with the required suction and is, for my intents and purposes, an entirely satisfactory contrivance. It was first introduced to surgery, as far as I have been able to ascertain, by *Perthes*, who recommended it for a number of years in the post-operative treatment of empyema.

In my subsequent operations I have used attachments made of glass, which enable the operator to accurately watch the effects produced by the suction. A clever glass-blower, employed by Warmbrunn, Quilitz & Co., 55–57 Heide Strasse, Berlin, blew a number of glass cylinders of various dimensions for me (10 to 60 mm.). Their forepart is rounded to insure a good grasp, and behind there is a rectangular attachment piece unto which the rubber tubing is mounted (see Fig. 98). To insure asepsis a rubber tube, about 40 cm. long, which may be boiled, is slid over the rectangle. From this tube another one, mounted with a glass cannula and about 5 to 6 metres long, is run along the floor to the water-pump.

After exposing the tumor as much as possible the largest fitting glass-bell is applied to its surface and suction is begun. As a rule, the suction is so strong that both—glass-bells and tumor—look as if they consist of one piece. It will sometimes happen that in cases where the tumor is hard and its surface considerably cracked, the attachment of the bell will be unsuccessful. Under such circumstances it is only necessary to slide onto the front of the suction-glass a few mm. of very soft rubber tubing. This may also be obtained in various sizes from François Fonrobert. To prevent the suction from becoming excessive, especially in the posterior fossa of the skull where it is possible to suck the entire medulla oblongata and the cerebellum into the glass, a device should always be at hand that will immediately suspend suction whenever desired.

To avoid misunderstanding, I once more wish to emphasize that I am not aiming at sucking the tumor out, but to accomplish its fixation on the surface in such a manner that by the

use of the described apparatus I am able to manipulate and move it at will. The mass of the great majority of tumors is, as a rule, resistant enough and will not tear from the suction it is subjected to. Neoplasms may be pulled to the front in their entirety. Pure sarcomata are of course frequently extremely friable. In one of my cases of sarcoma of the hypophysis, suction caused the tumor to fall to pieces, and its removal had to be accomplished with the sharp spoon.

Let me now cite a case of tumor of the frontal brain.

## OBSERVATION II, 1

*Removal of a Large Diffuse Glioma from the Left Frontal Brain by Means of Suction. Cure. Three Months Later Recurrence and Death.*

An official, thirty-four years of age, became ill, in July, 1908, with rigors, headaches, noises in the ears and dizziness which were so marked that he collapsed. Since October there frequently occurred, in the morning, nausea and vomiting. In November, his power of vision became bad and he saw objects double. His diplopia diminished only after a marked reduction in the power of vision of his left eye. His vision, which in the middle of December was R. $\frac{4}{6}$, L. $\frac{4}{12}$, at the end of January, 1909, sunk to $\frac{1}{36}$. From a neuroretinitis with hemorrhages and white spots, there developed a distinct choked disc. He was admitted to the Augusta Hospital at the end of January, 1909. Of late his vomiting ceased, which was also true of his headaches. He stated that the frequently occurring noises in his ears were now tolerable. From time to time he perceived a formication in the fingers of his left hand.

On the first of February, 1909, his status was as follows: The sense of smell of the left side was entirely gone. Atrophic choked disc existed on both sides. The atrophy, however, was more marked on the left than on the right side. He perceived light on the left side in the temporal visual field exclusively—nasal hemianopsia. He counted the fingers on the right at a distance of from two to three metres. Reading was for him almost impossible. There was no hemianopsia in the right eye.

Both corneal reflexes were lively. Slight paræsthesias existed on the left side of the forehead and in the left cheek. The left angle of the mouth was drooping; the innervation, however, was equal on both sides. The left tips of the fingers were paræsthetic; this was occasionally also observed in the tips of the right fingers. While ataxia was absent his fingers were tremulous when moving. All tendon, skin, and periosteal reflexes appeared lively, outside of which they showed no abnormalities. Presently the patient was not dizzy. When unsupported by

Fig. 97

the right he could not stand on the left leg. When walking with his eyes closed he always erred to the left. Outside of that nothing pathologic could be elicited from the nervous system. It seemed to me that the collective symptomatology justified a diagnosis of tumor of the left frontal brain. I operated in two sittings—the first on the 9th, and the second on the 20th of February, 1909.

On account of the large area that had to be exposed a double osteoplastic flap was formed—one behind and one in front (Fig. 97); they resembled a pair of folding-doors. The exposed dural surface extended from the sinus longitudinalis in front,

over the frontal brain to the *Sylvian* fissure behind. The latter could be recognized on the vaulted surface of the dura, as a depression about a centimetre wide. The tension of the dura was very marked. It did not pulsate, in spite of the extensive exposure. Even deep palpation with the finger could not detect

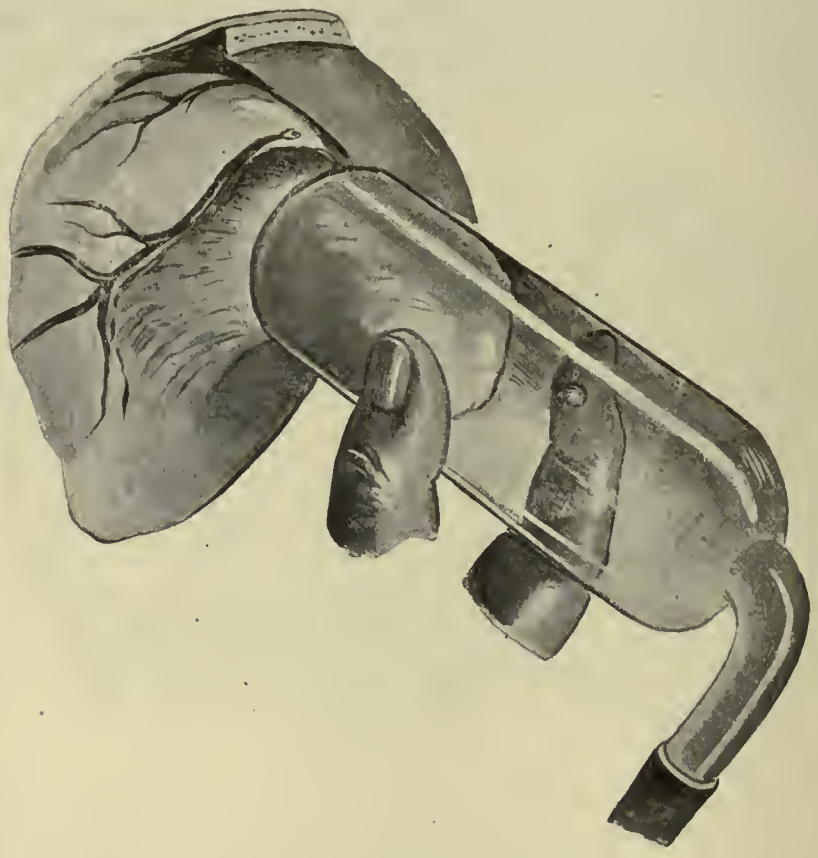

Fig. 98

pulsation. A striking appearance was created by the dura at the frontal pole, a little more toward the base, by its yellowish-red discoloration and a peculiar radiation of blue vessels. The size of this suspicious area was about that of a half dollar. Farther away the dura did not differ from its normal bluish-white color. At the end of the operation both flaps were replaced and sutured into position.

At the second operation, February 20th, the dura appeared

vaulted in the anterior half of the trepanation flap, to the shape of a hemisphere (see Fig. 97). Pulsations were now visible. On account of the large size, two flaps were formed of the exposed dura—an anterior, the base of which was directed downward and a posterior with its base toward the back. The tumor could now be seen in the frontal pole immediately under the cerebral cortex. The veins of the pia covering the tumor were doubly ligated and severed. The surface of the tumor now lay exposed. A glass bell, 40 mm. in diameter, was placed over the tumor, which was pulled into it by suction. While one hand

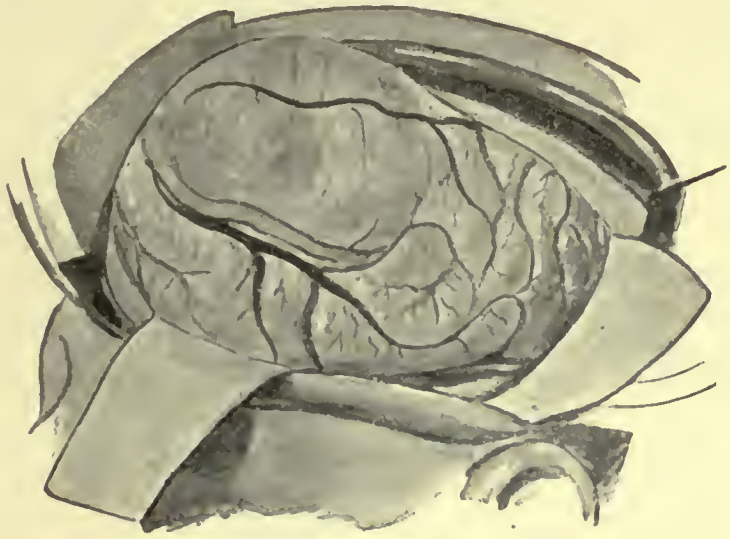

Fig. 99

was fixing the tumor and the suction glass (Fig. 98), the other carefully pressed the surrounding normal cerebral tissue out of the way, by means of sponges held in forceps. Very little cerebral substance was injured. After enucleation and dislocation of the tumor, its extensive pedicle, consisting of cerebral medullary substance was divided with scissors (Fig. 100).

The entire left frontal pole of the brain was thus removed. It measured 9 cm. in length, 6 cm. in width, and 3 cm. in thickness. The falx cerebri and the sinus longitudinalis also lay widely exposed. As a result of this extensive extirpation a large flap of cerebral substance was created (toward the central area) which was placed into the defect in the brain from below

and behind and kept *in situ* by the flaps of dura placed over it. The skin was then sutured without drainage.

On the day following the operation, total aphasia developed. Occasionally the patient would utter his name. Consciousness was retained. After two days the aphasia began to diminish and in two more days it had completely disappeared. The further post-operative history was an exceptionally good one. In a little less than three weeks (11th of March) the patient

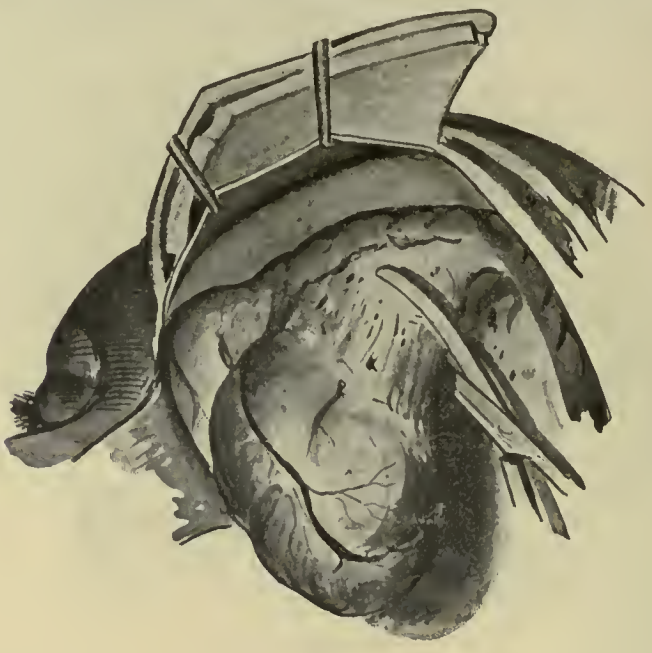

Fig. 100

was discharged cured. He left for his home. In enucleations with the finger, as ordinarily practised, the disturbances that follow are, as a rule, by far greater. By this method great masses of brain-tissue may be destroyed, besides, secondary processes of softening may set in and give us great trouble for weeks at a stretch and may even jeopardize the life of the patient.

A letter written in the middle of March informs us that the patient is enjoying good health. The power of vision of the left eye has in a great measure returned; that of the right, of course, has considerably regressed. The microscopic examination has unfortunately disclosed a diffuse glioma. In the mid-

dle of May, however, disturbances made their appearance again; at first aphasia, then right-sided spasms followed by paralysis of the extremities on that side. The patient died on the 25th of May, 1909, at the Hospital of Chemnitz with increasing paralyses.

## Symptomatology

### Psychic Disturbances

Psychic disturbances of a peculiar nature are occasionally met with in cases of tumor of the frontal brain. *Jastrowitz* describes the same under the name of *moria,* and *Oppenheim* under the name of *Witzelsucht.* They assume the form of manifold gasconades and exaggerations, which the patients recite with serenity, and also of jesting and childish remarks. There may exist, simultaneously, a certain degree of stupefaction which may interchange with periodic states of hyperexcitation which are the result of increased cerebral pressure. We also notice a decrease in the intellectual powers. The memory seems to suffer especially. That symptom may, of course, occur in cases of tumor in other portions of the brain, and even in neoplasmata of the posterior fossa of the skull. This fact naturally greatly detracts from its diagnostic value.

A characteristic example follows:

### OBSERVATION II, 2

*Osseous Elevation of the Right Tuber Frontale Consequent to Pachymeningitis Externa Ossificans. Inseparably Blended with the Inner Surface of the Dura. Mandarin-Sized Tumor in the Right Frontal Lobe Entirely Separated from the Cerebral Surface by a Narrow Space.*

A bar-house keeper, forty-one years old; an obese toper; at no time, however, specifically infected, became suddenly ill, five years prior to his admission, with extraordinarily violent headaches that lasted all day long. At that time already a slight protuberance of the right side of the forehead was said to have been noted which, in the first years, gradually increased in size

and later grew larger with greater rapidity. The intensity of the headaches fluctuated, and they are said to have disappeared for a long time after a certain "pill-cure." Transient pains and swelling in the right leg were also noted. In the last year and a half his intelligence had suffered to so marked a degree that he was obliged to give up his business. The first spasming attack was observed by his wife on the 12th of December, 1902. It set in some hours after indulging in alcohol. The patient felt ill, collapsed and fell to the floor; became cyanotic and lost his senses; bit his tongue and had involuntary passages. During the year 1903, he had a number of similar seizures. According to his wife, some of the attacks commenced in the left arm. There was frothing at the mouth and vomiting. Headaches always preceded the attacks and lasted for a few days. Since Easter, 1904, the patient was bedridden. His mental faculties were constantly on the decline. A diagnosis of gumma of the brain was made in a certain hospital, and while the patient was there a spasming seizure was observed that commenced in the lower extremities. He was admitted to the Augusta Hospital, June 30, 1904.

A goose-egg-sized osseous prominence was noted over the right tuber frontale (see Vol. I, Fig. 22) which was partly covered with skin richly beset with hairs. The protuberance was fairly well circumscribed and measured 8 cm. in sagittal and 6 cm. in horizontal diameter. The patient was frequently apathetic; his understanding of speech, however, was generally good. *Witzelsucht* (*Oppenheim*) was present. To the question of how he was, he usually answered "damned good." He told us, and the patients with him at the hospital, of his hair-raising experiences while tiger-hunting in Africa, and of other strange adventures, although he never left the limits of Berlin for a moment. He paid little attention to his surroundings. The examination of his extremities showed no tremors, atrophy, or other changes. He executed various movements, upon request, clumsily, but with certainty and tolerable force. All joints were passively mobile.

The halves of the face appeared to be unequal; the left nasolabial fold was effaced; the left angle of the mouth was somewhat drooping, and during movements the entire side of the face

remained distinctly behind. The outward turning of the right bulb was incomplete. The pupils were equal, round, and moderately wide. Only a trace of the reaction to light on the left side could be demonstrated. The confusion of the patient did not permit the test for convergence reaction. Choked disc was bilateral with hemorrhages on the right. The visual field was evidently intact; a thorough examination, however, was impossible. The acuteness of vision was, on both sides, $\frac{4}{5}$. The hearing was somewhat reduced on the left; on the right side it was normal. The tongue slightly deviated to the right upon protrusion. He yawned a great deal.

Light contacts were everywhere correctly recognized and located. There was a certain hypersensitiveness to pricking which was especially marked on the right half of the body; even superficial pricks caused the patient to perform defensive motions and in the apathetic state caused him to utter threats. The sense of position was retained; movements of coordination (crossing of legs, touching of tip of nose with finger, etc.) showed nothing noteworthy. Reflex anomalies were represented by the *Oppenheim* and *Babinski* phenomena. While at the Augusta Hospital, the patient was seized with a mild attack; according to his sister the twitchings during this attack commenced in the extremities of the right half of the body and in the right side of the face.

At the operation performed July 4, 1904, a sagittal incision was made over the most prominent part of the elevation (patient was, at this stage of the operation, bleeding very profusely), and the skin, together with the galea aponeurotica, dissected back. At the border of the osseous tumescence the periosteum was divided and detached toward the centre of the tumor. In drilling holes through the bone it was found extraordinarily thick (21 mm., see Vol. I, Fig. 21); its division with the *Dahlgren* hook could consequently be accomplished in certain places only; in other parts it had to be divided with the chisel. Grayish-red, warty proliferations were found on the exposed dura. It was very tense and non-pulsating, and strands were seen stretching from it in a radial manner toward the periphery. On account of the increased rapidity and small volume of the pulse as well as the great pallidity of the patient during the operation, the

opening of the dura and the extirpation of the tumor were postponed. After painstaking hemostasis the wound in the skin was sutured. While the patient was recovering from the operation, a bilateral lower lobar pneumonia set in on the 7th of July, and caused his death three days later.

The post-mortem examination (*Professor Dr. Oestreich*) showed, besides the double pneumonia and a flabby, fatty heart, the following: In the trephined space the dura appeared bluish in color and quite prominent. After circular detachment at the base of the skull and division of the tentorium cerebelli, and while attempting to reflect it over the cerebrum, a tumor the size of a billiard-ball, intimately adherent to the under surface of the dura, was delivered with remarkable ease from the right frontal brain. It was not adherent to the underlying brain structure which was excavated and resembled a deep acetabulum. The neoplasm measured from above downward 6 cm. and at the base 5 cm. in diameter. On transverse section a hemorrhagic wedge-shaped zone was shown; otherwise it was hard and distinguished itself from the white substance of the brain by its grayish-blue color (see Vol. I, Plate IV, Fig. b). The cavity remaining after the removal of the tumor was as smooth as that of a ball and socket joint. A sagittal section through the cerebrum, above the site of the tumor, showed distinct displacement of structure, especially of the cortical substance. The gray matter underneath the pia was compressed to an almost invisible streak. The white substance in the frontal brain was also displaced downward; this was especially true of the knee-shaped portion of the corpus callosum. The pressure, however, was not strong enough to have caused a decrease in the size of the lumen of the lateral ventricle.

### Which? Cerebral or Frontal Ataxia?

Neoplasmata of both upper frontal convolutions frequently give rise to disturbances of the equilibrium while standing or walking. In other words they create a picture of *cerebral ataxia* (*frontal ataxia of L. Bruns*), that reminds one of the peculiar swaying gait and uncertainty on standing observed in morbid conditions in the posterior fossa of the skull (*cerebellar ataxia*). The belief that in cases of frontal ataxia the walk and swaying favor the

side affected, is less true here than in the cerebellar form. An explanation for this phenomenon was sought in the ataxia of the musculature of the trunk, because *Munk* thought the centres of those muscles to be located in the frontal brain. The data at hand to prove this contention are as yet insufficient. The ataxia may be so strongly in the foreground that it overshadows all other manifestations, and in that event and in the absence of local disturbances of bone or neighborhood symptoms, one is apt to make a wrong diagnosis of cerebellar tumor. This certainly is likely to be the case, since choked disc and general symptoms of increased cerebral pressure are just as common in neoplasmata of the frontal brain as in tumors of the posterior fossa of the skull.

The following table[1] of association-symptoms as observed in cases of cerebellar and frontal ataxia, compiled by *L. Bruns*, may be used to great advantage in the differential diagnosis of these conditions.

| *Frontal Ataxia* | *Cerebellar Ataxia* |
|---|---|
| *shows as association symptoms* | |
| 1. Monoparesis or alternating hemiparesis; eventually motor aphasia. In the beginning of the latter frequently dysarthritic disturbances. Weakness of the muscles of the trunk. | 1. Either no paralysis of the extremities or paraplegic symptoms. More rarely hemiparesis of a spastic nature on the side of the tumor or crossed. Not infrequently also hemiplegia alterans. Frequently movement ataxia of the arm on the side of the tumor; more rarely also of the lower extremity; then, if at all dysarthritic disturbances of speech. |
| 2. *Jacksonian* or general epileptic spasms. Sometimes also tonic spasms of the musculature of the trunk or tonic rotation of the head to one side with rigidity of the neck. | 2. Partial epileptic spasms; seldom as distant symptoms at height of the disease. Sometimes also tonic convulsion of the muscles of the neck and back with rigidity of the neck. Opisthotonus and arc-de-cercle formation. |
| 3. Eventual spasmodic deviation of the eyes from the tumor. If the tumor be unilateral, no visual paralysis. | 3. Pons participating, frequently visual paralysis toward the side of the tumor alone or with alternating hemiplegia of the extremities. |
| 4. In perforation or pressure toward the base, lesions of an opticus, tractus or chiasma with unilateral choked disc—unilateral blindness or crossed homonymous or bitemporal | 4. On account of grave choked disc disturbances double blindness; frequently early; homonymous hemianopsia almost never; frequently nuclear paralysis of eye-muscles; also paralysis |

[1] *L. Bruns*, Die Geschwülste des Nervensystems, II Aufl., S. 123 f., Berlin, 1908.

| *Frontal Ataxia* | *Cerebellar Ataxia* |
|---|---|
| *shows as association symptoms* | |
| hemianopsia; at times abducens or partial oculo-motor paralysis. Neuralgia of the first branch of the trigeminus; anosmia, eventually protrusion of the bulb. Choked disc usually a late symptom. These cerebral-nerve paralyses occur sometimes on both sides or in connection with crossed paralyses of the extremities with an alternating hemiplegia. | of other cerebral nerves of the posterior fossa of the skull; above all of the acusticus and facialis and the trigeminus (also motor), then the 9th, 10th, and 11th cerebral nerves. Not infrequently alternating hemiplegia here also. |
| 5. Occasionally circumscribed sensitiveness and tympany on percussion. | 5. Never circumscribed. Frequently, especially in children, general percussory symptoms, i.e., extensive cracked-pot resonance. |
| 6. Sometimes slight headaches in the beginning. They are mainly felt in the forehead, sometimes also in the back of the head, even with rigidity of the back of the neck. | 6. Excruciating headaches with vomiting right from the beginning. Decreased pulse-rate and dizziness. Headache, mainly in the back of the head with rigidity of the back of the neck; at times also in the forehead; also crossed with seat of cerebellar tumor. |
| 7. Stupefaction; later frequently profound. *Witzelsucht?* | 7. Stupefaction in the terminal stage only; in profoundness frequently interchanging with increase and decrease of hydrocephalus internus. |

That errors cannot always be avoided with certainty, notwithstanding the most careful study of these symptoms, may be learned from the following history.

## OBSERVATION II, 3

*Tumor in the Pole of the Right Frontal Brain. The Symptoms in this Case Pointed to a Morbid Condition in the Left Posterior Fossa of the Skull. Trepanation Revealed a Tumor-Like Formation on the Upper Surface of the Cerebellum that was Shown on Microscopic Examination to Consist of Disintegrated Tissue Permeated with Round Cells.*

The patient, a man thirty-three years of age, progressively growing blind, was under the observation of *H. Oppenheim* since the middle of August, 1906. The symptoms noted on the history-sheet sent to him did not coincide with his own findings; neither did the diagnosis at necropsy tally with that made on

the same history-sheet. It was stated that the right eye was first to suffer, yet the choked disc, which just about reached the stage of atrophy, was more marked in the left eye. There existed an areflexia of the left cornea and bilateral nystagmus. Diplopia was said to have previously existed on the left side; erroneous perception of objects was also on the left. The closure of the eyelids was somewhat stronger on the right than on the left side. At opening of the mouth the lower jaw deviated at times to left. There was a spot on the left surface of the nose at which slight contacts were not perceived at all, and the pin-point and pin-head could not be distinguished by the patient.

On the left side the power of hearing was at times markedly reduced; disease of the cochlea and vestibular apparatus did however not exist. The hands were neither weak nor ataxic. The tendon reflexes of the lower extremities were normal; the abdominal reflexes were very active. The sensorium was free, yet the faculty of recollecting impressions was lately very much reduced. On the whole, the psychic irritability of the patient was slight; he cared little and did not worry about himself; he scarcely asked for things, he was indifferent as to what was going on about him, and so on. His gait was by far more uncertain than could be explained by the degree of blindness; when turning around he swayed to the right and backward. Standing up for a while caused both lower limbs to tremble. He answered questions during the examination as if in a slumber; he executed masticatory motions uninterruptedly. After reclining on the left side he once complained of pain in the right forehead and over the right eye.

Attacks of spasmodic contractions in the hands and arms, lasting from two to three minutes, occurred almost daily; at times they were accompanied by a turning of the head to the left and movements of the lower extremity, especially flexion of the left knee. During the attacks consciousness was retained; later it became cloudy and finally involuntary evacuations of the bladder supervened. Only after the 12th of September—on which day puncture of the left inferior horn was performed and 15 to 20 cm.$^3$ of a clear fluid evacuated—did striking psychic disturbances (hallucinations, delusions of memory) make their appearance. Hypæsthesia and hyporeflexia of the conjunctiva

were at that time equally marked on both sides. Nystagmus and limitation of vision on the left were constant; there was also blepharoclonus. Besides the area of anesthesia in the territory of the left trigeminus, spoken of above, the cerebral nerves showed nothing more pathologic.

The apathetic condition of the patient made an accurate diagnosis impossible. Gradually very severe general manifestations made their appearance, making a pressure relieving trepanation imperative.

On the 14th of September, *Oppenheim* sent me the following diagnosis: "In all probability endocranial neoplasm. Site of tumor not diagnosticable with certainty. There are some manifestations which point to the existence of a tumor in the left posterior fossa of the skull. These are: 1. Early development of choked disc with greater severity in the left eye; right eye is said to have lost its function first. 2. Hyporeflexia of the cornea which was (at least in the beginning) limited to the left side and is now bilateral. 3. Mild but definite sensory disturbances in the left half of the face. 4. Visual paresis and nystagmus, especially when looking to the left—a manifestation which in view of the existing amaurosis loses some of its diagnostic value. 5. Difficulty in the hearing of the left side (?). 6. The cerebellar ataxia.

"It appears to me that, under the existing circumstances and in view of the desperate condition of the patient, an exploratory trepanation of the skull, over the left cerebellar hemisphere, is entirely justifiable and warranted. It is, of course, questionable whether by so doing the tumor will be made accessible and its removal accomplished. To be sure, we may find a meningitis serosa chronica, pure and simple, but such a surprise is very improbable."

On September 16th, the left cerebellum was laid bare in typical fashion. The dura was stretched so tensely that it almost felt like a billiard-ball. On account of profuse emissary bleeding and collapse, opening of the dura had to be postponed. The patient suffered four spasming seizures during the night following the operation. The sensorium became free a few days after the operation, but the memory remained fogged as yet; anesthesia of the left cornea was almost complete. The motil-

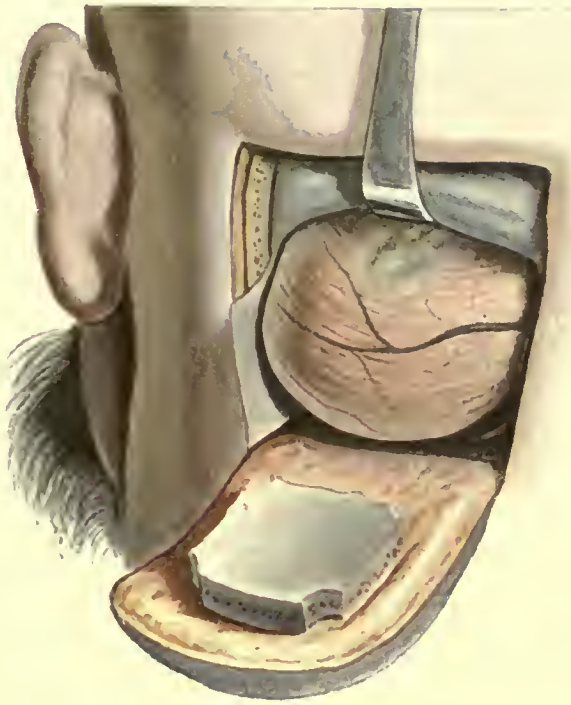

Fig. a.

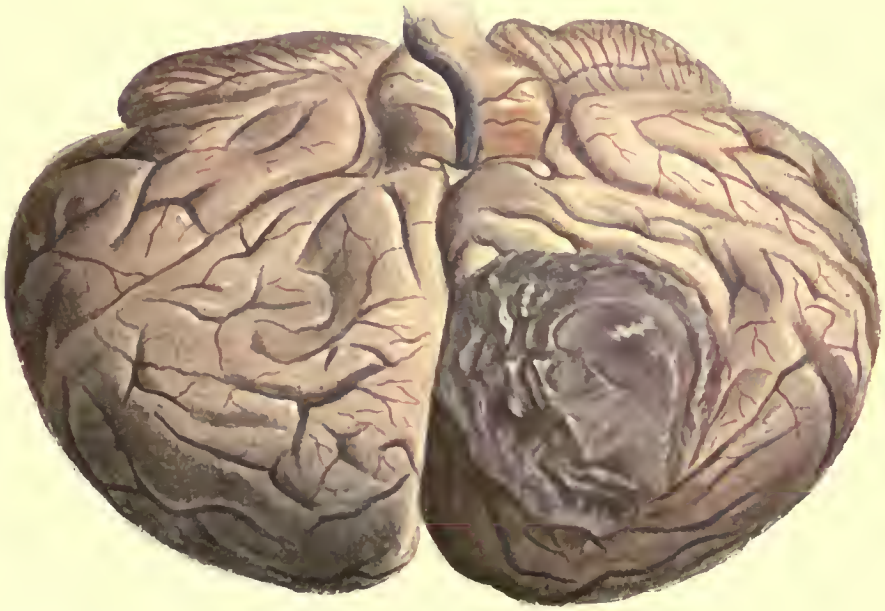

Fig. b.

ity of the arms remained unimpaired throughout; there existed neither ataxia nor adiadochokinesis.

The operation was completed on the 5th of October. Downward reflection of the osteoplastic flap brought at once to view the occipital brain. It was under great tension above the sinus transversus, and the cerebellum also was highly tense. Puncture of the occipital brain (5 cm. deep) yielded nothing.

A flap of dura with lateral base was created and the tentorium elevated with a brain spatula. A tumor, 4 cm.$^2$ large and yellowish-white in color, was discovered on the upper surface of the cerebellum (see Plate XXXIII, Fig. a). It was not distinctly outlined from the surrounding brain-tissue. There were no differences in consistency between neoplasm and brain structure (cerebellum). In the vermis, the petrous portion of the temporal bone and in all other parts examined, normal conditions were found. The anatomic incision into the hemisphere also showed nothing abnormal. The tumorlike mass including the cerebellar tissue surrounding it was now removed by means of the sharp spoon; microscopic examination proved it to be composed of disintegrated tissue and round cells. Distinct pulsations of the cerebellum were now visible. The occipital brain protruded no longer. The dura, so tensely stretched before, now lay collapsed over the cerebral surface. After accomplishing our object—relief of tension—the wound was sutured.

Wound healing was uneventful. On the 7th of October, the sensorium of the patient was entirely free again. There existed strong deviation of the eye-bulbs to the right, as far as the canthus; on the left they could barely be brought to the median line, accompanied with nystagmus. The bulbs remained behind when attempts were made to look upward. The areflexia of the left cornea and the anesthesia in the left trigeminus territory were very distinct; needle-pricks were perceived by the patient on both sides of the face, as contacts only. Facialis and hypoglossus were normal on both sides. There was neither weakness nor ataxia in any of the extremities. The tendon phenomena and skin reflexes showed no deviations from the normal. On the 21st of October pneumonia set in, to which the patient succumbed on the 24th of the same month.

At the autopsy (*Professor Dr. Oestreich*), the brain showed

the following conditions: On the anterior pole of the right frontal brain a tumor was found that distinctly distinguished itself from the rest of the surrounding cerebral substance by its grayish-red color (compare Plate XXXIII, Fig. b). The neoplasm was as large as a divided apple; its largest surface was in contact with the base of the frontal brain; in height it exceeded the convexity of the hemisphere by about 2 cm. and overreached its median surface by fully 3 cm. Its consistency was softer than that of the cerebral mass. A few yellowish and necrotic looking spots were found on its median surface. The convolutions of the frontal brain were displaced occipitalward; they were also compressed. Sharp transition from tumor-mass to cerebral substance could not be demonstrated.

The left cerebellum appeared less bulky than the right; this difference may have been due to the operation at which, it will be remembered (about three weeks before the death of the patient), besides incising the hemisphere a little cerebellar substance had also been removed. There existed, at any rate, a diffuse atrophy of the entire left cerebellar hemisphere; this is not an uncommon condition in chronic diseases of the frontal brain, and it depends upon its connection with the contralateral cerebellum. This is of importance, because it may possibly explain the cerebellar symptoms.

The dura, arachnoid, and pia showed nothing of importance.

### Rotation of the Head and Eyes

Centres for the rotation of the head and for the movements of the eyes have been demonstrated in the posterior section of the second frontal convolution of monkeys. Innervation from one part of the cerebral cortex is responsible for simultaneous lateral movements of the eyeballs to the opposite side. If the cortical (motor) visual centre in the frontal brain be paralyzed, the patient will not be able to look to the opposite side. He will direct his eyes toward the portion of the cortex harboring the morbid focus. The resulting *déviation conjuguée* results from the action of the antagonists. I have cited an observation on page 294, where irritation of the base of the second frontal convolution resulted in a forcible rotation of the head toward the opposite side. With reference to the movements of the eye-

balls, nothing definite could be ascertained. It is generally conceded that irritation of the area containing also the centre of cortical (motor) vision will cause the eye-bulbs to rotate in the direction the head is seen to turn—away from the morbid focus in the cortex. As a matter of fact rotation of the head, in cases of neoplasmata of the frontal brain, has been described to take the direction to the opposite side. Spasmodic rotation of the head and conjugate movements of the eyes may therefore be considered valuable symptoms in the diagnosis of tumors of the frontal brain.

I have seen this symptom develop in a girl twenty-three years of age, after the performance of lumbar puncture. The chaotic symptomatology in this case suggested the puncture. Five cm.$^3$ of clear, non-flocculent, cerebro-spinal fluid, rich in albumin and containing only a slight quantity of sodium chloride, were evacuated. Microscopically it was shown to contain very few red blood corpuscles, still less lymphocytes and a very small number of yellow platelets. Immediately after the puncture the patient complained of violent headache, inclination to vomit and weakness. She had to be put to bed. In the first few hours following the puncture the headaches became more intense. The vomiting was repeated a number of times until the next morning, when the condition of the patient became tolerably good. Four days later, however, the pains recurred, but now in the back of the head. She kept her head turned to the left. The bulbs were turned to the right; nystagmus present. Attempting to look to the left brought the bulbs only to the middle line; complete visual paralysis existed toward the left; in all other directions the bulbs were movable. The right cornea was completely anesthetic; the left reacted. Diadochokinesis was retarded in both hands; more so in the left than in the right. There were manifestations of general cerebral pressure, but no local symptoms; a diagnosis was therefore impossible. After some time the patient died and the post-mortem examination revealed a sarcoma springing from the inner surface of the dura; it was as large as a mandarin, encapsulated, and was located in the posterior section of the right frontal lobe.

The neoplasm has in this case caused an irritation of the centre of rotation of the head and a paralysis of the visual

centre. This was only after lumbar puncture had been performed. In cases of tumor this apparently innocuous little operation has frequently been noted to give rise to an aggravation of symptoms that at times became very threatening indeed.

In neoplasmata of the frontal brain, lasting rigidity of the back of the neck has sometimes resulted from spasmodic contraction of the muscles of the neck and trunk; in these instances they resulted in opisthotonus. Again, these manifestations are similar to those observed in cases of the tumor in the posterior fossa of the skull.

### Neighborhood Symptoms

*Disturbances of Smell. Participation of the Nerves of Vision, the Nerves of the Ocular Muscles and the Anterior Central Convolution.*

As a result of pressure from the tumor the conductivity of the olfactory bulb and tract may suffer on the side the pressure is exerted, and the nearer the neoplasm is to the base of the frontal brain the more likely is this to be the case. Wherever possible the sense of smell should always be tested. Unilateral disturbances of this sense are of great diagnostic importance; it is always of greater significance when on one side than when bilateral. Total anosmia as a diagnostic sign, without other symptoms, is hard to value, since we can never tell what the olfactory condition of the patient has been before he came under observation.

The reason just given is also responsible for the sympathetic involvement of the opticus, in which case (in frontal neoplasmata) choked disc is usually an early manifestation on the side of the tumor. Unilateral blindness sometimes occurs as a result of atrophy. Pressure on the chiasma or optic tract may also lead to the various forms of hemianopsia. Exophthalmus and participation of the nerves entering the orbit (abducens, oculomotorius, trochlearis, parts of the trigeminus) occur in cases where the tumor is of large size. These symptoms are noted more frequently in cases where the tumor springs from the base of the skull.

It will be remembered that the centre of *Broca* is situated in the foot of the third frontal convolution on the left side (see Fig.

85, p. 427). Therefore, tumors involving this area or its vicinity will lead to motor aphasia and occasionally also to agraphia. It is best to refer the reader to the chapter dealing with the question in detail (see p. 426).

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Now taking into consideration collectively everything that has been said, it must be admitted that even with the focal symptoms of tumor of the frontal brain, of which we have positive knowledge, the diagnostic result is indigent in the extreme. It is for that reason that the frontal sections of the cerebrum are justly spoken of as "silent territories." On the right side, conditions are still less favorable because in right-handed individuals the centre of speech is wanting, or at best poorly developed. The clinical manifestations are more abundant when the tumor encroaches upon or is near the anterior central convolution. In these cases the foci of the lower or upper extremity, or the facialis or hypoglossus, become sooner or later involved, depending upon the seat of the neoplasm—superior, middle, or inferior frontal convolution. In these instances focal localization may be attempted with proper reserve. Irritation of the anterior central convolution leads to clonic spasms on the opposite side of the body; these twitchings assume the character of *Jacksonian* spasms. Pressure of the tumor in this locality may give rise to paralyses.

## Neoplasmata of the Central Region

The anterior and posterior central convolution, of which this chapter deals, form the anterior and posterior boundaries of the *Rolandic* fissure. They may best be located by *Kroenlein's* construction (see Vol. I). I should like to emphasize, however, that not one of the methods at present in use in cranio-cerebral localization is absolutely dependable. In markedly long skulls, as well as in short and dome-shaped crania, conditions of course immediately change. This fact should always be kept in mind, and in operating on such individuals the opening into the skull should be made sufficiently large to meet the necessary requirements for thorough work.

Fig. 66, on p. 291, well illustrates the position of the foci for the lower extremity. They are seen to occupy a space near the central fissure of the brain. Foci for the facialis, hypoglossus, etc., are to be found on the operculum *Rolandi* or within its substance proper—hence in immediate contiguity to the *Sylvian* fissure. Between these two and high up, the foci for the upper extremity are to be looked for. Mistakes in locating these anatomic parts are of quite frequent occurrence, however; and I have found abundant evidence of this fact in reoperating on cases that have undergone surgical intervention in other quarters.

Both surgeons and neurologists have for a long time pointed to the motor region as the only region amenable to successful surgical intervention in cases of brain tumor. It was *E. v. Bergmann* who especially adhered to this contention. Two important facts supported that view. First: the entire cortical territory of the cerebral hemisphere corresponding to the convex surface of the skull is easily accessible and operative intervention, therefore, comparatively simple. Secondly, and of still greater importance, is the clear cut symptomatology that betrays existing affections of the sensory-motor sections of the brain. In no other portion of the cerebrum, with the exception

perhaps of the cerebello-pontine-angle, can a focal diagnosis of tumor be made as easily and as accurately as in this particular portion of the brain.

The mere fact, however, that the central area is easily accessible should not be taken too much advantage of, and during the removal of tumors one must proceed with the utmost possible care and gentleness and avoid unnecessary traumatization. Paralyses of motor and sensory nature remaining after operations destroy our therapeutic results.

## Symptomatology

### Unilateral and Bilateral Innervation from the Cerebral Cortex

The motor-foci situated in the anterior central convolution (see Fig. 66, pp. 291, 292) are connected with the pyramidal fibres; and since these cross, they stand in direct connection with the muscles of the opposite side of the body. This exclusively unilateral innervation mainly concerns the muscles of the extremities of the lower facialis and the hypoglossus. Certain groups of muscles receive their impulses from both central regions. These are the muscles of the pharynx and the larynx and the territory of the upper facialis (forehead and eyelids). An exception to this is occasionally noted in the levator palpebræ superioris. The muscles of mastication, the sterno-cleido-mastoid, the upper portion of the trapezius as well as the greater portion of the muscles of the trunk are in most instances supplied from both sides of the cerebral cortex. In focal disease of one central region the muscle groups just mentioned are, as a rule, unaffected, but this, of course, is not always the case, as will be seen later on. The musculus frontalis and the muscle closing the eye are especially weakened by cortical foci. Of visual-motor paralysis and *déviation conjuguée* more is said on p. 530.

### Motor Signs of Irritation and Paralyses

Since the cortical motor area occupies the extensive territory from the sinus longitudinalis down to the *Sylvian* fissure, the development of a neoplasm of fair or even small size will, in the beginning at any rate, sympathetically affect a number of

proximate foci. This means that any motor disturbance originating in the cerebral cortex may at first be limited to one extremity or to a portion of a limb only. This, of course, includes the lower facialis.

The symptoms produced by the tumor at first assume the type of irritations in the form of spasms, and are strictly limited to a greater or lesser portion of a particular limb. The neighboring foci, however, gradually become sympathetically affected until, by encroaching upon a great number of foci, a picture of *Jacksonian* or cortical epilepsy is created. The reader is here referred to the chapter on this subject on page 320, where the physiology has been thoroughly considered. Only an exhaustive and thorough study of the latter enables us to accurately locate the morbid focus.

Since the physiologic arrangement of the foci within the motor area is definite, the symptoms produced by their affection are especially valuable in diagnosing an existing pathologic process when other signs of tumor are wanting. As an illustration of cerebral tumor in which the symptoms of *Jacksonian* epilepsy were in the foreground while all other manifestations of cerebral pressure (headache, vomiting, stupefaction, vertigo, slowing of pulse-rate, choked disc) were absent, the following case from the practice of *Oppenheim*, may well serve the purpose.

## OBSERVATION III, 1

*Typical Jacksonian Spasms without General Symptoms of Cerebral Pressure. Diffuse Glioma of the Upper Central Region.*

The patient, a man fifty-three years of age, retains a scar in the upper portion of his skull that corresponds to the front of the anterior central convolution. This cicatrix is the result of an injury he sustained in 1892 by being thrown with his head against the step of a boat. He first became ill in 1903. On the 12th of October the first severe attack of spasms set in which was preceded by a number of seizures of lighter grade. The spasms are said to have commenced in the right arm, and were here strongest. They occurred at intervals of about two months. The patient bit his tongue and involuntarily evacuated his blad-

der and bowels. *Oppenheim* saw the patient for the first time on the 17th of February, 1904. He suspected a tumor of the motor zone, and his observations yielded the following findings: Occasional attacks of general convulsions that began in the right arm were followed by a period when twitchings would manifest themselves in the right lower limb exclusively. Since July the attacks became more frequent and were of a genuine cortical character; they usually commenced at first in the right lower limb, with tonic then with clonic spasms; after that the right arm and occasionally the abdominal muscles on the right side would also become involved. During the seizures the consciousness remained clear and the speech unaffected. All other symptoms of cerebral tumor were absent. The fundus oculi remained normal throughout. The left parietal region was painful on percussion. After repeated attacks weakness of the right lower limb ensued which was at first transient but later became stationary. In the beginning of August, a flaccid paralysis of the extremities of the right side was noted without participation of the facialis, hypoglossus, or the speech. The paralysis of the right arm was subtotal.

Under the influence of the iodides and a course of mercurial inunctions there was marked improvement of the paralyses. In the beginning of November the spasms recurred; some of these attacked the patient at night, others were accompanied by loss of consciousness. I was consulted on the 14th of November, 1904. At the consultation we had the opportunity to observe an attack. It began with tonic dorsal flexion of the right foot followed by spasmodic extension of the right knee-joint. This was succeeded by volar flexion of the right hand and fingers accompanied by clonic twitchings; flexion of the right elbow-joint and contraction of the elevators of the right shoulder then followed. The tonic spasms were joined with clonic twitchings. The patient, who during all that time was perfectly conscious, complained of violent pains. Symptoms of cerebral pressure were entirely absent. Percussion of the skull was perceived everywhere alike. Deep pressure over the parietal region caused the patient pain. A slight degree of œdema could here be demonstrated and the percussion-note was somewhat different from that of the right side. *Oppenheim* made a probable diag-

nosis of tumor in the region of the anterior central convolution, with which I concurred. I observed the patient until November 17th. The *Jacksonian* spasms became as frequent as nine in an hour.

The operation, performed on November 17, 1904, confirmed the diagnosis. The dura was very tense and showed only slight pulsations. The upper third of the central convolutions was occupied by a glioma which was not encapsulated (compare Vol. I, Plate IX). The operation lasted one and a half hours. A medium quantity of blood was lost. The use of stimulants helped the patient to react, but on the same afternoon he collapsed again and died six hours after the operation was completed.

In cases of tumor of the central convolutions, paralyses, as a rule, supersede the initial spasms; in the beginning the former are of a transitory nature and they may interchange with spasms in a given extremity. In this case it is not unusual to find the affected member in a markedly weakened condition. Even with stationary pareses isolated *Jacksonian* seizures may befall the affected extremity. Transient conditions of asthenia and paralyses of one extremity, or even of an entire lateral half of the body, have not infrequently been seen to occur as an exhaustion phenomenon following epileptic attacks of the *Jacksonian* type.

As the tumor increases in size it destroys the cerebral cortex and the subcortical nerve mechanism. This explains the characteristic paralyses appearing in the form of monoplegias (*monoplegia facialis, facio-lingualis, facio-brachialis, brachialis, cruralis*). The pareses and paralyses develop in conformity with the arrangement of the foci in the cerebral cortex. Since paralyses that have lasted for a longer period always indicate that certain portions of the cortex have been destroyed, they are therefore of greater diagnostic value than are monospasms; the latter may be occasioned by the influences the tumor exercises on neighboring sections of the brain. Paralyses resulting from cortical trouble are of a spastic nature.

That these manifestations may be caused by a tumor of even small size, I will show in the following observation. It is of even greater interest because it shows that in the child cortical par-

alyses not infrequently assume a hemiplegic character from the very beginning.

## OBSERVATION III, 2

*Beginning Small Angioma of the Left Central Region, with Paresis of the Right Side and Bilateral Choked Disc. Ligation and Incision. Cure.*

A ten-year-old boy was admitted to the Augusta Hospital on a suspicion of tumor cerebri by *H. Oppenheim*, on the 4th of September, 1903. The history dates from the beginning of December, 1902, when the patient fell from a chair and landed with the back of his head on the floor. At that time the boy neither vomited nor did he lose consciousness. The first morbid manifestations were noted fourteen days later in the right arm —he elevated it with difficulty; he was also unable to spread his fingers or extend them. A few days later the first spasming seizure was noted; this was succeeded by other attacks, on the average of from four to five a week. These attacks were preceded by an aura that was felt as a sensation of fear and formications in the fingers of the right hand. A few minutes later the boy lost his senses and the spasms began. At first the right arm began to twitch—especially the fingers—then the right half of the face and finally the right lower extremity. The spasms generally lasted about three or four minutes, and on one occasion they continued for a number of hours; in this instance they are said to have involved the left side as well. The bromides have apparently caused an improvement in the spasms; considerable weakness of the right arm, however, still persisted. Lately the right leg was noticed to drag in walking. The intelligence of the boy did not suffer to any appreciable extent. Until the first appearance of the spasms the boy was always normal. His hereditary history was negative.

On the 7th of September his status was as follows: Healthy looking and well-developed boy; organs sound, complains of pain when head is being percussed; this pain is not localized—diffuse. On deep pressure, however, a distinctly circumscribed point of tenderness was discovered—where the occiput, the squamous portion of the temporal bone and left parietal bone

meet. Slight weakness of the right facialis was brought out while the patient was gnashing his teeth; this was rectified upon laughing. Extension of the right arm was very incomplete. The weakness was especially marked toward the periphery—in the hand and fingers. Less marked, yet noticeable nevertheless was the weakness in the right lower limb which the patient was seen to drag after him.

The pupillary reflexes were distinct on both sides; tendon and bone reflexes were in the main exaggerated (patellar-, triceps-, radius reflex), but without noteworthy peculiarities. There was no ankle-clonus. *Babinski* was indicated; inconstant. Sensory disturbances could not be demonstrated.

On the 11th of September, *Geheimrat Hirschberg* found choked disc commencing on both sides, accompanied by marked œdema. Choking of the discs was more distinct on the 18th of September; the excavation was gone, the round form lost, the contour less sharp than normally and on movement there was parallactic displacement. Percussion of the head now caused pain in the above indicated area only.

The boy was operated on September 19, 1903. A cicatrix was found in the middle vertical of *Kroenlein*, exactly 8½ cm. above the upper margin of the auditory meatus. This corresponded to an area situated about 1½ cm. above the lower limit of the *Rolandic* fissure. After forming an osteoplastic-flap (6 : 7 cm.) and reflecting it, its base lay about 7 cm. above the left auditory opening. It brought to view the tense dura which was pulsating in its exposed anterior third only. No differences were found on palpation. A flap was formed of the accessible dura that was reflected.

In the posterior part of the opening of the skull a section of brain (about 4 cm. in diameter) was seen to slightly bulge outward. Over this the veins of the pia were found extremely turgid, distinctly dilated and increased in number. We were evidently dealing with a beginning angioma of the veins of the pia. At the periphery of the protruding brain the veins were doubly ligated and severed. After a number of punctures the section of brain was now split to an extent of about 2½ cm. in length and to a depth of 1 cm.; this was done for purposes of exploration, to determine the presence or absence of subcortical

foci. This having been found negative, the moderate hemorrhage was arrested with pledgets of sterile gauze. The dura was now replaced over the brain surface and the osteoplastic flap sutured into position. The patient bore the operation well. Wound healing per primam. In the beginning of November, 1903, the boy was discharged cured.

In April, 1904, the condition of the patient was as follows: No spasms have occurred since the operation. The intellect of the patient did not suffer in the least. The choked disc disappeared and the fundus oculi was normal. The paralyses existing before the operation have regressed; disturbances in the right extremities at active movements still persisted. In the wrist-joint, extension and flexion were almost completely gone, equally so were the movements of rotation. The patient could flex his fingers only when all digits were moved together —individually they could not be flexed. Extension of the fingers could be performed to a very limited degree only. In the elbow-joint, pronation and supination were executed poorly; extension and flexion were nearly normal. The shoulder-joint could be abducted well; adduction and the movements of rotation were poor. Passively all movements of the right arm could be well executed; a few of these, however, were accompanied by some rigidity. In the lower extremity the disturbances of motion were limited to the foot; dorsal flexion of the ankle-joint could not be accomplished, plantar flexion poorly and the movements of the toes to a limited extent only. On the whole the right lower limb was somewhat weaker than the left.

Slight ankle-clonus on the right side. *Babinski* positive. On the right side the periosteal reflexes of the upper extremity were active: on the left, and in the biceps and triceps, they were sluggish. The senses of touch and pain were normal. The temperature-sense of the fingers and tips of toes on the right side were retarded. The stereognostic sense on the right was only in so far abnormal that while the patient could differentiate between round and cornered objects he could not recognize them.

In this case the choked disc was the deciding factor. Even though a history of trauma preceded the occurrence of the *Jack-*

*sonian* spasms and the pareses following them, another explanation could have been offered for their existence. Judging by the result of the operation, it can hardly be doubted that this extremely small tumor formation in the central region was responsible for the choked disc (may be because it was composed of veins).

In the first volume of this work I depicted and related the operative findings of a very extensive vascular tumor—an *angioma venosum racemosum.* The history of this case follows.

## OBSERVATION III, 3

*Jacksonian Epilepsy. Extensive Angioma Venosum Racemosum of the Pia Mater in the Left Central Region. Very Numerous Deligations. Complete Cure Since Four Years.*

According to the statement of the patient, who is a man forty-six and a half years old, there have never existed any kind of nervous or mental disorders or spasms in his family; one brother, however, is said to be extremely nervous. The patient himself has gone through, while young, measles and scarlet fever which were uncomplicated. When five years old he was injured in the left temple by a flying stone; his wound bled profusely and the remaining scar is very distinct. Potus and lues negatus. Otherwise, until 1890, he enjoyed excellent health. Since that time attacks of dizziness would bother him at long intervals—say about once in six months; the objects around him would at such times appear to jump and twitch; at times his right thumb and index finger would also twitch back and forth. These seizures lasted from a quarter of a minute to one minute; they left no bad after-effects and the patient did not attach any importance to them. In 1893, he got married and is the father of a healthy child. In January, 1893, while pleading before a court of justice, he was seized for the first time with a fully pronounced convulsive attack. Immediately preceding the seizure the patient experienced a sensation of deafness and formications in the right hand which were followed by twitchings. The latter began in the thumb, travelled thence to the fingers of the right hand and advancing toward the trunk affected the entire right arm. After this the

patient collapsed and fell to the floor. Since 1893, the attacks were repeated at intervals of from two to three months in precisely the same manner as heretofore; at one time they were continually absent for quite a long period, and then recurred again with intervals of from four to six weeks between attacks. Not always did they break out in full blast; quite frequently there was only a twitching of the right hand without participation of the arm or loss of consciousness. The sensory disturbances of irritation have in the last year markedly increased. The deafness (temporary) and the formications in the fingers, especially the thumb, index, and middle fingers—less in the fourth and fifth fingers of the right hand—did not only precede the spasms in the form of an aura but there occurred frequent attacks which were of purely sensory nature and during which the peculiar sensation rapidly advanced from the fingers to the hand and then to the arm. They were frequently associated with slight dizziness. In the last years the attacks were preluded by a sense of vertigo, pressure over the forehead or the right half of the head, together with paræsthesias in the right arm. This afforded the patient an opportunity to sit or lie down in time. Thereupon followed strong muscular contractions and twitchings in the right fingers, the hand and the musculature of the shoulder; the spasms then jumped over to the right side of the face. At this juncture the patient was still aware of his lower maxilla being displaced to the right; then his consciousness disappeared. According to eye-witnesses both eyeballs were turned during the seizures upward, the head strongly rotated to the right, and both lower extremities were seen to twitch. While the attack lasted the face was alternately red and pale. Five minutes later the spasm ceased; consciousness returned, however, in from ten to fifteen minutes later.

In 1906, the condition of the patient became worse. The pressure on the right side of the head, above alluded to, persisted for a long time and the patient complained of a sense of paralysis in the right hand and right arm. Immediately after the seizures a transient facial paresis on the right side could a number of times be demonstrated. At nights, especially, the patient would awaken from profound sleep complaining of a paralytic weakness in the right arm, a dull sensation in the lips, twitch-

ings over the right eye, and a sensation as if to utter a sound could only be accomplished at the expense of extreme difficulty. He also noticed that in the last few months he had lost the dexterity of his right hand to a considerable degree; he could not play the piano as readily as heretofore. He could not write, grasp objects, or perform other movements with satisfaction, which caused him to largely abstain from the use of his right upper extremity. At that time a slight weakness was also noted in the right lower limb. In spite of all suffering the memory and intellectual powers of the patient did not deteriorate in the least; yet he was compelled to desist from following his vocation—he was an attorney.

On admission—December 10, 1907—a slight paresis in the region of the right facialis was discovered, the degree of which, together with the manifestations in the right hand, varied on different days. The speech was substantially undisturbed, yet engaging the patient in a lengthy conversation, it could be discovered that at certain words he would hesitate and stutter. Cues and difficult word-connections were remembered by the patient well, and he repeated them whenever asked to without thinking. The tongue quivered strongly upon protrusion. Disturbances of hearing and sight did not exist.

Striking vascular disturbances were noted in the upper right extremity, especially in the hand. It was cold and varied from a red to a blue-red color. Distinct disturbances of motility could here be demonstrated as little as could sensory disturbances (differences between heat and cold, point and blunt, etc.). The stereognostic sense and sense of position were present. Complicated movements, such as buttoning and unbuttoning garments, writing, etc., were well executed by the patient. As previously stated he himself had noticed a growing decline in the dexterity and utility of his right hand for months past. All reflexes were equally strong on both sides and unchanged. There was a slight tremor of the hands, but no ataxia. Sometimes the patient was seen to drag his leg after him when walking. With the exception of a staphyloma posticum, the retinoscopic examination showed nothing abnormal.

On the 16th of December, 1907, the patient was trephined and a cleft was created exposing the brain in the left sensory-

motor region that measured 85 mm. in height and 68 mm. in width. Immediately preceding the operation, while the patient was being anesthetized, he was seized with tonic spasms of the right upper extremity and maxillary spasms, and his respiration became seriously embarrassed. This lasted for about five minutes. The right arm was in tonic contraction; the hand was pronated; the thumb and middle fingers were flexed and the index finger extended *in toto.* During the operation two more attacks of a tonic character were observed.

A globe-shaped elevation protruded about the middle of the cleft, which measured 3 cm. in length, 2½ cm. in width, and about 2 to 3 cm. away from the edges of the bone. The margins of the wound were closed without drainage. After awakening from the anesthetic, the patient reported that his right arm felt weaker; this was found to be true on comparing again the power of both hands. In the following days the strength in the hands was again the same as before. While no more spasms occurred the patient continued to complain of his old paræsthesias in the right hand and right lower limb; on one occasion, at night, the patient described a sensation of paralysis on the entire right side of his body that persisted over half an hour.

On the 23d of December, 1907, the second operation was performed. After reflecting the osteoplastic flap the dura pulsated visibly and was principally seen to dome in the anterior half of the cleft in the skull. You will find an exact description and illustration in the first volume of this work (Plate VIII, p. 88).

Notwithstanding the severity of the operation and the fact that it lasted about one and three-quarter hours the general condition of the patient was affected very slightly. The wound healed undisturbed. I shall now turn to a discussion of the *manifestations of irritation and after-effects* that resulted from the deligation of the veins of the pia and the disturbances of circulation and nutrition occasioned by it.

A few hours after the operation there was an almost total motor aphasia. To every question put to the patient, all he could answer was, "Yes, yes." There was no doubt that he was fully aware of his condition. In the following weeks his vocab-

ulary remained limited to a very few words only. Besides a few other expressions he would call out at objects shown him: "Know, know, O God! yes, yes." It was impossible for him to read aloud or repeat even a single word. In uttering the few expressions he knew he resorted to considerable "perseveration." While his understanding of words was on the whole unaffected, a thorough examination uncovered, in this respect, undoubted defects. If different utensils were shown him and their names correctly uttered he affirmed their identity by saying "yes." Sometimes he hesitated in his decision or quickly changed it. He frequently made use of the sense of touch of his left hand to aid him in forming an opinion. After so doing he did not change it. When objects before him were named he pointed them out correctly; he also executed simple orders at once and with precision. He soon learned to communicate his wishes and make himself understood by his nurse and physicians by means of signs he executed quickly. At the examination, made a few days after the operation, he understood written and printed composition fairly well. He almost invariably executed written orders at once. Strictly speaking, there existed no agraphia, even though his handwriting was clumsy and distorted as a result of the existing sensory and motor disturbances that are hereafter described.

As early as the second week after the operation the motor aphasia tended to regress to a slight degree; and the third week after the operation the patient was able to repeat simple words as bed, chair, etc. At that time marked "perseveration" was noted, during which words spoken were awfully distorted; for instance, "bed, bed, bed, bed, bes, besh, besh," and so on. In the next week his entire vocabulary gradually returned. A few months later, during lengthy conversations, a slight difficulty in expressing syllables, or a little trouble in finding certain words, was noted—a state similar to that existing before the operation. He now asserts that he experiences no difficulty whatever in conversing fluently or to enjoy himself in company.

Of the cerebral nerves only the trigeminus and facialis showed disturbances after the operation. With reference to the former there existed a distinct reduction in the sensibility of the right half of the nose, in the right lower eyelid, on the right

cheek to the anterior border of the masseter muscle, in the right upper and lower lips and half of the lower jaw, exactly to the median line and finally in the right half of the tongue. All the contacts made in these localities were described by the patient as blunt or dull. The sensibility of the forehead remained unaffected. After the operation there also existed a marked hypo-reflexia if not an areflexia of the cornea. A few weeks later, the hypo-reflexia of the cornea had almost entirely disappeared, but a distinct difference could still be demonstrated for a number of weeks, when compared with the other eye. The hypæsthetic regions in the right half of the face were on the whole diminished. On the 8th of April, the sense of touch on the right half of the nose and in the portion of cheek adjoining it was found to be somewhat reduced.

Immediately following the operation, the right oro-facialis was found to be completely paralyzed. The patient had to eat carefully, as the food would otherwise fall out of the right angle of his mouth. The ocular and forehead branch, while less affected, were nevertheless markedly paretic. This severe paralysis lasted a few days only and then subsided. A slight paresis of the right oro-facialis, mainly visible when the patient was speaking or laughing, could still be demonstrated on the 8th of April, 1908. This was hardly discernible when at rest.

No disturbances of motion or sensation of any kind were demonstrable in the trunk, in the left upper and in both lower extremities.

While on the day of the operation and on the following day, the upper extremity appeared to be somewhat weaker than the left, the patient could nevertheless use it freely and perform all movements with it. On the second day the movements of the right shoulder and elbow joints could be executed fully but somewhat awkwardly and with reduced power. The movements of the right wrist-joint (pro- and supination, dorsal and volar flexion) were also possible, but the range of motion was much restricted and the power markedly diminished. Combined movements of the fingers, such as flexion and extension, were executed weakly. Single movements, on the contrary, could not be performed at all. The movements of the right hand were ataxic. The sense of position of the right wrist-joint and the

joints of the fingers were much disturbed. On the right side the stereognostic sense was completely gone; even large objects, such as a matchbox and the like, could not be recognized by the patient. Distinct disturbances of touch and pain could not be demonstrated. I should again like to emphasize, however, that on account of the existing motor-aphasia and the somewhat difficult comprehension of speech the examination of the patient was quite a hard task.

The motility returned quickly. As early as the 29th of December, 1907, all movements of the joints of the right hand and fingers, while still reduced in power, could nevertheless be executed quite well and unrestricted. The fingers, however, could not be moved singly, and attempts at complicated motions betrayed marked incoordination. A few weeks later only a slight reduction of power was present, and the disturbances of motility then present were entirely due to the existing sensory abnormalities. On the 8th of April, 1908, outside of a decided tremor no other disturbances of motion could be demonstrated. The patient stated that he could use his arm just as well as before the operation. He could not, however, play the piano as well as before, and his handwriting was still wavy.

The sense of position of the fingers and of the right hand improved gradually, but three weeks after the operation it was still noticeably disturbed. This abnormality was noted, on the 8th of April, 1908, to have completely disappeared.

In the course of six weeks the stereognostic sense returned; on the 8th of April, 1908, however, the patient could still recognize objects better and with greater certainty with the left than with the right hand.

The disturbances of localization were at this time still considerable. Four weeks after the operation, the patient still mistook one finger for another, and, when the back of his hand or the palm were touched, he pointed to parts quite distant from the points tested. There were differences ranging from 10 to 12 cm. On the 8th of April, 1908, the sense of locality was still abnormal. On the hand and fingers distinct errors were committed by the patient; this was not the case on the left.

While in the first days after the operation, disturbances of the senses of touch and of pain could not be demonstrated with

certainty, on the sixth day the patient asserted that the sensation in the right fingers and hand, as far up as the elbow, was different from that of the left, i.e., it was duller. He nevertheless perceived all contacts. On the 3d of January, 1908, a distinct reduction of sensation was demonstrable. This regressed in a few days and the subjective sensory manifestations in the forearm, hand, and fingers also improved. Needle-pricks, in the thumb and index finger of the right hand, were perceived by the patient April 8, 1908, as slight dull sensations.

There also existed a slight degree of transitory hypotonia in the joints of the upper extremity.

The result of the operation encouraged the patient so much that four weeks later he requested me to operate on him under local anæsthesia for a hydrocele of the spermatic cord (January 22, 1908). Eight days later he left the sanitarium.

The last seizure with spasms occurred during the first operation (December 16, 1907). After this, real spasms did not occur for two months. In the days immediately after the operation there occurred twitchings in the right half of the face a few times at night. During the night of the 29th of February, 1908, there occurred a slight seizure of short duration, that manifested itself in the right side of the face, but it was not closely observed. Two other attacks of milder degree were observed on the 7th of April, 1908. During an examination on the 20th of April, 1908, the patient complained of a general uneasiness and of a sense of pressure on the right side of the forehead that extended up to the parietal region. The color of his face frequently changed from blue to red and vice versa. There further existed a peculiar sense of weakness in the right upper limb, which began in the thumb and then extended to the hand and to the lower half of the forearm. The patient described it as "a peculiar sensation seated on the surface of the skin." Slight twitchings in the lower facial region occurred a few times; they were unaccompanied by loss of consciousness. Otherwise the patient felt good and appeared well nourished. These disturbances have also almost completely disappeared.

The last examination was made on the 17th of March, 1911. At that time the patient looked the picture of health. Mentally he was perfectly normal. His general condition was excel-

lent. In ordinary conversations his speech was entirely undisturbed and only when he was laboring under severe psychic excitement did a slight awkwardness of speech become apparent. Occasionally, say on the average of about every three or four weeks, the gentleman would perceive a strange sensation—as though he were dead. Similar but much stronger manifestations of sense-abnormality were noted by the patient before the operation had been performed; they commenced in the right hand, and at once appeared in the right angle of the mouth and in the right half of the tongue. There was also a peculiar twitching perceived by the patient in the angle of the mouth, but invisible to the observer. On the right half of the tongue exclusively the patient at times perceived a metallic taste. As soon as these peculiar manifestations appeared in the angle of the mouth and in the tongue the right hand at once became free from disturbances. A peculiar prickling sensation would at times remain in the right thumb, which would last about a minute or a little longer. When all these disturbances, after persisting for a few minutes, disappeared, a non-painful sensation of pressure would be perceived by the patient above the forehead. This would sometimes be connected with transitory pain in the region operated upon—the left central area. There was a non-osseous union in the trepanation-valve. It was neither sunken in nor did it project above the level of the surface of the cranium. There existed a distinct valve formation. Over this, slight cerebral pulsations were visible. At its anterior border the superficially situated and very tortuous branch of the temporal artery was visible, and in it a soft systolic murmur could be heard. There were no further spasms or muscular twitchings of any description since the Easter of 1908.

The examination of the nervous system showed no abnormalities. The stereognostic sense and the sense of position of the right hand and fingers were also normal. The patient stated however, that the mobility of the right hand was "a shade weaker" than that of the left, and that the sense of touch on the point of the right index finger appeared to him somewhat blunter than that on the left side; this, for instance, could be clearly demonstrated when the patient was taking coins from his purse.

The appearance of spasms are generally regarded as characteristic manifestations of a new-growth developing in the central region. However, even in cases of extensive cortical invasion, I have seen them entirely overshadowed by the resulting paralyses as shown in the following case.

## OBSERVATION III, 4

*Sarcoma of About the Size of a Fist in the Upper Section of the Left Central Region. Enucleation. Cure.*

Man, forty-four years of age, with negative family history, states that he had always enjoyed good health hitherto. In the winter of 1905–6, his wife noticed that he became excited and irritable at times, and apathetic and indifferent on other occasions. The patient himself began to complain of occasional dizziness and pain in the temples, and when arising in the morning it frequently took him some time to regain his own self. In March, 1906, while eating his dinner, he was suddenly seized with a violent spell of vomiting. In May, there commenced a gradually increasing weakness in the right lower extremity and in the right arm, in which there occurred occasional and barely perceptible twitchings. As a result of this, the patient found difficulty in writing, and at the end of July he was seen to drag his leg after him when walking. A course of inunctions of 150 gm. of gray ointment at first apparently produced an improvement in the symptoms. It soon, however, became aggravated again. After completing the inunction cure, *H. Oppenheim,* at the end of October, 1906, found the following condition:

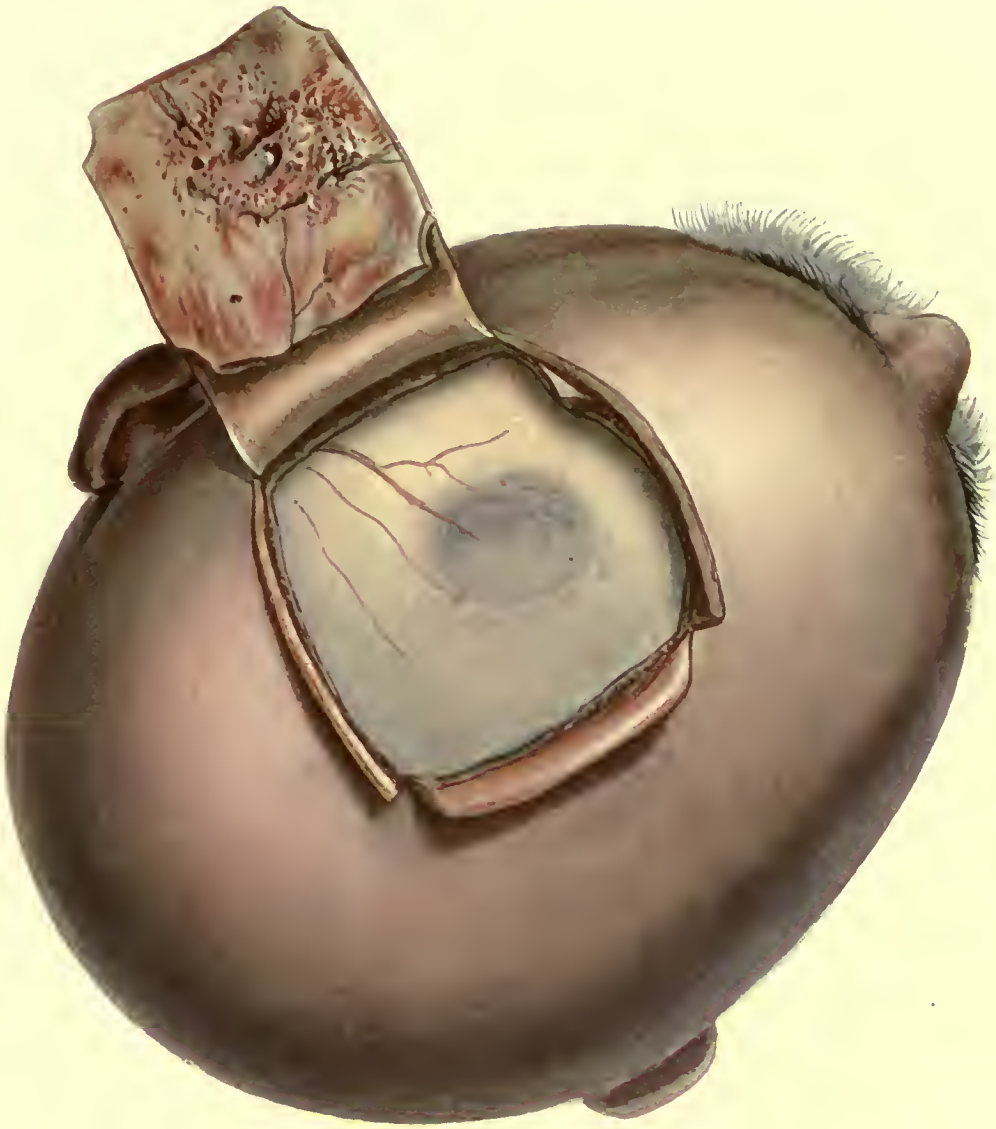
"The state of nutrition of the patient was good. He dragged his right leg when walking in a spastic-paretic manner. Sensitiveness on pressure and differences in the percussion of the skull did not exist. The movements of the eyes were free. No nystagmus. Pupils reacted well. Corneal reflex present. There was double optic neuritis, more pronounced on the right than on the left. The right facialis (oro-facialis) was somewhat paretic. The other cranial nerves showed nothing abnormal. There was a spasticity in the right hand; its fingers were flexed and could not be moved. The tendon-reflexes of

the right upper extremity were highly exaggerated; the coarse power of this arm was far behind that of the left, and this was also true of the right lower extremity as compared with its opposite fellow. The right patellar reflex markedly increased. Ankle-clonus, a trace of *Babinski* present on the right. While the paresis extended over the entire right lower limb, it was most marked in the muscles of the foot and toes. Sensory disturbances and disturbances of the temperature sense (cold and heat) and abnormalities in the sense of position did not exist; neither were there any other digressions from the normal."

In the following fourteen days this condition changed only in so far that in addition to it there developed a spastic paresis of the entire right arm and shoulder-joint. These were accompanied by disturbances in the sense of position of the right index finger and in that of the right big toe. The tendon phenomena on the right side were extremely heightened and amounted to clonus; there also existed a tendency to tonic tension of the extensor hallucis longus. On the right, the *Babinski* phenomenon became more pronounced.

*Oppenheim* made a diagnosis of tumor in the region of the left lobus paracentralis and the adjoining portion of the anterior central convolution. It was also considered possible that the neoplasm originated somewhere in this vicinity—say in the posterior portion of the frontal lobe.

*Neisserian* punctures (see Vol. I, pp. 236 to 243, and Fig. 55) were carried out on the 15th of November, 1906, in the region of the anterior central convolution and over the centres of the arm and lower limb. Since this disclosed the presence of a sarcoma, I at once proceeded to form an osteoplastic flap, the base of which was directed downward. The flap was overlying the left central area. The anæsthetic used in this operation was a combination of chloroform and oxygen. In the centre of the brain area thus exposed the dura was adherent to the tumor, and for this reason it was thought best to remove the bone. The lamina vitrea of the same was strongly altered (see Plate XXXIV). Strips of gauze were permitted to remain for a few days on the surface of the profusely bleeding tumor; the skin flap was replaced and sutured. It was only after fourteen



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days that the patient had recuperated sufficiently to withstand the second operation (December 1, 1906).

After the skin flap was reflected, the dura was seen to bulge

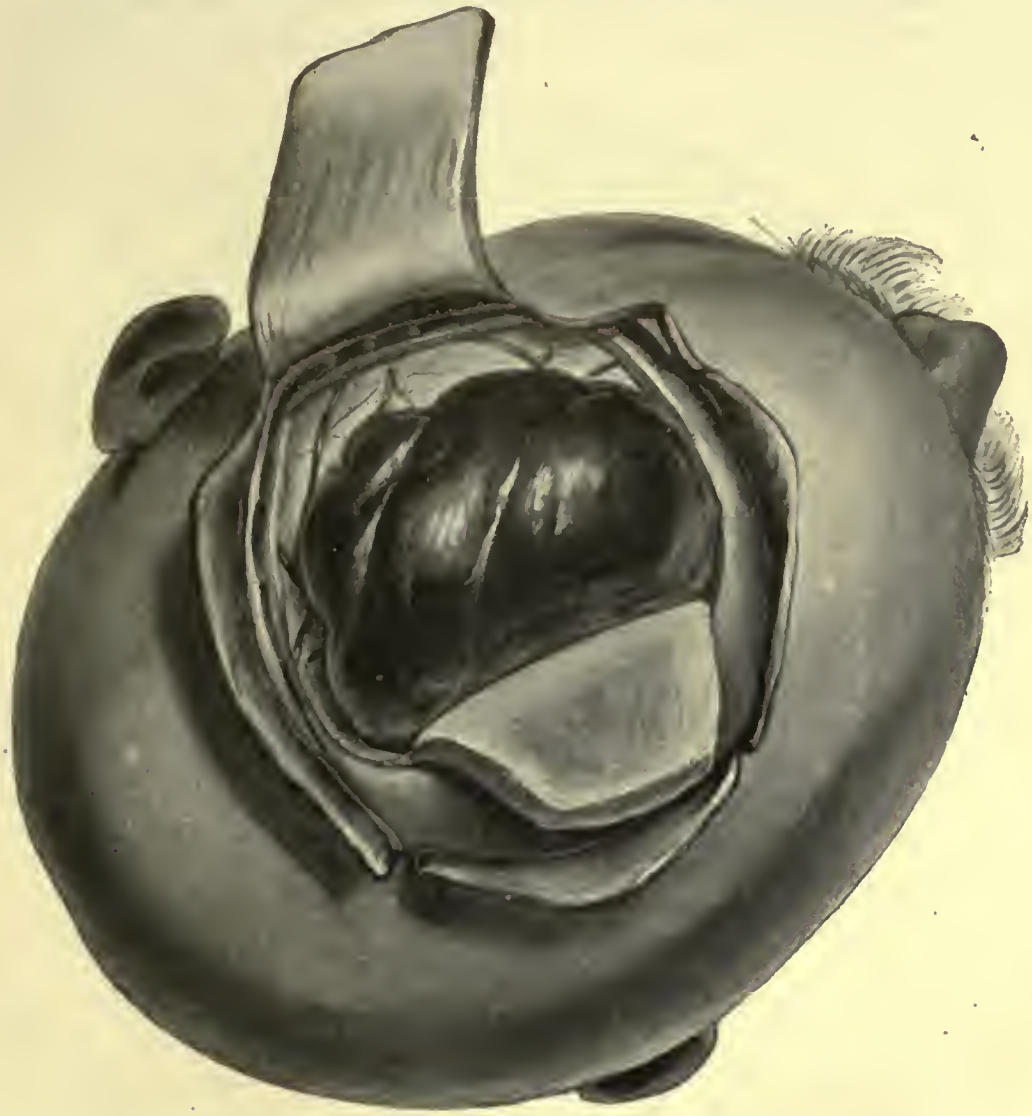


Fig. 101

out very forcibly. The dark, blue-red tumor was visible in the entire extent of the exposed and translucent dura. (See Plate XXXIV.) Since the limits of the neoplasm were not visible,

proved. He was also able to execute slight active movements with his right foot and toes. The right arm, on the contrary, still remained paralyzed. Brush contacts were here as yet erroneously located; there was also a marked reduction in the temperature sense.

Later on the speech improved remarkably well, so that at his departure (March 13, 1907) the patient was able to converse without a flaw. Only during psychic excitement did he stutter, and this, of course, is to be looked upon as a purely functional condition. The field of operation was somewhat flatly convex, for it should be remembered that in this case the bone and dura alike had to be extensively removed. Outside of the aforementioned paralytic disturbances the patient showed no other abnormalities. A letter dated September 14, 1907, informs us that he is in good condition. On the 9th of November, however, the patient was killed by a falling beam.

### Symptoms of Sensory Irritation and Paralyses

The sense of position, the sensation of movements and senses of locality and space are mainly represented in the posterior central convolution. Their arrangement (face, extremities) is similar to that of the foci and centres in the anterior central convolution. The senses of touch and pain extend unto the anterior portion of the upper parietal lobe (see Fig. 95).

Neoplasmata of the middle third of the posterior central convolution and of the immediately contiguous portion of the lower parietal lobe (see Fig. 95, p. 507, No. 7, red) will cause *tactile paralysis* (*tactile agnosia*). This represents a cortical symptom. Tactile anæsthesia may also result from conditions interfering with the spinal conduction and declares itself in that the tactile impressions—that are naturally to be tested with relative intact sensations (tactile sensitiveness, sense of location, of position and muscle-sense)—are either indicated wrongly or are not recognized at all. This symptom is explained by a loss of the power of tactile imagination that creates conceptions of objects from the wealth of cerebral perceptions. If the power of perception of form of objects by touch be lost, the condition is spoken of as *astereognosis*. To test the stereognostic function—which may also be disturbed by paralysis

of the peripheral nerves—the motility must be sufficiently preserved to enable the patient to palpate. The complicated manner in which objects are recognized is effected by the joint action of the various forms of sensation (tactility, muscle-sense, joint-sense, temperature-sense) and the compound sense or rather experience of motion. A person able to move his hand and fingers normally will recognize objects placed in the palm of his hand much better by palpation than if they were simply placed there or rolled about.

In new formations of the central region motility and sensation are sympathetically affected alike. Corresponding to the spasms there occur symptoms of sensory irritation, and these may be the only manifestations from the beginning of the trouble to the time of the operation. The manner of their first appearance and progress occurs, in some cases exactly as *Jacksonian* spasms and are then uncommonly characteristic. Such a case has been related in Observation I, 5, p. 330.

Tumors originating in the posterior central convolution at first produce sensory disturbances; motor phenomena consequent to the involvement of the anterior central convolution, occur later. The location of the anterior central convolution can be ascertained, during operations, by means of faradic irritation only. (See chapter on "*Epilepsy.*") We remain entirely in the dark if faradization of the motor area fails—as is frequently the case in tumors of this locality. A case in which the post-mortem examination showed the posterior central convolution to be exclusively involved and in which during life the clinical symptoms pointed to an affection of that region, deserves mention at this time.

## OBSERVATION III, 5

*Tumor of the Middle Portion of the Right Posterior Central Convolution. Trouble Began with Sensory Disturbances of the Left Hand.*

Six months prior to her admission to the hospital (February 4, 1905) the first symptom noted by the patient, who was forty-nine years old, was a frequently occurring paræsthetic-feeling in the left hand. For a long time this formed the only clinical manifestation. A few months later involuntary twitchings were

observed in the same hand. Soon thereafter a convulsive seizure set in that commenced in the fingers, soon extending to the left arm, and finally involving the left half of the face. In connection therewith there gradually developed a paresis that manifested itself at first in the left arm, then in the left lower limb, and lastly in the left half of the face. Twitchings of the left hand occurred until recently. These motor phenomena of irritation decreased in intensity as the paralyses became more intense and extensive. Outside of the statement of the patient that she was a continual sufferer from moderate headaches, the anamnesis disclosed nothing of importance.

On admission the patient complained of a tearing pain in the right lower extremity and on the right side of the neck, and of a paralysis of the left half of the body. The persistent moderate headaches were partly located in the forehead and partly in the parietal and occipital regions. Percussion of the skull showed the right parietal region to be more sensitive than the left. Vomiting, high-tension pulse, vertigo, tremor, and other general symptoms were absent. The examination of the fundus oculi disclosed pronounced double choked disc; this was more marked on the right than on the left side. The entire left facialis, as well as the left hypoglossus were paretic. The patient kept her head strongly rotated to the left and somewhat tilted to the front. Further movements of the rotation and bending were well executed on the left side, and with difficulty on the right. Disturbances of speech could not be demonstrated. The left arm hung limp; active movements were totally wanting, while the execution of passive motions met with no resistance. The musculature of the left side of the back was more flaccid than that of the right, yet differences in the movements of both sides could not be detected. In the left hip-joint the movements of inward rotation and flexion were restricted; active adduction and abduction were impossible; flexion of the left knee was executed with lessened power. In the movements of the joints of both feet and toes no difference could be noted, despite a reduction in the coarse power of the left foot. On account of the paralytic condition of the left lower limb, the patient could neither stand nor walk. When she attempted to sit up in bed she invariably fell over to the left side. The

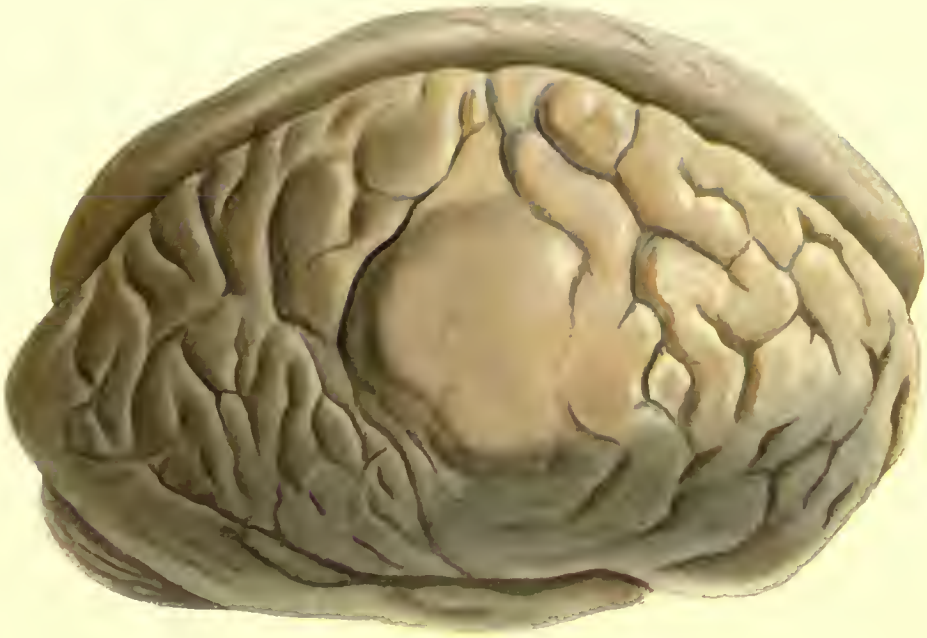


Fig. a.

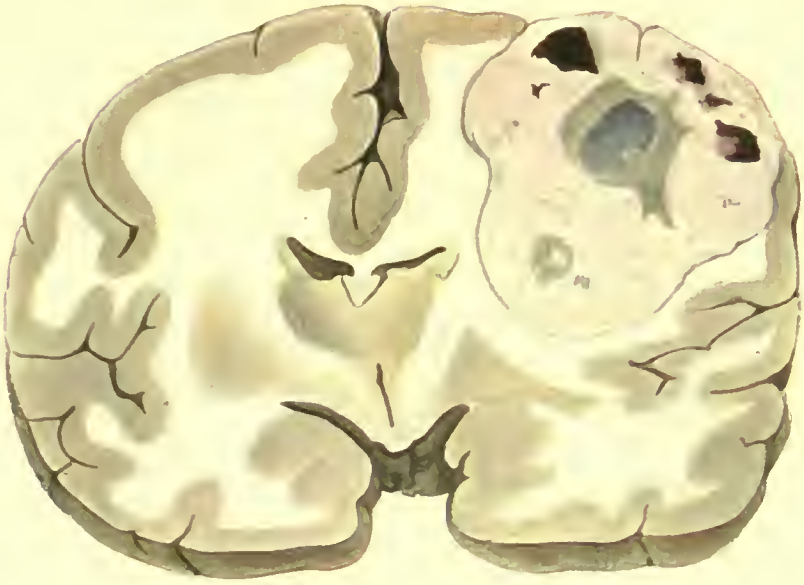


Fig. b.

reflexes of the left triceps and radius were exaggerated. The protests of the patient did not permit a thorough examination of the sensory conditions of the arm and the body generally.

We made a diagnosis of neoplasm of the right central region that originated in the posterior convolution in the region of the centre of the hand. Notwithstanding the exact diagnosis, operation was not thought advisable on account of the asthenic condition of the fat patient, her weak, small, and irregular pulse that ranged from 80 to 90 beats per minute and her peculiar weak appearance. She died a week after her admission from cardiac failure, complicated by pulmonary œdema.

The post-mortem examination (*Professor Oestreich*) showed, besides a flabby myocardium and adhesions with shortening of the mitral valve, a beginning broncho-pneumonia of both lungs. On the brain (see Plate XXXV, Fig. a) the *Sylvian* fissure could be distinctly recognized even before the pia was removed. The much-widened and decidedly prominent posterior central convolution was now visible. It was about the size of half a dollar. The gyrus supramarginalis, together with the end of the *Sylvian* fissure, were compressed and displaced temporalward.

Frontal section through the height of the tumor (see Plate XXXV, Fig. b) showed it to be distinctly surrounded by a capsule. This was not the case on its convex surface. It projected greatly into the right hemisphere, and reached exactly the summit of the island of Reil with its pointed portion. The island, together with the large ganglia and the white substance of the brain, were compressed by it into the form of an arch. The resulting downward displacement of the corpus callosum, to an angle of 45 degrees, caused the lumen of the anterior cornu of the lateral ventricle to appear narrowed. The internal capsule was almost horizontal. The lenticular nucleus, which under normal conditions is directed with its point upward, was transformed from the pressure to a narrow ribbon, one end (the one corresponding to the point) of which was still displaced underneath the island.

Besides many other details, there finally existed an excavation of the entire right hemisphere of the brain that reached over to the fissura longitudinalis toward the left hemisphere.

Apart from the fact that, in this observation, the tumor was demonstrated to belong to the posterior central convolution, the case is also of importance because, as a result of the irritation of the centre at the foot of the second frontal convolution (see Fig. 95, p. 507, No. 1, red), there existed a strong continuous rotation of the head of the patient toward the opposite side as a neighborhood symptom, during the entire eight days she was at the hospital.

At other times again, the motor pareses and paralyses of the extremities are associated with sensory paralyses of slight degree only; of course, in that event the deep-seated sensibility is then, as a rule, more profoundly affected than is the sensation of the skin. Disturbances of the sense of position and of stereognosis as well as ataxic manifestations will then ensue. A considerable participation of the sensibility in the clinical picture justifies the conclusion that either the posterior central convolution or the subcortical fibres leading to it are affected by the tumor. In cases where only the anterior central convolution is affected, only deep-seated sensibility seems to suffer. However, pure

### Apraxic Disturbances

mainly occur in neoplasmata of the left parietal lobe. This may also be the case in tumors of the central convolution and the centrum vemiosale when total paralysis of the upper extremity has not as yet resulted. Even then the left hand frequently shows dyspraxic disturbances. The following observation serves as an example.

## OBSERVATION III, 6

*Solitary Tubercle of the Middle Portion of the Posterior Central Convolution. The Disease Began with General Epileptic Seizures Accompanied by Loss of Consciousness. Besides the Other Symptoms there was also Right-sided Apraxia. Death One Month After the Operation from Rapidly Progressing Pulmonary Tuberculosis.*

The patient, thirty years of age, suddenly became ill in March, 1907, with spasms in the face, both hands and feet. These were preceded by unconsciousness. The spasms were at

first thought to be of an epileptic nature. The attacks became more frequent and would sometimes occur a few times in a day. In the intervals between attacks no disturbances existed. In July, 1909, the right half of the face became paralyzed, and three months prior to the admission of the patient to the hospital (January 3, 1910) she noticed a progressively increasing weakness of her eyesight. At times she would suffer intense headaches over the left eye and in the back of the head. It is to be noted that for the last year and a half, while the patient was at work (she was an embroiderer) she was impressed with the gradually declining dexterity of her right hand and the needle would occasionally fall out therefrom. Both of her pulmonary apices were involved.

Our examination, made January 12, 1910, disclosed an attenuation of the sense of smell on the left side. There also existed choking of the discs on both sides—stronger on the left. Only the left pupil did not respond to the direct reaction of light. The reaction of convergence was diminished. The sight of the left eye was almost completely extinguished; in the right eye it was reduced to counting of fingers at a distance of 2 metres. Besides a right-sided facial paresis, the examination of the cranial nerves also disclosed an areflexia of the left cornea and hypæsthesia of the left half of the face. On moving the knee-joint of the right lower limb it showed slight weakness, and the presence of the *Oppenheim* reflex. Typical ataxia on standing or walking did not exist; the perceptible uncertainty was rather due to the existing visual disturbances. Symptoms of aphasia were absent.

The state of the right hand was indeed remarkable. The coarse power was not reduced in either the hand or arm; the hand-shake was as powerful as that of the left hand. Upon forceful downward pressure of the elevated right arm there was perhaps somewhat less resistance offered than on the left side. Sensory disturbances and ataxia of the right hand could be demonstrated only to a very slight extent, and even then we were not always certain of their presence. However, every attempt to button the wearing apparel with the right hand caused the patient great difficulty. Movements of expression and purpose, such as winking, threatening, snapping of the

fingers and kiss-throwing were likewise executed with extreme awkwardness. On account of the existing blindness the test of imitating movements was rendered difficult; however, testing for adiadochokinesis disclosed the fact that the ability to imitate movements was preserved, even though the same inaccurate and clumsy execution of the motions just spoken of resulted.

It therefore appears that there existed, in the right upper extremity, in addition to extremely slight lesions of sensibility and motility, disturbances at attempts of complicated movements which were not of an ataxic character. We were, therefore, dealing in this case with *apraxic disturbances* which *Liepmann* has described as *limb-kinetic apraxia.* While the mental design to perform certain movements was undisturbed—which was also true of the transfer of the plan of movement to the centre of the limb (in the sense of *Liepmann* neither ideo-kinetic nor ideatory apraxic)—the movements proper were performed awkwardly, with difficulty, and without precision—very much like some one who is attempting to perform a certain difficult movement for the first time. The self-possession of the centre of the limb to kinetic recollections was destroyed; hence the existence of a limb-kinetic apraxia.

Since such disturbances usually result from slight lesions that do not lead to total paralysis of the centre of the hand on the left side, and also taking into consideration the other clinical manifestations, I made a diagnosis of tumor in the region of the left posterior central convolution.

Following trepanation of the central region on January 14th, the radical operation was continued on the 26th of the same month. A flap of dura was formed which was closely adherent to the inner surface of the tumor to the extent of the breadth of a finger, while the rest of its surface lay freely exposed on the cerebral cortex. The finger was used in enucleating the fairly firm and well-encapsulated tumor. The medullary layer of the brain was now visible, and with the exception of a place the size of a phalanx that was a few millimetres thick, it was found normal. This area was removed with the scissors.

The tumor was the size of a small plum and occupied a space in the median portion of the posterior central convolution. It

had displaced the anterior central convolution and the parietal lobe. To all appearances we were dealing with a fibrosarcoma that originated from the inner surface of the dura or the arachnoid. However, the microscopic examination proved it to be a solitary tubercle. The wound healed well. Unfortunately, the pulmonary symptoms rapidly increased, and on the 28th of February the patient died from exhaustion.

The autopsy (*Professor Dr. Oestreich*) showed extensive tuberculosis of the lungs and the mesenteric glands. No other tuberculous foci were found in the brain. In the area operated on, a thin section of cerebral substance, partly reddish and partly of a brownish-yellow color, was found, the consistency of which was not much different from the surrounding normal cerebral tissue. The defect resulting from the operation occupied a position mainly in the middle portion of the posterior central convolution.

### Subcortical Tumors

I have frequently observed in cases of subcortical glioma the convolution covering the neoplasm to be of a peculiarly yellow color and, in one instance, it was very much widened. In a rare case of metastatic hypernephroma, situated subcortically in the motor area, the entire region imparted to the examining finger a peculiar sense of fluctuation.

In neoplasmata of the cortex of the central region, *Jacksonian* seizures are the rule; they occur less frequently in tumors developing subcortically and are here often entirely absent, especially in instances of diffuse gliomata. Nevertheless, tumors of even exclusive subcortical location may cause typical motor and sensory symptoms of irritation. An example follows.

## OBSERVATION III, 7

*Subcortical Glioma of the Central Region Contained in a Hemorrhagic Cyst. Sensory and Motor Symptoms of Irritation Followed by Paralysis. Death in Collapse.*

The patient, a woman, forty-nine years old, had always enjoyed excellent mental and physical health. On one occasion, three months prior to her admission to the hospital, she

suddenly became conscious of formications in the left hand, followed by twitchings in the left thumb, and soon thereafter the patient fainted. She remained unconscious for five minutes, after which a sense of bluntness and disturbed motion in the fingers of the left hand was perceived by her. A few days later these disturbances disappeared and the motions, as well as the sensory conditions, regained their normal state. After the attack, the woman, although completely recuperated from the seizure, was constantly dominated by the fear of an approaching second attack. In fact such an attack did set in, five weeks later. The relatives of the patient attributed its occurrence to a certain mental excitement. This second seizure was observed by a sister of the patient. While the woman was quietly sitting on a sofa she noticed formications and twitchings in the left thumb, and, as on the former occasion, she soon fainted. Real convulsions, however, did not occur. Following this second attack there remained a sense of weakness in the left arm. The patient became very irritable. After five weeks a third and similar attack was observed; but this time the patient did not lose her senses entirely.

Paralysis and anæsthesia of the entire left upper extremity is said to have followed the last seizure. The anæsthesia gradually disappeared, so that at the time of my examination sensation was normal again. The paralysis, on the other hand, remained unchanged. In the last week there occurred pains and swelling of the phalangeal joints of the left hand. Headaches existed only occasionally. Of late the patient complained of vertigo when suddenly rising, and that her sleep was disturbed. No urinary and bowel disturbances were complained of. Her menses were normal.

I was called in consultation by *Sanitaetsrat Jastrowitz* on the 27th of October, 1903. He made a probable diagnosis of cerebral tumor located in the right central convolution. The possibility of hemorrhagic extravasation was not lost sight of, yet corroborative evidence thereof could not be discovered upon examination of the heart or bloodvessels nor from the anamnesis. The ophthalmoscopic examination was negative outside of a certain blurring of the median border of the left papilla. Choked disc and heightened arterial tension were absent.

The nervous status showed the following changes: The left upper extremity was in a state of flaccid paralysis. Active movements of the shoulder, elbow, hand and finger joints were entirely absent. The patient could elevate the arm slightly by means of the shoulder-blade. Rigidities could nowhere be demonstrated. Passive movements of the left elbow, hand and finger joints caused the patient severe pain. The periosteal and tendon reflexes of the left upper extremity were found exaggerated as compared with those of the right side. No other digressions from the normal were found. No *Babinski.* At present, no twitchings or spontaneous contractions could be discovered in any portion of the body musculature. This was also true with reference to the sensory conditions. Finally, a very slight paresis of the left lower facialis could be shown to exist. Percussion over the area of the right central convolution showed greater sensitiveness than any other portion of the convexity of the head.

I operated on the 30th of October, 1903 (compare Vol. I, Plate X, p. 96). A flap of dura (pulsating in its posterior third only) was formed and reflected. The exposed cerebral surface at once brought to view a suspicious-looking domed area (marked X, on Plate X) that distinguished itself from the surrounding brain-tissue by its yellow color. Unipolar faradization of this region (large electrode, 70 $cm^2$., applied to upper-inner surface of left thigh) with the patient superficially narcotized, at once caused twitchings of the left thumb which were soon associated with twitchings of the left index finger so that index and thumb were snapping against each other, finally assuming a position of opposition, in which attitude they persisted. This was followed by flexory movements in the other fingers and in the wrist-joint and forearm. The spasmodic contractions continued even after the electric irritation was discontinued and disappeared only after two minutes. Since these particular spasmlike twitchings occurred in the totally paralyzed left upper extremity (hand, forearm) they could, in spite of the superficial anæsthesia, by no means have been of the active kind.

Puncture of this area to a depth of 2 cm. yielded 5 $cm^3$. of a clear sero-sanguineous fluid. The evacuation of a like quantity of the same kind of fluid followed an incision over the highest point of the dome (see Fig. b, on Plate X). Before the incision was

made the veins of the pia were, of course, ligated. After dividing the cortex to an extent of about 4 cm., my finger entered a cavity, the exploration of which disclosed (in its depth toward the front below) the presence of a spherical, smooth tumor of about the size of a walnut. The smooth-walled cavity resulting from the evacuation by puncture was (measured from the cerebral surface) 4 cm. deep. The surrounding cerebral substance was discolored yellow and soft in consistency. The palpating finger clearly felt the difference between the firm consistency of the tumor and the soft feel of the cerebral structure. The tumor could be easily removed with the scissors. During its removal the lateral ventricle was not entered into. After its removal the tumor measured (Fig. b, Plate X) 30 mm. in length, 25 mm. in width, and 15 mm. in thickness.

The cavity remaining in the brain was now filled with gauze strips, the dural flap reposited and the wound sutured in front and above; it was left open posteriorly to permit the gauze tampon to pass.

The operation was performed in one sitting and lasted about an hour. The pulse was always of good volume, not accelerated and regular. The respirations were also normal. Immediately after awakening from the anæsthesia, the patient was in the best possible condition. She squeezed the hands of her son and son-in-law and conversed with them. Pulse slow, 96. This excellent condition lasted until the next morning. Soon, however, the pulse increased to 132 beats per minute, and it became small and thready. At 12 o'clock noon, twenty-four hours after the operation, the patient died, with all symptoms of cardiac failure. To my regret autopsy was not consented to.

The examination of the tumor proved it to be a glio-sarcoma.

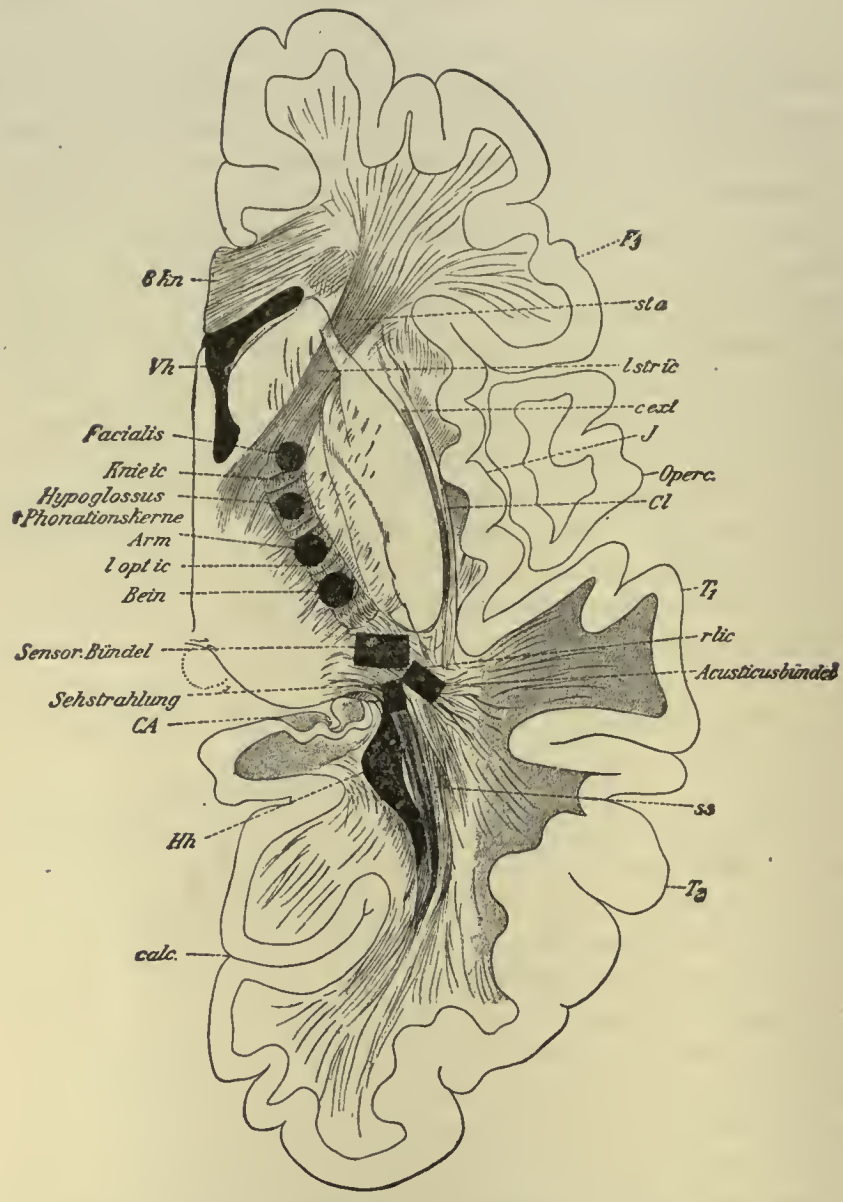
It is important to recall at this time that the probable diagnosis made in this case was corroborated by the operation. The repeated seizures spoken of in the anamnesis were evidently due to hemorrhagic extravasations into the brain-tissue surrounding the tumor; these hemorrhages ultimately culminated in the formation of a hemorrhagic cyst. The tumor developed under the anterior central convolution, in the region of the centres of the finger and hand, and preceded by symptoms of irritation, it

finally led to a complete motor paralysis. The sensibility, on the other hand, remained entirely undisturbed because the posterior central convolution was but slightly or not at all affected.

One more point should be here considered and that is the result obtained from faradic irritation. As shown above, faradization can be successfully used only in those instances where the tumor is situated cortically. From the tumor itself we get no responses, even though the particular cortical region is not completely paralyzed. In the case just described the entire upper extremity was totally paralyzed. In spite of that, however, distinct responses were obtained from the faradization of the cortical tissue that, with the exception of being discolored yellow, was to all appearances normal. The impulses of the will and faradic irritation did therefore not go hand in hand. This observation again goes to prove the great value of applications of the faradic current to the cerebral cortex. I shall now speak of

### The Fibres of the Corona Radiata and the Internal Capsule

The motor and sensory fibres originating in the cerebral cortex converge in a fan-shaped manner toward the internal capsule. It therefore at once becomes evident that while pathologic foci in the cerebral cortex and subcortical medullary layer will, at first, affect sympathetically a limited number of cerebral foci only, it will be found that the nearer the morbid areas are to the internal capsule the greater will be the number of centres involved. The reason for this is the closer association of the conduction tracts and their restriction into a necessarily small space in this particular anatomic locality (deeper parts of the medullary layer). In the pars occipitalis of the internal capsule, arranged very close to one another (compare Fig. 103, p. 568) there are found the tracts of the facialis, hypoglossus muscles of the upper and lower extremities, and in its posterior third also the sensory fibres of the opposite side; therefore, an affection of this particular part of the capsula interna results in complete hemiplegia and hemianæsthesia. Since, in the hindmost portion of the internal capsule, the acustic fibres leading to the temporal lobe and the optic fibres running to the occipital lobe




*Bkn* = knee of corpus callosum.
*Vh* = anterior horn.
*Knie ic* = knee of internal capsule.
*Phonationskerne* = nuclei of phonation.
*l opt ic* = lenticulo-optic section of internal capsule.
*Bein* = lower extremity.
*Sensor Bündel* = sensory bundle.
*Sehstrahlung* = visual radiation.
*CA* = calcar avis.
*Hh* = posterior horn.
*calc.* = fissura calcarina.
$F_3$ = third frontal convolution.
*sta* = corona radiata.
*lstric* = lenticulo-striated section of internal capsule.
*c ext* = capsula externa.
*J* = island.
*Operc.* = operculum.
*Cl* = claustrum.
$T_1$ = first temporal convolution.
*rlic* = retro-lenticular section of internal capsule.
*Acusticusbündel* = acusticus bundle.
*ss* = visual radiations.
$T_2$ = second temporal convolution.

Fig. 103

The Principal Segments of the Internal Capsule

Horizontal section through the right cerebral hemisphere in man. Section made at a level corresponding to the genu corporis callosi and the pulvinar. From *C. v. Monakow's* "Gehirnpathologie," II, Auflage. Wien, 1905, p. 954, Fig. 295

come into very close contact with the tracts of sensation, an interruption of continuity in this situation, of even the slightest degree, will cause, in addition to hemianæsthesia, crossed hemianopsia and hemianacusis. For this reason the French are in the habit of referring to this region (hindmost portion of the internal capsule) as the *Carrefour sensitif.*

Although in extirpations of tumors we fortunately cannot advance to the internal capsule (I say fortunately because if this were the case motor and sensory paralyses would inevitably result), I nevertheless thought it best to briefly mention the symptoms. Besides destroying certain portions of the brain and supplanting them, neoplasmata also produce

### Neighborhood Symptoms

The pressure exercised by the growing tumor, the œdema surrounding it (now greater now less) and finally the hemorrhages into the adjoining cerebral substance all produce effects which are of the greatest importance for the diagnosis. Tumors, encroaching upon the internal capsule, cause symptoms corresponding to the extent of their interference with the tracts contained therein. Neoplasmata of the motor region and of the parietal lobe may occasionally lead in this way to crossed hemianopsia; this important symptom is, therefore, not always to be ascribed to disease of the visual sphere in the occipital lobe or to interrupted conduction in the tractus opticus.

Neighborhood symptoms are noted in both, superficially located morbid conditions and those situated deeply. For an example: If a tumor affects the centre of the arm the adjoining regions of the lower facialis and the lower extremity may also become paralyzed. If the neoplasm be of small size (slight irritation) symptoms of spastic irritation will result. These effects, of course, extend from the anterior central convolution to the posterior, and vice versa. It is therefore possible for tumors situated in the posterior central convolution to give rise to *Jacksonian* convulsions. The likelihood for this is the greater, the nearer the neoplasm is to the *Rolandic* fissure. In like manner the centre of *Broca* at the foot of the third frontal convolution and the centre of *Wernicke* in the upper frontal convo-

lution may be affected by growths in the sensory-motor region (see Fig. 85, p. 427); disturbances of a motor and sensory nature will not infrequently result if that be the case. Examples for all manifestations thus far described have already been detailed in the preceding observations.

It is characteristic of neighborhood symptoms to extremely vary in their appearance. Spasms interchange with pareses until finally paralyses supervene. This is also true of sensory disturbances of irritation.

After what has already been said of the character and regression of cortical paralyses, nothing need here be added, because this phase of the question has been thoroughly gone into and the cases there considered were instances of excision of the "primary spasming" cortical centre—therefore pure cortical paralyses.

It should finally be especially emphasized that as far as the surgical treatment of these cases is concerned it matters little whether the tumor affects the anterior or posterior central convolution. It will be recalled that none of the constructions described (see chapter on "Craniocerebral Topography," Vol. I, p. 210) are infallible, and that we are not even able to recognize the central fissure of man on the widely exposed cerebral surface. Therefore, in all operations on the brain, a fairly large area should be exposed, so that it will at least uncover the entire width of the sensory-motor region.

### Failures after Successful Extirpation of Tumors

In the first volume of this work I pointed out the serious consequences that may follow even successful extirpation of brain tumors. These are caused by softening in the tissues immediately surrounding the neoplasm, and will destroy a good operative result or in some instances even lead to the death of the patient. A fatality of that nature has been detailed above. In the following case the wounds healed and while no relapse occurred the paralyses did not improve while the patient was under my observation. Cases of this class also represent failures and are to be regarded as though the operation was entirely unsuccessful or perhaps led to the death of the patient.

## OBSERVATION III, 8

*Fibrosarcoma in the Left Upper Central Region. Extirpation. Healing of the Wound, but Progressive Softening with Persistence of the Paralyses. No Demonstrable Relapse.*

The patient, forty-six years old, dated his trouble from the end of January, 1908. His history discloses nothing of importance. Hereditary taints did not exist. The disease was ushered in suddenly with paroxysms of spasmodic pains in the right lower extremity. While these attacks grew worse a gradually developing weakness of the right lower extremity was noted, which was soon followed by a like condition in the right upper limb. In June, 1909, the patient became aware of disturbances of vision that gradually became aggravated. On his admission to the hospital (beginning of October, 1909) the patient, who was powerfully built, presented a complete spastic paralysis of the right lower extremity and right arm with exaggerated reflexes. The sensibility was not much disturbed. Of general symptoms of cerebral pressure there existed: bilateral choked disc, marked reduction of the acuteness of vision (on the left $\frac{1}{10}$ and on the right $\frac{1}{4}$), cerebral vomiting, headaches, and stupefaction.

I operated in two stages—on the 15th and 23d of October, 1909 (consult Plate XXXVI). On account of the sinus longitudinalis the base of the dural flap was made above. The brain bulged into the cleft and pulsated only very little. At the upper border of the wound, the tumor (about the size of half a dollar) was seen to be distinctly elevated above the level of the surrounding normal brain-tissue; besides being raised it was flattened on top and distinguished itself from the rest of the brain-surface by its bluish-violet color. It was firmer in comparison with the rest of the surrounding brain-substance. Posteriorly and below the tumor-mass was sharply outlined from the rest of the cerebral tissue; above, it closely adhered to the dural flap and in front it continued under the frontal portion of the skull, so that in order to expose it completely a strip of bone, a few centimetres wide, had to be broken off from the anterior angle of the cleft. In order to avoid hemorrhage as much as possible, during the manipulations, the veins of the pia crossing

toward the tumor were deligated in the healthy regions. The lower ligatures were cut short, the upper ones (those toward the tumor) were left long and were utilized as tractors to deliver the tumor. The pia and arachnoid were now incised (always between two ligatures) a few millimetres away from the border of the tumor in the form of three-fourths of a circle. The tumor-mass was now carefully detached from the surrounding brain-tissue with the finger and dislodged from its cerebral bed. It now hung over the convex surface of the brain at the point of transition of the falx cerebri to the dura (see Plate XXXVI, Fig. b).

Immediately after the luxation of the tumor the bleeding from the smaller and large vessels, in the area surrounding it, ceased. The hemorrhage until that time could be controlled only with difficulty, by means of compression with gauze tampons. The strongly projecting cerebral substance was at the same time seen to gradually collapse and sink back to the cranial cavity under distinctly increasing pulsations. From the tumor-bed proper the hemorrhage was only slight. The hollow in the brain with its overhanging borders was seen to gradually fill in with cerebral tissue. There finally remained a very small cavity, the median wall of which was formed by the falx cerebri. From it, as well as from the inner surface of the dura, the tumor could be wiped away without difficulty; while so doing, however, the lateral wall of the sinus longitudinalis was laid bare. A large vein was found here bleeding, and it was ligated. The tumor was everywhere covered with pia arachnoid and vessels. Its surface toward the brain had an uneven humpy appearance and was quite firm to the touch. The whole mass of the elliptical neoplasm measured from in front backward 55 mm., from above downward 45 mm., and in its depth 40 mm.

The flap of dura was reposited and retained in position by two sutures inserted at its lowest point. The osteoplastic flap was sewn over it. Notwithstanding all precautions and measures to prevent hemorrhage the patient lost, until the time of luxation of the tumor, a considerable quantity of blood. The pulse ranged between 120 and 140 beats per minute during the entire time of the operation. Only very little chloroform was given at the beginning of the operation.

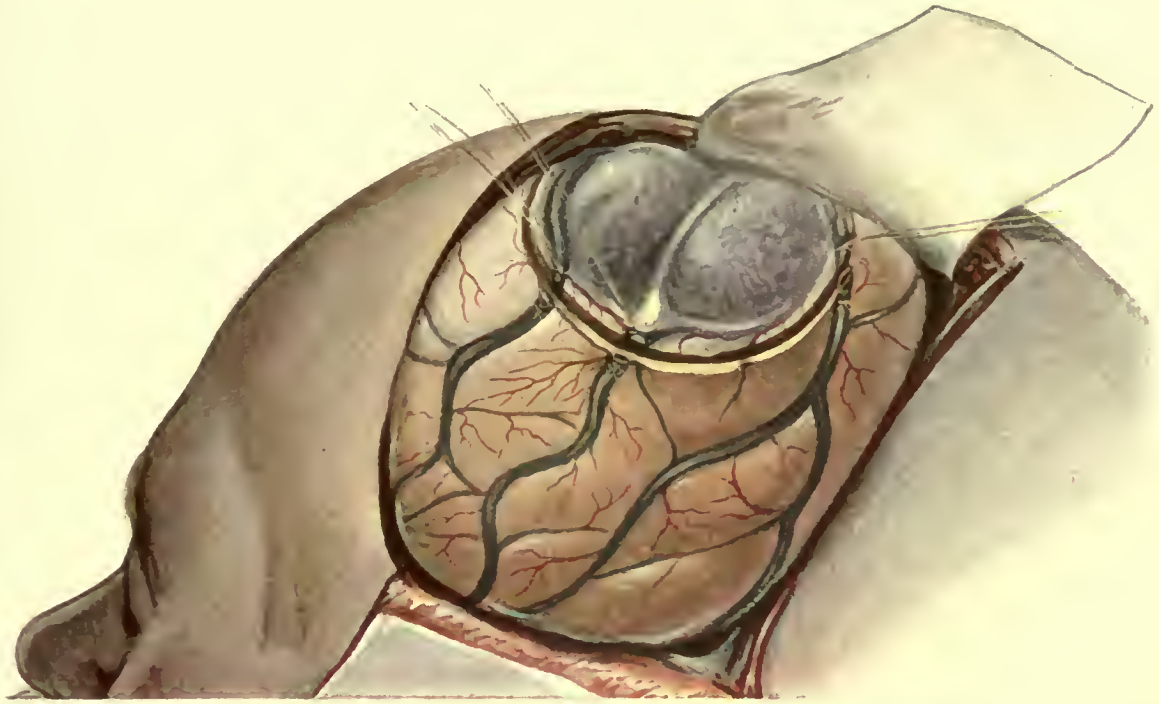


Fig. a.

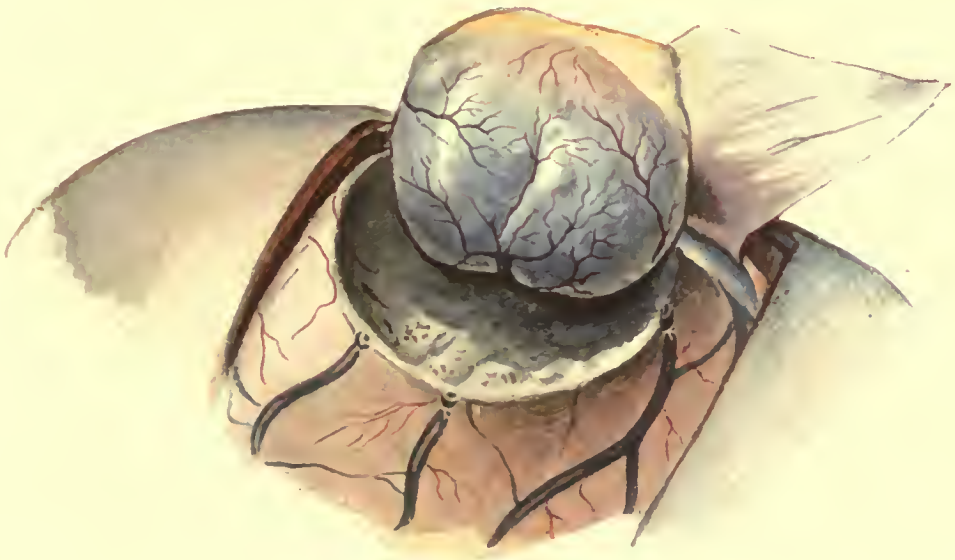


Fig. b.

As a result of the considerable quantity of blood lost and the seriousness of the operation, the heart action of the patient was superficial and greatly accelerated. The administration of excitantia however soon brought about an improvement in that condition. The temperature that soon after the operation mounted to 39.8° a few days later again dropped to normal.

The sutures were removed on the eighth day after the operation. Eleven days later a slight prolapse of the brain, the size of half a chestnut, was seen; from this prolapsus, in which cerebral pulsations were plainly visible, cerebro-spinal fluid was issuing in large quantities. As long as the flow of this fluid continued, the temperature of the patient kept high, but as soon as it ceased the fever abated. Three months after the operation the prominence in the upper portion of the wound resulting from the operation had grown larger and was softly fluctuating. Since these circumstances justified the assumption of a recurrence, with the patient in chloroform narcosis, I made an incision into the upper part of the old scar and dissected the flap backward (9th of January, 1910). Immediately under the flap a mass of œdematous brain-tissue was found which upon incision was shown to contain a number of large and smaller cysts that were filled with a clear aqueous fluid. The prolapsed and much changed brain-tissue (about the size of a mandarin) was removed *in toto*. No recurrence was found. Palpation of even deeply seated portions of brain did not indicate the presence of a tumor which if there, and of the kind of the original tumor, could have been easily recognized by its consistency. Toward the median line the falx cerebri was found as a smooth, distinct, and firm elastic surface free from unevenness. After excising the scars resulting from the first operation the wound was exactly sutured.

Following this operation the flow of liquor markedly diminished and after a few days completely ceased. The wound soon cicatrized, and during the time the patient was under my observation there was no more prolapsus nor vaulting in the area operated upon.

With reference to the further course of the disease, immediately after removing the tumor there occurred considerable disturbance in the power of speech. At first all the patient could

say was "yes." It was impossible for him to repeat words. The understanding of speech, however, was only slightly affected. The power of spontaneous speech and repetition of words and sentences gradually improved. At the examination (November 15th) the patient was still unable to understand requests directed to him, i.e., "Clinch your fist, please," and so forth; others again he understood well; for instance: "Close your eyes," "Lift your hand up high," etc. There undoubtedly existed a slight degree of sensory aphasia, especially was the perception dilatory. Some sentences ("Everything is all right") were spontaneously spoken well, yet the patient experienced difficulty in finding the word "no." "Nose," the patient could say correctly; on the other hand he could not say "mouth." Words that he could not utter he could not repeat. Until the patient was discharged (January 25, 1910), the disturbances of speech persisted unchanged and were of the same character as before.

During the entire period the patient was under observation the right facialis was slightly paretic; in the beginning, the extremities of the right side were completely paralyzed, and they showed muscular rigidities and exaggerated tendon reflexes. In the lower extremity there existed, besides other spastic symptoms, ankle-clonus and the *Babinski* sign. While the paralysis of the right arm remained stationary, the movements of the lower limb made gradual progress; meanwhile the spastic manifestations were receding. On the right side a paresis of the abdominal musculature could be demonstrated; the abdominal reflex was here absent. The sensory disturbances were insignificant. The choked disc completely receded from both eyes. The acuteness of vision improved in the right eye to $\frac{1}{2}$, in the left not at all.

The general condition of the patient was changeable, but on the whole it was better; the sensorium was occasionally cloudy.

Now, if we compare this case with the one described under Observation I, 5, on p. 328, we must wonder at the unfavorable result of the operation in the former and the complete cure resulting in the latter. The only difference between the two cases is, that in one (Observation I, 5) the tumor originated

from the dura, while in the other it sprung either from the brain itself or from the pia arachnoid.

*Conglomerated solitary tubercles* (compare Observation III, 6, p. 560) and *gummata* must, in a restricted sense, be looked upon as tumors and if deemed necessary subjected to operative treatment. They produce identical symptoms. In gummatous conditions specific medication will frequently fail while *Jacksonian* seizures resulting from syphilitic meningitis of the convexity not infrequently yield to such treatment.

That

**Cyst Formations**

of all kinds may produce the same manifestations needs no reiteration. Like tumors they also decrease the intracranial space and displace neighboring sections of the brain. If I follow these well-known facts by an example it happens because the history of the case shows in a good many respects such typical symptoms that its lengthy description is amply justified. I shall speak of the important points more fully in the epicrisis.

## OBSERVATION III, 9

*Trauma, Followed at First by Symptoms of Cortical Irritation and then by Paralyses. During the Operation Performed in the Acute Stage of Cerebral Compression, Two Plum-sized Cysticercus Cysts were Found in the Central Region. Good Progress at First until Normal. Sudden Death, After Thirty-three Days, from Acute Cerebral Compression. Numerous Cysticercus Cysts at the Base of the Brain and in the Cerebral Substance.*

The patient, a laborer, thirty-one years old, sustained an injury on the 19th of June, 1901. He was struck on the head by a screw-wrench weighing from three to four pounds that fell from a height of about 5 metres. The small wound thus created over the right parietal bone was dressed at an emergency station, and the patient departed for home on foot. About a week later he began to suffer from headaches and dizziness, and later on he complained of paræsthesias, formications, and a sense of

weakness in his left hand. A few times the patient noted spasmodic contractions of the musculature of the left side of the neck, and it is said that on one occasion he fell on the left side.

On the 2d of October we found the following conditions: The patient complained of an increasing weakness in his left hand; he could no longer hold anything in it nor button his coat with it. Before the accident he was of a happy disposition; for the last few weeks, however, he showed extreme irritability of temper. A movable scar, about 1½ cm. long (see Fig. 20, Vol. I, p. 68), was discovered in the parietal region (right), 11 cm. above the upper border of the auricle, corresponding to a vertical line that touched exactly the posterior border of the pinna.

The examination of the nervous system showed distinct paresis of the left lower facialis (the upper branch was free). The movements of the tongue were normal. The coarse power of the left hand was very much reduced. It was impossible for the patient to perform fine movements with the left hand, and the stereognostic sense was also here somewhat disturbed. The coarse power of the left arm was a little less than that of the right; that of both lower extremities was normal. The patient staggered to the left when attempting to stand with his eyes closed. His walk was undisturbed. The conjunctival reflex was normal on the right and very much reduced on the left side. The other reflexes showed nothing abnormal, except that the patellar reflex could be more easily elicited on the left than on the right side. Bladder and rectum not disturbed. Slight hypalgesia of the left half of the face and the left lower extremity. Visual field normal. No paralysis of the ocular muscles; pupils of equal size; their reaction normal; fundus oculi free from abnormalities; pulse, 72; respirations, 18.

During the examination a marked inhibition of the psychic functions was manifest. The patient, for instance, could not figure out simple examples (9×11, 7×12); he was nevertheless well informed of his surroundings and evidently of a happy frame of mind. He said he felt fine.

The operation was set for the 5th of October, when on the 4th a sudden aggravation of the condition of the patient set in. On the preceding evening he ate a very hearty supper and en-

joyed himself playing cards with his neighbors. About 8.30 in the morning of the 4th of October, the patient was seized with headaches and vomiting; he stated that the cephalalgia was in the back of the head on the right side. Pulse 76. At this time the fundus oculi was normal on the right side, but showed a blurring of the nasal border of the papilla on the left; the arteries here were not much narrowed, the veins were dilated. At 9.30 the patient complained of much nausea and he was very restless. He remarked that "His head felt as though everything wants to get out of it." He could no longer exert pressure with his left hand. At 11 o'clock his stupefaction became more marked, he tossed around in bed and continually grasped for his head. His speech was babbling and his pulse was 64. It was decided to operate at once, but a number of reasons prevented us from carrying out our plans until 2.30 of the same afternoon. At that time the patient was almost completely stupefied, so that nearly the whole operation could be performed without the use of chloroform. Two cysts, each the size of a plum, were found in the central region, subcortically. The patient bore the operation (1½ hours) remarkably well. An hour later the pulse was 84; he had completely regained consciousness and complained only of great pressure in the head.

On October the 5th, after a prolonged sleep, the patient awoke stating that he felt very good, and he extended his hitherto completely paralyzed left hand to every one who came near him; its coarse power was as good as normal. There were no motor disturbances in the lower extremities. The ocular fundus was the same as on the 4th of October—normal on the right with blurring of the median border of the papilla on the left. On the 6th of October the power of the left arm was entirely normal. The facial paresis was also very much improved and on the 7th of the same month no trace of it could be demonstrated. In the following days the patient felt very good. The great excitement that was noted on the day after the operation had almost completely disappeared. On the 9th of October the drain was removed; it entered the brain substance to a depth of 5½ cm. The osteoplastic flap was originally sewn in with interrupted sutures of silk. The ophthalmoscopic examination showed the same conditions as before.

On the 11th of October, a distinct reduction in the power of the left arm was noted, and also to a slight extent in the left lower extremity. The patient urinated involuntarily. In the following days (until October 15th) the left arm and left lower extremity became progressively weaker. The paralysis of the bladder persisted. On the 15th of October, the sutures were removed. The wound of the operation was completely healed. The general condition of the patient was satisfactory; he slept well without the use of hypnotics, and his psychic condition was nearly normal. After the 16th of October, the condition of the left arm and lower limb gradually improved from day to day; the facial paresis also gradually regressed. On the 25th of October the coarse power of the left arm and lower limb were nearly normal again, and only a trace of the facial paresis could be demonstrated. On the 20th of October, the paralysis of the bladder had disappeared and the general condition of the patient was excellent. He got up on the 25th of October and walked about all day.

However, the changes in the fundus oculi were increasing at this particular time. While, as already stated, they were at first restricted to the mesial half of the left papilla, they now affected at first the nasal half of the right papilla and then the entire cross-section of both papillæ, so that on the 5th of November a well-developed bilateral optic neuritis existed. Small, whitish and glistening spots of exudation situated radially were visible in the inner upper quadrant, near the papilla on the left.

Outside of the changes enumerated, the patient had to be looked upon as clinically cured. He was out of bed all day long for some time and complained of no symptoms whatsoever. His movements were perfectly normal. I could present him to my students on the 29th of October as cured. Not the slightest symptoms of increased cerebral pressure (nausea, vomiting, slow pulse, headaches) existed. On the 5th of November the patient went to bed in this excellent condition and soon fell asleep.

At 4 o'clock the next morning (November 6th) he was found unconscious. Pulse, 86; temperature, 36.8°; patellar reflexes normal on both sides; pupils moderately dilated and reacting sluggishly. Corneal reflex diminished on the right, absent on

the left side. Outward deviation of the right eye. No spasms nor convulsions. At 6 o'clock, pulse 78. At 8 o'clock, commencing œdema of the lungs, pulse 98. Cyanosis. Three-quarters of an hour later death supervened under increasing cyanosis (pulse, 120; respirations, 10) in the absence of spasms.

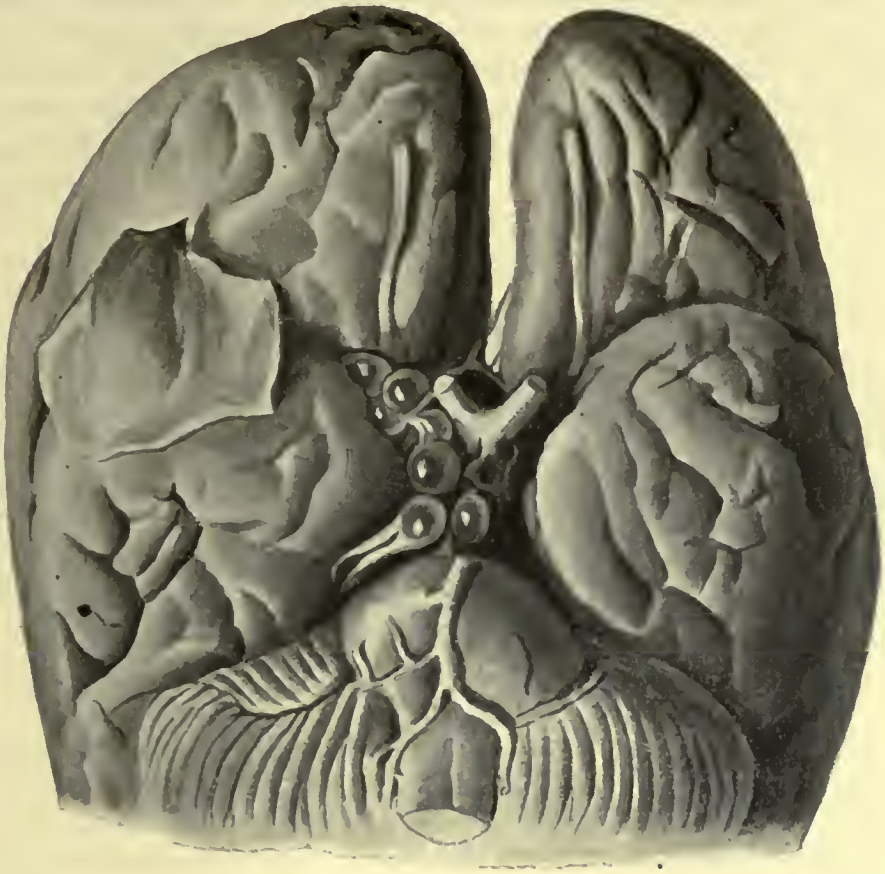


Fig. 104

Cysticercus at the Base of the Brain, $\frac{3}{4}$

I shall now give in brief the most important findings of the autopsy (*Professor Dr. Oestreich*). The osteoplastic flap was united by cicatricial tissue only—hence still freely movable. The four corners of the dura were intimately united with the pia and underlying brain surface; they could, however, be bluntly detached from it. An old, flat blood-clot of brownish-yellow color was found on the inner surface of the dura; by keeping it

under a stream of water it was shown to be firmly attached only at its borders. On the convexity, the cerebral membranes were normal; they continued normal at the base of the brain as far as the *Sylvian* fossa; there were, however, no signs of inflammation; between the pia and dura mater a whole series of cysts were found. The largest of these was the size of a small plum. It lay in the lateral section of the fossa *Sylvii* and caused a flat impression in the brain in the region of the second temporal convolution. It was intimately blended with the thickened dura. From this cyst to the hypophysis, in the region of the *Sylvian* fossa, a

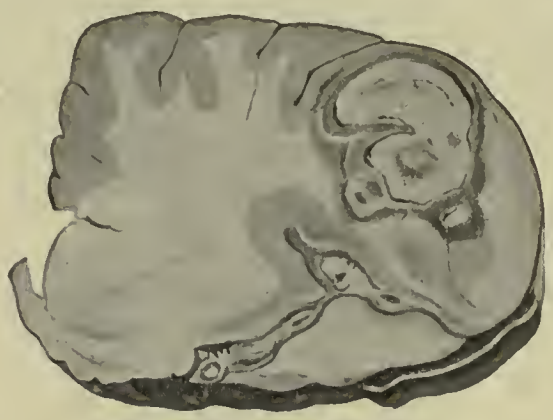


Fig. 105

Frontal Section. At *a*, in Fig. 104. 6 to 7 cm. from the anterior pole, $\frac{3}{4}$

great number of other cysts were found; they had waterlike contents and pedicles and ranged in size from that of a hazel-nut to that of a cherry. The pia was considerably thickened in this place and adhered to the cysts and to the adjoining sections of the brain, so that a separation of the right frontal from the temporal lobe was well nigh impossible. On section, another cyst, 2 cm. wide and 4 cm. long, was found within the medullary substance of the temporal lobe at the level of its second convolution.

The consistency of the brain was everywhere normal. Section of the region originally operated on (central area) disclosed a yellowish-brown area of softening that extended into the depth of the medullary layer of the hemisphere for a distance corresponding to the size of the two cysts removed at the operation.

The cerebral substance surrounding this small area of softening was sclerosed to a thickness of from 1 to 2 mm. and then gradually transgressed to the normal cerebral mass. Microscopic examination of the sclerotic tissue showed it to consist of fibrous connective tissue. The softened portion was composed of necrotic brain-tissue and leucocytes, and between these two a zone of transition could be seen that was well on the way to organization.

The cysts found at the autopsy and those removed at the operation were shown by the microscope to be caused by the *cysticercus cellulosæ*.

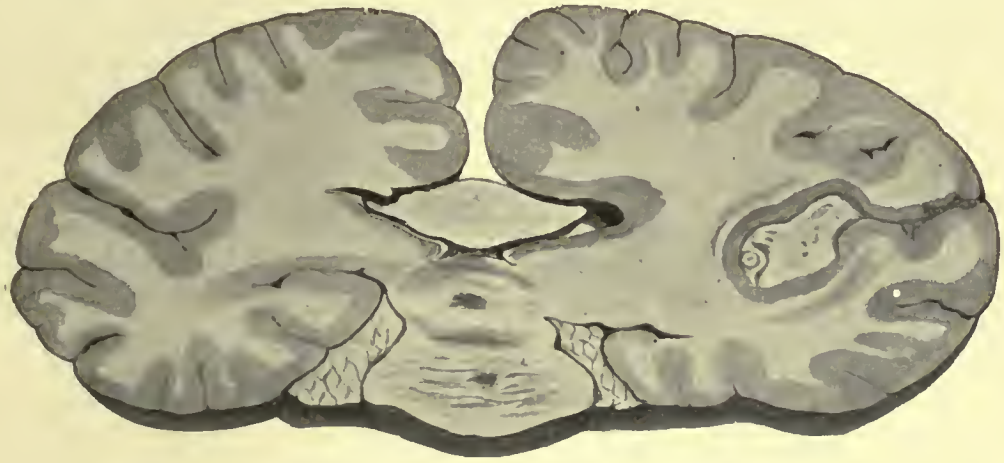


Fig. 106

Frontal Section; 13 cm. from the anterior pole, $\frac{3}{4}$

Both lateral ventricles were of equal width, and together with the ependyma showed no changes. The deeper cyst opened at the operation was in no way connected with the right ventricle.

Immediately behind the scleræ both optic nerves showed bulbous swelling, and they were somewhat jellylike in consistency. The spleen, lungs, and liver were hyperæmic. Cherry-sized hemorrhagic foci were found in the lower lobes of both lungs. A thorough search disclosed no more cysts in the spinal cord or in any other portion of the body.

The diagnosis before the operation conclusively pointed to a focal condition in the right central region, principally to the

area of the motor centre of the arm in the anterior central convolution. A trauma preceded the onset of the disease by three and a half months, and even though it did not correspond to the place at which I expected the morbid focus which was found at the operation, we must nevertheless bear in mind that the pathologic foci later discovered in other portions of the brain may have been the result of contrecoup, concussion, hemorrhagic extravasations and the like, at the time of the injury. Sarcomata, cysts, and abscesses are also known to have resulted from traumatizations. An extravasation of blood may not be absorbed, and acting as a chronic irritant it may lead to the formation of cysts or abscesses. The fact that the morbid foci were very distant from the point of injury spoke against sarcoma in this case. As is well known, sarcomata, as a rule, develop at the point where the injury has been inflicted. For the reason stated, my diagnosis in this case was either cyst or abscess.

The sudden, life-endangering aggravation in the condition of patient manifesting itself by symptoms of increased cerebral pressure, forced us to immediate operative intervention. A sudden decrease of space within the cranial cavity had undoubtedly taken place.

Above all other symptoms detailed, the behavior of the pulse was exceedingly characteristic. A few remarks pointing out its peculiarities may not be amiss in this connection. The day preceding the sudden turn for the worse, the pulse-beat ranged between 72 and 76 per minute; no particular characteristics. A few hours before the operation its frequency was reduced to somewhere between 60 and 64, and during the disinfection it sank to 56 beats per minute. Its tension was heightened to the extreme (sign of increasing cerebral pressure). As soon as the osteoplastic flap was fashioned and reflected, the pulse suddenly jumped to 124 beats per minute (sudden decrease of cerebral pressure consequent to valve formation). During the further manipulations the pulse-rate decreased to 116 and remained so until the conclusion of the operation. One and a half hours later it was 84, on the following day 96, and three days later 82, without any peculiarities.

Equally important were the changes appearing in the *fundus oculi*. While on the 3d of October it was found normal on both

sides, at 10 o'clock in the morning on the following day (4th) the mesial half of the right papilla was blurred and opaque, and streaks were seen extending into the retina. The veins were considerably dilated and tortuous, and the arteries in the median area of the papilla were somewhat narrowed and veiled. The left papilla was normal. Other details are given in the history.

Two groups of manifestations are distinguished in the clinical course of this case—those caused by the two cysts found in the central region, and those produced by the numerous cysts found at the base of the brain. Only the first caused distinct focal symptoms. This enabled us to make a correct diagnosis of their location and to remove them by an operation.

The post-operative course of the disease offered the following noteworthy facts: Immediately after the conclusion of the operation all symptoms of general and local cerebral compression at once disappeared and the paralyses quickly subsided and completely vanished. Paralytic manifestations appeared again from the 7th day on (11th of October). These were undoubtedly brought about by the traumatic cerebral softening in the vicinity of the field of operation—corroborated by anatomic (gross) and microscopic findings. According to the clinical manifestations this operative traumatization of the cerebral tissue continued until the 16th of October (five days). Thereafter the condition of the patient improved. Definite processes of repair were in progress; this was shown by the marked improvement of the paralyses. After five days complete restoration ensued and the patient was able to be up and around all day long, as any other healthy person.

Feeling as well as he did, only one symptom caused us anxiety—the changes in the right papilla which did not regress.

On the contrary, they became intensified and soon spread to the entire cross-section and similarly affected the papilla of the right eye. While we were watching the progress of this ominous symptom, we were unable, notwithstanding the most scrutinizing examinations and observation, to find other corroborative symptoms that would lead us to the right road. While the existence of cysticercus cysts in some portion within the cranial cavity was presumed, nothing tangible as to their location could be obtained from the clinical symptomatology. The sudden

onset of the grave condition of the patient on November 5th, that resulted in death in a few hours, surprised us very much. The cause of death was shown by the autopsy to be due to the many cysticercus cysts found at the base of the brain. The large cyst found in the depth of the second temporal convolution and the one developing in the medullary substance of the right temporal lobe occasioned, outside of the neuritis optica, no clinical manifestations whatsoever.

# Neoplasmata of the Temporal Lobe and the Region of the Island of Reil

The temporal lobe fills the middle fossa of the skull and rests with its posterior end, for a considerable distance, on the tentorium cerebelli. It then at once blends with the occipital lobe behind and with the parietal (lower) lobe above.

There is quite a difference between involvement by tumor of the left temporal lobe and that of the right. It has already been pointed out that the areas of speech in the vicinity of the *Sylvian* fissure (both motor and sensory) are, in right-handed individuals, developed in the left hemisphere exclusively, and vice versa, left-handers have their speech centres in the right cerebral half. If the latter cases (comparatively rare) be left entirely out of consideration we find that the right temporal area is another silent territory analogous to the anterior sections of both frontal lobes, and that only when the surrounding portions of the brain, i.e., the operculum and the base of the central convolutions on one side and the deeply situated visual tracts on the other, become involved, either by contiguity or sympathy, will we find characteristic local symptoms such as: hemiparesis, hemianæsthesia, and hemianopsia. In view of this fact *Wernicke* has pointed out that ptosis and dilatation of the pupil occur consequent to pressure on the trunk of the oculomotorius on the same side.

## Symptomatology

### Aphasia

In view of what has just been said, neoplasmata of the left temporal lobe, as a rule, result in aphasia, and we can hardly ever make a diagnosis of newgrowth in that portion of the brain without this important symptom. However, since disturbances of aphasic nature may result from diseased conditions of various

parts of the brain, I fear I cannot cite examples of the various disturbances of speech in one chapter and still do justice to the classification I have adopted from a surgical standpoint. For that reason I shall now give a very brief review of aphasia as a whole. We must, however, bear in mind that only a part of the symptomatology given is true for neoplasmata of the temporal lobe and the island of *Reil.*

Disturbances of speech that result from morbid foci in the brain are divided into two great groups. One concerns the ability to successively innervate the muscles used in speaking and the other embraces the aphasic disturbances proper. The first, the disturbance of sound production, is known as *anarthria*, and occurs in all conditions where disturbances of the nerve-tracts that supply the various muscles of speech exist. This principally occurs in bulbar paralysis where the nuclei in the region of the fourth ventricle participate in the morbid processes. As far as our present observations are concerned, this disease is of little importance. The same symptom nevertheless occurs when the tracts of conduction leading from the cerebral cortex (lower section of the central region) to the nuclei mentioned become affected, and they are therefore the result of supranuclear foci. This disturbance is known as *pseudo-bulbar-paralysis* (*anarthria and disarthria*), and can occur only when the supranuclear tracts running from the operculum through the centrum semiovale, through the posterior section of the internal capsule, through the peduncle and pons are in any part of their course bilaterally interrupted. It has already been pointed out above, that at least a part of the musculature concerned in speaking receive their nerve-supply from both central regions (the motor branch of the trigeminus; the fibres of the glossopharyngeus supply the muscles of the palate, and the motor branches of the vagus supply to a lesser extent the muscles of the larynx). While the hypoglossus and lower facial mainly receive their impulses from one central region, practical experience teaches us that anarthric disturbances in the muscles supplied by these nerves principally occur in bilateral focal conditions.

In the second large group of aphasia proper, we distinguish two kinds of disturbances—motor and sensory. The *motor* or *aphasia of expression* has already been thoroughly

dealt with in the chapter on "Results of Cortical Excision," on p. 426.

In cases of involvement of the temporal lobe, we have mainly to do with *sensory or the aphasia of perception.* The patient, in these instances, blunders in his speech and uses words that do not fit in or even resemble the correct expressions, or, the disturbance is manifested by the patient using wrong letters. It will be remembered that the sensory centre of speech (*Wernicke's* centrum) is located in the posterior section of the upper temporal convolution (see Fig. 85, p. 427). It contains the sound-pictures conditioned by the understanding of speech, and is for that reason also referred to as the sound-picture centre.

Disturbances in the ability of the patient to read, write, and figure also stand in relation to aphasic disturbances. These occur in diseases of the left temporal lobe and will there be considered in detail (see Observation V, 1, on p. 616).

In focal diseases of the left temporal lobe there also occurs

### Psychic Deafness (Acustic Agnosia)

as well as sensory aphasia. Besides the ordinary sounds of speech the patient, in these cases, is also unable to hear or understand all other sounds and noises (sounds of musical instruments, sounds uttered by animals, etc.). The central tract of hearing ends in the cortex of the temporal lobe and the greatest part of its fibres are to be found in the transverse convolutions (*Heschl's* convolution) and the adjoining middle third of the upper temporal convolution. Figs. 107 and 108 depict the anatomic border-lines of the sphere of hearing as worked out by *Flechsig.*

Hallucinatory symptoms of irritation through the organ of hearing that manifest themselves in all forms of abnormal noises have also been described.

We must finally mention hallucinatory sensations in the regions of smell and taste, that are usually ascribed to an involvement by the tumor of the mesially situated sections of the parietal lobe (anterior portion of the gyrus hippocampi and uncus).

The **island** is found interpolated between the motor and sensory centres of speech—in the depth of the fossa of *Sylvius*. Neoplasmata of this region may, therefore, give rise to manifestations of disturbed speech as neighborhood symptoms. Hence the character of the aphasia (motor or sensory) will depend upon whether the tumor extends more to the upper temporal convolution or toward the frontal brain. It furthermore appears that the anterior section of the cortex of the island is closely

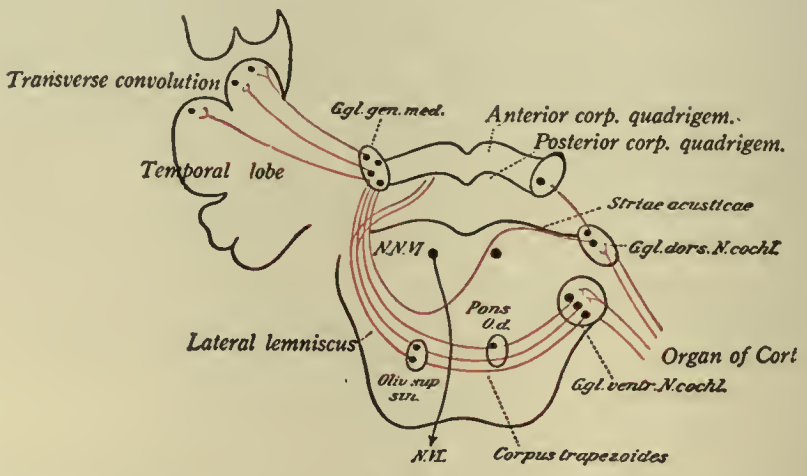



Fig. 107

Scheme of the Central Tract of Hearing according to *H. Liebmann;* from *Curschmann's* Lehrbuch der Nervenkrankheiten, Berlin, 1909, page 461. Interruption in the nuclei of the lateral lemniscus disregarded. N. N., VI nucleus of the abducens; O. d., Oliv. Dextra superior.

related to the motor centre of speech and that tumors in the region of the island may finally cause an interruption of the fibres running between its cortex and the lenticular nucleus—two additional factors sufficient to give rise to aphasic symptoms. It is common to all foci in the region of the island to occasion disturbances of the power of expression.

As an example of tumor of the territory of the left island and the first temporal convolution, I cite the following observation. This case is remarkable in many other respects, so that a thorough description of it is warranted.

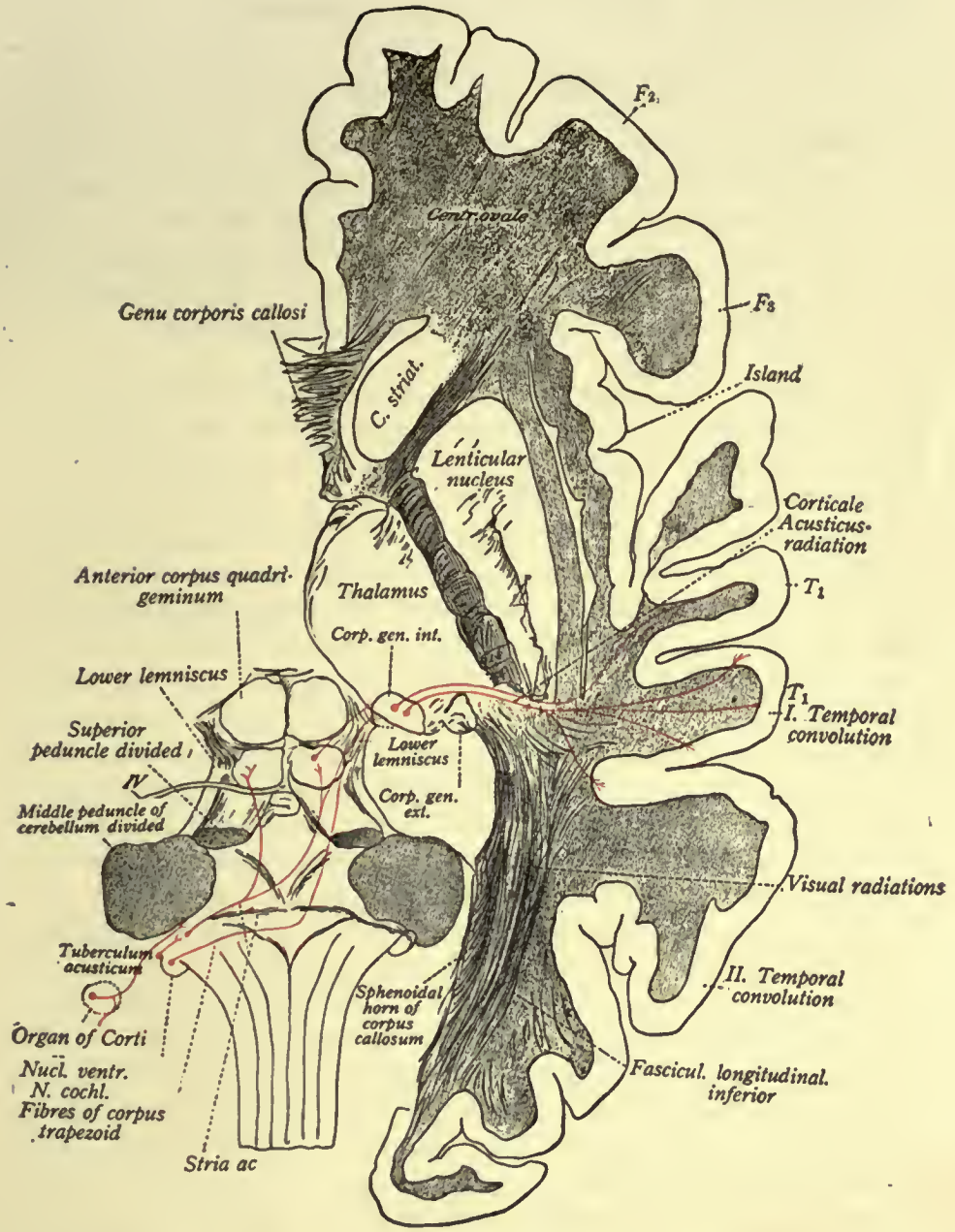



Fig. 108

Topography of the Tracts of Hearing. Illustrated through a deep horizontal section of the right hemisphere and at a brain-stem. Arrangement of the neurons of the acustic tracts red. IV = root of the trochlearis. Str. ac. = striæ acusticæ

*Lower lemniscus* = lower or lateral lemniscus. *C. gen. int.* = corpus geniculatum internum or mediale. A connection is here shown between the corpus quadrigeminum posterior (not shown) and the *C. gen. int.* (From *v. Monakow's* "Hirnpathologie," II Auflage, Fig. 94, page 143.)

## OBSERVATION IV, 1

*Fibrosarcoma in the Region of the Left Island and First Temporal Convolution. Successful Extirpation of the Primary Tumor and of Two Very Large Recurrences; in the Last Operation Incision into the Lateral Ventricle. Closure of This Place with Two Interrupted Sutures. New Recurrence and Death Three Years After the First Operation.*

The following is taken from the clinical report of *H. Oppenheim.* At the age of thirty-seven years, Mrs. H. was admitted to the Hubertus Sanitarium at Schachtensee, on the 25th of September, 1907. She complained mainly of headaches over the left eye, and in the left temporo-frontal region. These headaches were first noticed by the patient in May, and then they became more and more severe. She also complained of a failing of her memory, disturbances of speech, attacks of dizziness, thirst, and of depression. The disturbances of speech were in the beginning, in all probability, of slight nature. At that time, a prominent colleague made a probable diagnosis of dementia paralytica. While at the sanitarium, she frequently had attacks of violent headaches and vomiting; her pulse was noted to slow down to 60 beats per minute. Lumbar puncture showed, besides moderate increase of pressure, nothing abnormal.

*H. Oppenheim* examined the patient for the first time on November 3, 1907. Briefly stated, his examination revealed the following conditions: There existed a considerable degree of *aphasia* of sensory and *amnesic* character. The patient could not understand many questions she was asked. She also could not find words for certain objects and could not interpret the meaning of certain words; at times, however, she was able to utter complete sentences. Her reading was mechanical—paralectic and without understanding of what she read. In attempting to write she interchanged letters. There existed no hemianopsia, but double choked disc was found to be present; this was somewhat more marked on the left than on the right side. There was also sensitiveness on percussion and higher pitched percussion sound in the left temporal region. There was a distinct paresis of the right oro-facialis. Besides these findings

neither motor nor sensory disturbances could be found on the right side of the body. *Oppenheim's* [1] diagnosis was: "Tumor in the region of the left cerebral hemisphere—in all probability in the left lobus temporalis." He also thought of the possibility of multiple neoplasmata—this especially because of an inexplicable severe pain in the left arm. He did not place much weight on the latter assumption, however, and recommended radical operation after primary cerebral puncture.

This advice was heeded by the patient, and on the 5th of November she came under my care. I found evidence of severe cerebral compression; her pulse was much reduced in frequency, falling at times as low as 60 beats per minute. Of ominous significance was also a rapidly increasing stupefaction. I decided to operate soon and her skull was trephined without opening the dura on the 8th of November. I planned to expose the upper temporal convolution, the *Sylvian* fissure and the parts contiguous thereto. A rectangular osteoplastic flap was fashioned in the temporal region that measured 80 mm. on either side, and the basis of which lay near the malar bone. The exposed, highly tense and barely pulsating dura disclosed a hardened area the size of a finger-nail; besides this it showed nothing pathologic. Corresponding to the location of the *Sylvian* fissure, the outline of which was marked with a stick of silver nitrate on the surface of the skull, a shallow depression in the dura, a few centimetres long, was found. The hardened space just spoken of lay close behind the beginning of the *Sylvian* fissure.

The patient bore the first step of the operation well, and its second step—opening of the dura and extirpation of the tumor—had to be performed on the following day on account of rapidly increasing symptoms of cerebral pressure. The pulse fell to 63 beats per minute. On the evening preceding the first operation, with a temperature of 37.9°, the pulse ran up to 104 beats per minute. The consciousness of the patient became more cloudy from hour to hour. While during the night after the operation and the early hours of the following morning she still

[1] *H. Oppenheim* and *F. Krause*, Über eine operativ entfernte Hirngeschwulst aus der Gegend der linken Insel und ersten Schläfenwindung. "Berliner klinische Wochenschrift," 1908, No. 46.

reacted to calls and even answered some questions, after 11 o'clock she lay totally apathetic and did not defend herself even when pinched forcibly. At 1 o'clock it was possible to open the wound and to accomplish all necessary manipulations without administering even a drop of chloroform to the patient; during all these procedures the patient did not react at all, but was in a state of profound somnolence.

The operation disclosed the presence of a knotty fibro-sarcoma the size of a small apple originating from the inner surface of the dura in the anterior lower end of the left fossa *Sylvii.* It extended into the depth of the region of the island displacing the latter medianward and strongly compressing the upper temporal convolution. The fairly firm and encapsulated tumor was delivered from the depth of the *Sylvian* fossa without effort, and could easily be luxated to the front of the cerebral surface. At a point where the dura was united with the tumor to the size of about a pea it was widely removed therefrom. An exact description of the case, together with illustrations, have already been given in Vol. I, on pp. 79 to 82. After the tumor had been enucleated the cavity remaining in the substance of the brain was widely separated with large retractors, thoroughly inspected, and palpated for tumor-remnants, but none were found.

The patient bore the severe operation well, and the post-operative course of the case was afebrile. Soon after the operation the patient recovered from the profound somnolence. On the evening of the day of the second operation she was able to move her left hand and was also able to grasp with it. The right arm was completely paralyzed; so was the right facialis. The right lower extremity was fairly rigid and showed spastic phenomena. The eyeballs deviated to the left. Her speech was almost completely gone. The pulse was accelerated and often changed in frequency. On the following days the patient was heard to say, "Oh, God"! To all questions she invariably answered, "No." The sensorium became free. In the following days there occurred attacks of cardiac weakness that necessitated the use of camphor and other heart stimulants.

The understanding of words was found by *Oppenheim,* on the 15th of November, to be improved. ("Show me your tongue; close your eyes; where is your handkerchief?"—all these she un-

derstood; others again she did not.) She picked out the right ones named from a group of objects held before her; she was able to repeat words. There was perseverance. All reflexes on the right side of her body were spastically increased. The paralyses had by this time considerably decreased. She was able to lift up her arm and clench her hand into a fist. The choked disc of the right eye had almost completely disappeared.

While on the following days the general condition of the patient progressively improved, on the 12th day after the operation she developed, within twenty-four hours, a flaccid paralysis of the right side of the body. There was now an almost total paralysis of the right arm, a marked paresis of the lower facialis and considerable weakness in the lower extremity. The speech, which at that time had about returned, was again lost. The reason for these disturbances was thought to be an œdema or probably processes of softening going on in the particular foci in the central region or in the course of their fibres. I have already spoken of these processes in detail, in the first volume of this work. Since every form of surgical intervention, even a simple lifting of the valve seriously affects the strongly altered cerebral substance and in this manner enhances processes of softening, we should, wherever possible, rigidly practise watchful expectancy.

Besides the paralyses described, there also existed in this patient slight symptoms of irritation (headaches, patient complained of pain in the wound, slight rigidity when nodding the head, increased pulse-rate, about 100 per minute, with fairly normal remittent temperature). The sensorium was at that time not entirely free, but two days later it had almost completely recuperated. The paralyses continued for a few weeks but finally disappeared. The speech returned very gradually. I am indebted to *Dr. Oppenheim* for the following data:

On November 29th the patient understood the following: "Give me your hand," "Show me your tongue," "Close and open your eyes." The following she was unable to understand: "Lift your hand up high." She correctly repeated "Sister." To the question "Where is your sister"? she repeated the word "sister." When a ring was shown her she also said "sister." When the watch was shown her she also said "sister." She was

shown a glass of water; this brought from her the word "rinse" (she meant rinsing the mouth). She could not find the name for flower and was also unable to repeat it. She repeated the name "Sparman" (of her nurse). Immediately after this, bread was held before her, which she also called "Sparman." In the beginning of December the patient became mentally more active and self-satisfied; her understanding of words improved a great deal, but her spontaneous speech was still very defective. There existed total agraphia, also alexia, but no appreciable apraxia. On January 25, 1908, her vocabulary was somewhat more extensive; she could also repeat words better than heretofore. The tendency to perseverance was much less noticeable, but the understanding of words was still damaged to a moderate extent. Occasionally the patient would utter a complete intelligible sentence. During the month of February she received instruction in speaking from *Dr. A. Liebmann.* On the 22d of February she was able to understand complicated questions, such as: "Have you children?" "Are you married?" "Have you any brothers or sisters?" "What business is your husband in?" etc. She also responded to some requests, for instance: "Nod with your head!" During the examination, she could name objects or parts of the body only when assisted with the first vowel or syllable. Some words and sentences she occasionally uttered spontaneously while mentally abstract or during emotional moments.

Now, with reference to the other symptoms, on the 29th of November, 1907, the ophthalmoscope showed everything normal on the right side, and on the left it was seen that the papilla was still somewhat of a grayish-red color. Its outlines were fairly sharp and its prominence fairly gone. The paralysis of the right arm and oro-facialis still persisted as before. She was able to slightly move her right foot and toes and also bring the thigh of that side toward the abdomen. Ankle-clonus, *Oppenheim* and *Babinski* positive on the right. In the middle of December the active mobility of the extremities on the right side, especially the arm, returned; the improvement in that respect was very rapid. The sensory disturbances also became milder. When the patient attempted to stand, her knees gave way.

On the 4th of January, 1908, the asymmetry of the face

had very much decreased. The general appearance and the disposition of the patient were good. Complete active movements of the muscle-groups of the right arm were now executed with facility; the power here was, however, still reduced. The spastic manifestations in the right lower extremity now gradually disappeared. There still existed tactile hyperæsthesia in the right arm, while the sense of pain was retained. On January 7th, the first attempt at walking was made. The first recurrence of menstruation after the operation was noted on January 19th.

At that time the paresis was still marked while the patient was at rest; it was especially noticeable when she was laughing.

Her tongue deviated to the right. The small muscles of the right hand were distinctly atrophied, especially the interosseus primus. Patient could execute all movements of the right arm, but still with reduced power. Tactile anæsthesia in the right hand with active retention of the sense of pain. In the right lower extremity the power was only slightly reduced; it was much improved when walking, yet slight drawling was still there.

On the 28th of January, I was compelled to slightly reopen the scar and remove a small layer of necrotic cerebral tissue. The wound healed in a very short time and the patient was soon thereafter discharged in a very satisfactory condition. She at first went to her home and in the summer sojourned to Bad Elm. Her house physician, *Dr. Bradt*, was suddenly summoned to her side (June 12th) on account of the setting in of alarming symptoms. I am greatly indebted to him for the following notes:

In the beginning of her stay at the watering place she felt very good. Until a few days before the onset of these untoward manifestations she was up and around and evidently very happy. She suddenly became ill with vomiting. Mild headaches around the scar that existed, for a few weeks, now became aggravated. She became apathetic and discouraged. It was then noted that there was a bulging of the anterior and posterior margins of the wound. When *Dr. Bradt* arrived, he found the lady sitting on a sofa and absorbed in thought. Her mouth was drawn to the left, and all other signs of a right-sided facial paresis were

present. The right hand was moved with difficulty, the arm could be raised to the head and the lower limb of the same side was seen to drag at walking. The sensibility was fairly well preserved. *Babinski* present on the right. The ophthalmoscope showed choked disc on the left. The patient became fatigued with extraordinary ease when attempting to think; this was also true with reference to movements in general. She spoke with difficulty. Temperature, 37.2°. No high-tension pulse. The bone plate in the scar, previously sunken in, was now bulging outward. The previously existing depression was not effaced. The palpating finger perceived a sense of fluctuation in the anterior and posterior parts of the scar; both of these places seemingly communicated. The plate of bone was actively gliding underneath the finger when pressed upon; the sensation here imparted was that of a hard object plunging up and down on a water-cushion.

I opened the old scar on the 16th of July, 1908, and removed the upper two-thirds of the bone plate. There at once appeared a smooth nodular tumor that was covered by a thin layer of cerebral substance. It was enucleated from the surrounding brain-tissue with comparative ease on account of it being much firmer than the brain-substance. The neoplasm was approximately of the same size as that of the primary tumor. It measured 43 : 55 : 60 mm. It had practically the same form and the same histologic character; it did not have a pedicle. The wound was at once sutured. It healed smoothly. In three weeks our patient had fully recovered from the second operation and she improved very rapidly. Pareses and choked disc disappeared.

*Dr. Oppenheim* and I presented the patient to the Berlin Medical Society on the 28th of October, 1908. The lady was at that time a picture of health, and enjoyed, in addition to a perfectly free sensorium, the ability to conduct her domestic affairs notwithstanding the defect in her speech that was quite marked. She was very active at social functions. All symptoms of cerebral compression, especially the choked disc, the violent attacks of headaches, vomiting, vertigo, etc., completely disappeared. Occasionally, especially when there were changes in the weather, the patient would perceive pain in the scar which,

however, was of slight nature only. Her movements were perfectly free. The functions of her limbs on the right side of her body were faultless, in spite of the fact that a scrutinizing examination would still disclose the existence of certain disturbances, especially in the facial territory. The hemianæsthesia had disappeared. Disturbances of speech, however, still persisted. While during ordinary conversations practically everything spoken was understood by the patient, a cursory examination of her was nevertheless sufficient to prove that there still existed a defect in this respect. She found many words spontaneously, and while her vocabulary became more extensive from day to day, she was still unable to speak connectedly. She was able to name objects held before her only partly, and this only when given aid. Her reading and writing were very imperfect. The second operation nevertheless gave a strong impetus to a progressive improvement of all symptoms. Hopes entertained that a permanent cure may have been obtained, did unfortunately not materialize.

In January, 1909, pain in the scar was again complained of. These pains radiated to the forehead and were most marked during the menstrual period that recurred every three weeks or oftener. Occasionally pains in the right leg were complained of —from the knee down to the ankle-joint, and on rare occasions in the wrist-joint. She frequently became impatient and did not sleep well. She never suffered from dizziness. Her speech improved even more. Her intelligence was good and her memory, as she stated, "brilliant." The field of operation was sunken in, especially above where the plate of bone had been removed. The ophthalmoscopic examination showed nothing abnormal. Now, an increasing weakness in the right upper and lower extremity was noted, and the performance of movements with the fingers became difficult. A very careful examination, made by *Oppenheim* on the 8th of March, 1909, showed a certain apraxia of the right hand; the patient could not, for instance, accomplish movements of threatening; she could do this well with the left hand. There was also an analgesia of the right hand. Contacts were here not perceived by the patient. In the right lower extremity the sense of pain was retained; the tendon phenomena were here highly exaggerated. Marked *Babinski* and *Oppen-*

*heim* present. The patient could not be very well communicated with because she did not understand when spoken to. For instance, when asked to grasp her ear, she responded at once; immediately thereafter she was again asked to touch her chin—this she did not understand at all. She correctly named a ring shown to her; coins and spectacles she could not name if not helped out with the first syllable. Words she repeated fairly well. A bulging portion of the cranium on the left side, immediately above the ear, was found very painful on pressure. The previously existing depression was entirely filled out within ten days.

Taking into consideration all manifestations here described collectively, we cannot but conclude that a recurrence of the original trouble had in all probability taken place. The general condition of the patient being excellent, and swayed by her own requests and urged by her relatives to interfere surgically, I decided to operate again on the 11th of March, 1909.

With the patient in chloroform narcosis, I circumcised the old scar in its entire extent and carefully worked my way into the depth, through the upper border of the wound until the brain-substance appeared; the latter was of a somewhat yellower shade than is normally the case. The skin flap was carefully and gradually dissected away from the brain, in its upper two-thirds, and while so doing (blade of knife against the skin) the rest of the plate of bone remaining from the previous operation was uncovered and completely removed. A soft neoplasm, grayish-red in color, now made its appearance. Its character was entirely different from the tumors removed at the previous operations. An indurated area, located in the anterior lower angle of the wound and basalward, required excision. This exposed the tumor to view to a greater extent. After the layer of cerebral tissue covering the tumor had been sagittally incised in its centre, with the exercise of great care the neoplasm could be enucleated from behind and above. It extended deeply into the medullary layer in which it created an enormous cavity. It was about the size of a kidney, but thicker. A pedicle was seen to extend from it inward, downward, and to the front. This necessitated an enlargement of the incision inward and downward to an angle of about 45 degrees. After the soft

parts had been detached and displaced backward the bone had to be removed to the size of about half a dollar. The trephined cleft now widely reached into the anterior fossa of the skull. Since the tumor had also extended to the front and above, a section of bone, smaller in size than the one just removed, had to be snipped off with a pair of rongeur forceps, from the upper anterior angle of the wound. The dura was here well preserved, but for the sake of safety it was thought best to excise it; this was, I believe, important, because the tumor was seen to extend underneath it. The middle of the normal frontal brain could now be seen very plainly, immediately below the portion of dura excised. The cerebral mass was bluntly detached toward the front and severed with a pair of scissors. We were now able to enucleate the neoplasm from the frontal brain above. It extended still farther, however, underneath the cortex to the front and below. A large pedicle was uncovered that extended toward the base of the brain and cranium. This, therefore, necessitated the further removal of a great deal of bone toward the front and below. The tumor could now be enucleated at the base. A large node, inseparably blended with the dura and attached to the bone right in front and below, had to be excised. Some branches of the meningeal artery spurted here very forcibly and had to be ligated. It could be asserted, with quite a degree of certainty, that the brain-tissue, now seen everywhere in the wound, even in the depths of the skull, anteriorly and below, was to all appearances normal, so that the extirpation could this time also be looked upon as radical and complete. The incision of the soft parts finally extended to the margin of the left eyebrow, and the defect in the bone corresponded to a perpendicular line drawn over the middle of the brow.

During the inspection of the cavity left after the removal of the tumor (larger than the fist of a man), in the region of transition from the central area to the frontal brain, we were unable to discover any remnants of tumor-tissue. However, on the anterior third of the floor of the cavity, toward the median line, a bluish translucent membrane, the size of a quarter of a dollar, was sighted. I made an incision into it for the purpose of assuring myself that it was not a portion of the tumor that had undergone cystic degeneration. The borders of this suspicious-

looking membrane were seized with *Péan* forceps, retracted, and its exploration proved it to be the anterior horn of the much-dilated lateral ventricle we had entered. Its walls were normal. In order to avoid the dangerous flow of cerebral liquor, the incision of the wound thus involuntarily created was united with two interrupted linen sutures. A peglike process of the tumor had in its growth reached the lateral ventricle and would undoubtedly soon have perforated it. The **suture of the lateral**

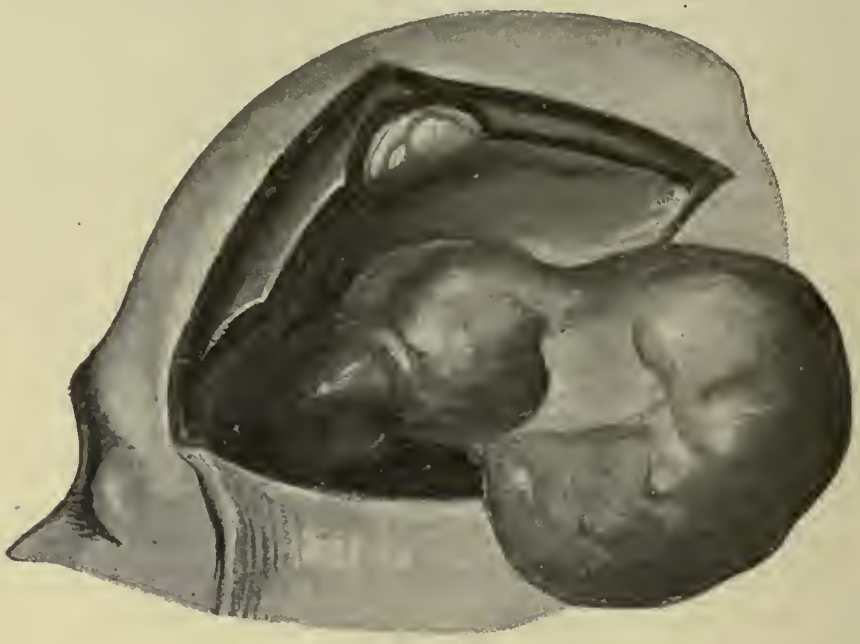


Fig. 109

**ventricle was entirely successful.** No cerebro-spinal fluid issued from the wound after the operation. The enormous cavity in the brain healed by primary intention after the soft parts were united over it. No drain was inserted into the wound.

The patient withstood the terrific operation exceedingly well. It is remarkable that only the hand and fingers of the right upper extremity were paralyzed; the active movements of the shoulder and elbow joints, as well as those of the lower extremity, could be executed as well as before the operation. Fourteen days later the patient could feel pricks with a needle in this hand; the sense of pain, however, was still reduced. Contacts

with the brush were not as yet perceived. The psychic condition, the speech, as well as the general condition of the patient, were exactly as before the operation. An examination made on the 11th of April showed weak active movements in the wrist-joint and fingers. Contacts with the brush were now perceived here, but they were wrongly located.

I am thankful to *Professor H. Oppenheim* for the following notes on the results of the examination of the *speech and understanding of reading.*

The patient made herself understood to those about her, principally by gestures and affirmative answers to particular questions. She communicated her desire to take a bath by permitting the bathroom-door to be opened and then pointing in that direction until it was understood what she wanted. She communicated with and entertained her little ten-year-old son in a similar manner. She asked about the school, about his mistakes and those of his schoolmates by a simple continual repetition of the word "and" until she felt that he understood her. If she wished to state a certain number, she showed the corresponding (correct) number of fingers, or she would begin to count until the right number was reached. With the exception of slight errors she was able to count forward very well; on the other hand she was entirely incapable of counting back, and, on attempting to do so she invariably counted forward: 30, 31, 32, and so on. In answering questions she would sometimes say "yes" when she meant "no," and vice versa. Her understanding of reading was first discovered when she called the attention of her relatives to the sign on a passing delivery wagon, the owners of which she happened to know. When glancing through the society columns in the newspapers, she frequently pointed to items concerning individuals of her circle of acquaintances. In one of the newspapers she happened to see the name of *Professor Krause;* she at once recognized it and identified it with his person. She also understood the article that had reference to his address before the Surgical Congress. Written requests she understood only partly.

The naming of objects improved with practice. The word "lamp" she could name spontaneously—maybe because she made use of it very frequently. She made frequent mistakes

when her understanding of words was tested by more difficult examples. When asked to take two matches from a box and light one of them, she took the match-box, and acted as though wanting to remove one match and then she turned on the electric lamp. She was unable to write spontaneously with either hand or to take dictation, but she copied tolerably well.

The mental activity was the same as before the operation. Soon thereafter the patient began to play chess. On the 9th of May, 1909, for instance, she played a game with *Professor Oppenheim*, of which the latter writes as follows: "She placed the chess figures correctly, but later mistook some moves—these mistakes she also made before the operation (last) but to a lesser extent. Taking it as a whole the impression was gained that the patient did not remember the meaning of some of the figures on the chess-board. Generally speaking, she played badly, but the number of moves made, clearly showed judgment and forethought."

Requests to perform certain acts were now almost without exception carried out by the patient with precision. She was discharged from our care and left for her home in April, 1909. The wound resulting from the operation had completely healed. It represented a very deep cavity in the skull. The general condition of the patient was good. She could walk when supported. The mobility of the right arm had considerably improved; the patient was even able to move individual fingers—this however was slow and incomplete. The facial paralysis had almost completely disappeared (see Fig. 110).

On the 10th of May, 1909, the patient, who had recovered from three serious operations, was presented before the Berliner Neurologische Gesellschaft, by *H. Oppenheim.* Her general physical condition was now still more improved; she was able to walk about without support and was able to use her right hand fairly well. In spite of the repeated serious surgical attacks on the left temporal lobe the understanding of the meaning of words was generally well preserved even though it was affected slightly in certain respects. Spontaneous speech was naturally limited to naming of objects; the patient spoke connectedly only during emotional moments.

She continued to enjoy comparatively good health until

September, 1909. At that time she commenced to vomit for the first time. Her hand and lower limb on the right side again became paretic and her walk consequently worse. In the middle of October, the depression in her skull became much flatter—a recurrence had undoubtedly taken place. In March, 1910, exactly a year after the last operation, the tumor that was now the size of a man's fist was visible externally. Remarkable as it may seem, it is nevertheless a fact that the paresis of the right side considerably improved with the growth of the tumor, so that the patient was again able to walk unassisted. Her menstruation was regular until February.

Fig. 110
Taken June 6, 1909

On the 19th of May, I found the tumor enormously enlarged. In its lower portion it was knotty and firm, and in its upper part it evidently contained fluid.

An examination, made June 9, 1910, showed the following conditions:

The tumor was attached broadly and with great firmness. It extended from the lateral frontal region to the base of the mastoid process. It consisted of two great sections; the lower one was solid, and imparted, in some places, an elastic and in others a solid sensation, while in its upper part it was distinctly

fluctuating (collection of liquor cerebro-spinalis). The skin covering it was (in the hairless portions) mainly thinned, and in some places it was cicatricial; it contained everywhere thick veins, some of which were as thick as a finger. In some places there were solid pegs of the tumor resembling macroscopically those found on the tumors extirpated at the previous operations.

Mentally the patient was perfectly clear. Her memory was good; she supervised her household and settled with her help. She played chess and cards every evening until 11 o'clock. She read no more. However, she looked through the daily papers to see the numbers that won on the lottery, and to her great rejoicing one day found that she was a lucky winner. Her speech did in no way get worse—it was in every way the same as before. She was able to get about when supported on her left arm. Her hand and fingers on the right side were barely movable; on the other hand, active movements of the arm at the elbow and shoulder joints as well as in the lower extremity were possible to an almost normal extent. The foot and the right lower branch of the facial were paretic. The extremities of the left side were normal.

In the course of the following week the paresis in the right arm and lower limb became somewhat worse, so that the patient could only walk with difficulty. The tumor grew so rapidly that on the 20th of July it was about twice the size shown in the drawing of June 9th (see Fig. 111). On account of the enormous weight of the tumor the patient could no longer support her head and was therefore obliged to remain in bed for the last fourteen days. Notwithstanding this, however, neither the mental state of the patient nor her speech suffered to any appreciable extent—she still kept on playing cards. For the last few weeks clear liquor was seen dribbling from the lower peg of the tumor. On the 10th of July, disintegration of the extremely stretched skin in the upper part of the tumor set in, and necrosis of the tumor-mass with effusion of ichor. With all this there existed no symptoms of meningeal irritation or cerebral compression. Choked disc was absent until death. The eyelids on the left side were œdematous. Otherwise no disturbances were noted and the appetite of the patient was tolerably good. The bladder function and defecation were normal. Death supervened

Fig. 111

Taken June 9, 1910

on the 22d of September, 1910, with a temperature of 41°, high pulse-rate and increasing stupefaction.

The cerebral section (*Professor Dr. Oestreich*) revealed the

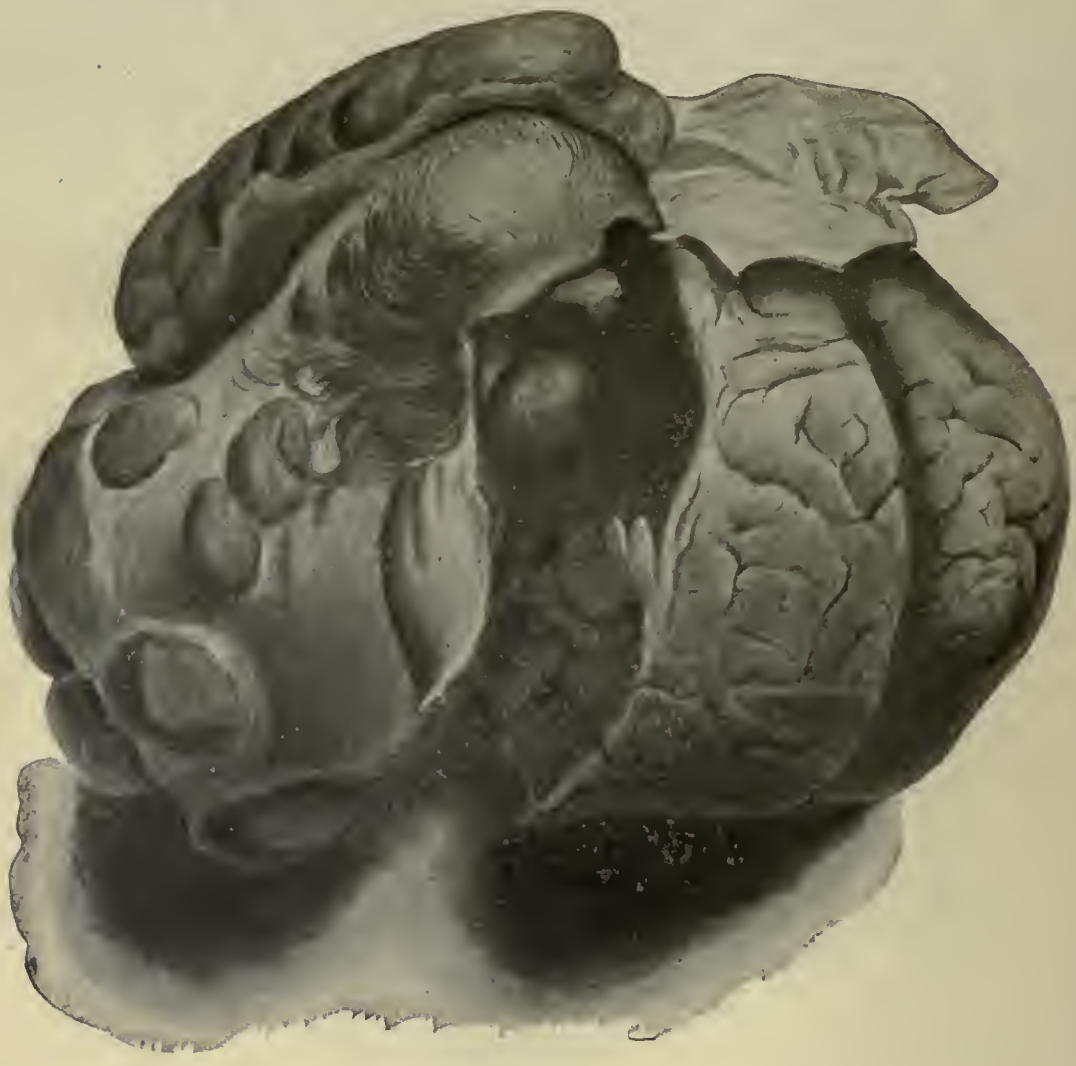


Fig. 112

Brain and Tumor Seen from the Left Upper Surface, ½

following conditions: No meningitis. The left cerebral hemisphere was surrounded by a tumor of enormous dimensions. It greatly overreached the frontal pole in front, and the occipital pole by about 5 cm. behind. The entire length of the tumor

measured from the front to the back 25 cm. Its width over the occipital brain was 13 cm., and at the frontal pole 10 cm. It looked like a third but much larger hemisphere. While the

Fig. 113

Brain and Tumor Seen from the Base

right hemisphere was entirely unaffected, only a small bit (about 5 cm.) of the left half of the brain remained. In its form the tumor showed a suggestion for the *Sylvian* fissure. After a few days of hardening in formalin, the tumor was of much firmer

consistency and distinctly separated from the still soft cerebral mass. The entire tumor-mass was in parts covered with pia and epidermal layers, and in other places with skin and hairs, while in still others it lay freely exposed on the surface. It could be removed from the brain *in toto*. In so doing, however, large portions of softened cerebral substance were torn. This exposed the entire median wall of the left ventricle to view. The lenticular nucleus was also shown to have entirely retained its form.

In the frontal brain the tumor-mass diffusely merged into the cerebral substance. The parietal portion of the central convolutions was preserved, while the farther, basally situated, sections, together with the entire temporal lobe, invisibly blended with the tumor. A portion of the cortical substance of the occipital lobe was also preserved. When the most marked enlargement of the tumor-mass was here pressed aside, it was shown that the processes of softening had extended deeply into the medullary substance of the occipital brain. The cerebellum did not appear to have participated in the morbid process. However, a striking narrowing was seen to exist in the left half of the pons, as well as in its left pedunculus cerebelli.

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Further observations on affections of the temporal lobe will be found in the chapter on "Cerebral Abscess."

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# Neoplasmata of the Parietal Lobe

The lower parietal lobe is composed mainly of the gyrus angularis and supramarginalis, and adjoins the posterior section of the lateral temporal convolutions and is situated immediately below the tuber parietale and in its vicinity—behind and above. The upper parietal lobe joins the lower one above and extends to the sagittal line above and to the lambdoid behind.

### Participation in the Central Innervation of the Opposite Side of the Body

With the sensory motor region, the parietal lobe of the brain also participates in the central innervation of the opposite side of the body. The upper section of the parietal lobe adjacent to the posterior central convolution is, together with it, representative of some sensory functions of the opposite side of the body—sense of pain and touch. While the *Rolandic* fissure sharply divides the motor from the sensory zone, the latter has no such limitations posteriorly. Consequently, foci in the upper parietal lobe and in the adjacent gyrus supramarginalis will, as in morbid conditions of the central region, cause disturbance of deep-seated sensibility, in the sense of position and in the stereognostic sense in the hand of the other side of the body as well as ataxia of the same hand. Disease of the middle third of the posterior central convolution and in the adjacent region of the lower parietal lobe occasion tactile paralysis (see p. 556). According to *Mills* and *Oppenheim*, astereognosis (ability to recognize objects by the sense of touch) is only then of diagnostic value, when it is severely damaged or entirely lost, while the other sensory functions are only slightly or not at all disturbed.

## Symptomatology

### Alexia, Agraphia, Hemianopsia

The gyrus angularis of the left hemisphere (in right-handed individuals) is the seat for the recognition and interpretation of

letters and written figures; it is related, on the one hand, with the visual cortex of the occipital lobe, and, on the other, with the sensory centre of speech in the upper temporal lobe. If the left gyrus angularis be destroyed by a neoplasm, or its function be interfered with in some way or other, the ability to read is destroyed, *alexia* (*word-blindness*) is the result. However, there is a difference between these symptoms. These depend upon whether the morbid foci have a superficial or deep location. Tumors, situated immediately behind the sensory centre of speech, in the gyrus angularis, when located in the cortex or superficially in the medullary layer, cause, simultaneously, severe disturbances in reading and writing (*alexia* and *agraphia*, see Fig. 95, p. 507, No. 12, blue); all the other functions of speech are at the same time only slightly affected in the form of a light paraphasia and difficulty of finding words. The almost constantly occurring hemianopsia observed in cases of deep-seated focal disease is wanting in these instances. Neoplasmata affecting the deeper medullary layers of the gyrus angularis, near the median surface of the brain, occasion *pure alexia* (inability to read, while the ability to write is retained). Since the visual radiation is located in the depth of the gyrus angularis, it may be directly influenced by focal diseases or indirectly by morbid foci distantly situated; *hemianopsia* is then the result (compare p. 654).

### Apraxia

Disturbances of apraxia, based upon the thorough studies of *H. Liepmann*, stand on the same scale with the symptoms of aphasia. Just as the aphasic individual is unable so to direct his intact muscles of speech that the proper words result in speaking, so is the apraxic patient impotent to combine and execute fine movements he has learned, although the functions of the muscles of his hand and arm are entirely uninterfered with. Aphasia may result from many causes. In motor aphasia the *kinæsthetic picture recollections* of sounds and syllables, as well as of simple words, are lost; in other forms of aphasia, again, recollections of past occurrences, essential in the act of speaking (loss of recollections of sounds in sensory aphasia), are inoperative. We designate as kinæsthetic the sensations we are

made conscious of during every movement of our joints, muscles, tendons, ligaments, and the skin; the recollections of these complexes we call kinæsthetic picture recollections.

Similar to these, apraxic disturbances may also have many causes. *Liepmann*, therefore, recognizes three forms of apraxia: the *limb-kinetic, the ideo-kinetic, and the ideatory.*

### *Limb-Kinetic Apraxia*

In this form, the specific recollections of very simple and much practised movements of the centre of a given limb are lost. All movements are performed by the patient heavily, awkwardly, and with uncertainty—like a child attempting to perform certain movements for the first time. Finer movements, such as threading a needle, sewing, writing, etc., cannot be performed at all. These disturbances have heretofore in part been considered under the heading of "cortical ataxia." Ataxia should, however, be spoken of only when the disturbances of motility result from very severe sensory disturbances. This form occurs in foci of the central convolutions, for which I have cited a very instructive example in Observation III, 6, on p. 560. Since paralyses overshadow the apraxia, limb-kinetic apraxia makes its appearance only in cases wherein the middle third of the central convolution is not completely destroyed, but only damaged to the extent of loss of kinæsthetic picture recollections. In processes where the posterior central convolution and portions of the parietal lobe, situated immediately behind it, participate to a considerable extent, the apraxia will be complicated by tactile paralysis and sensory disturbances. The decision for the existence of apraxia is then furnished by the circumstance that there will occur derailment of movements that cannot sufficiently be explained by the existing sensory disturbances.

The second form is the

### *Ideo-Kinetic Apraxia* (*motor apraxia* par excellence).

While we must assume that the pictures of recollection for simple and very practiced movements are deposited together as ready stamps in the centre of the hand in the central region, more intricate and less practiced motions condition a joint action of

the centre of the hand in conjunction with other territories of the brain—especially the optic, acustic, and tactile centres. Therefore, in such motions as combing, brushing, striking of matches, lighting of cigars, etc., the centre of the hand receives directions from other parts of the brain. The correct execution of a particularly designed mental picture (*ideatory design*) can be accomplished only *when the connections between the regions of the brain mentioned and the centres of the hand are intact.* If, on the other hand, these connections be interrupted, as principally obtains in instances of large foci behind the central convolutions in the parietal lobe, the ideatory design and the kinæsthetic recollection of pictures of the performing limb are torn apart—hence the term ideo-kinetic apraxia.

The patient may casually be able to perform simple and well-practiced movements, but he cannot execute them whenever he wishes or is compelled to do so. He may, for instance, be unable to perform the simplest movement when *asked to*, for, in order to accomplish these motions, no matter how simple or apparently insignificant, it is essential that the connections between the left temporal lobe and the centre of the hand be intact. He is also unable to imitate even the simplest movements, because here again the connections between the optic centre and that of the hand must remain uninterrupted. Frequently the patient will perform movements that are entirely unintended and disorganized; this is due to the fact that the impulses travelling to the centre of the hand run in the wrong direction, and the result is that if the patient wishes to execute a motion of threat he will, because of this derailment, wink his eyelids. The severest forms of derailment and interchange of motions will occur in the case of combined movements (lighting of a cigar, etc.) already referred to.

Both forms hitherto described may, in the sense of *Liepmann*, be classed under the head of motor apraxia.

For purposes of better illustration, both schemes sketched by *Liepmann*, together with his explanations, are herewith given.

The third form,

*Ideatory Apraxia,*

has been principally established through the observations of

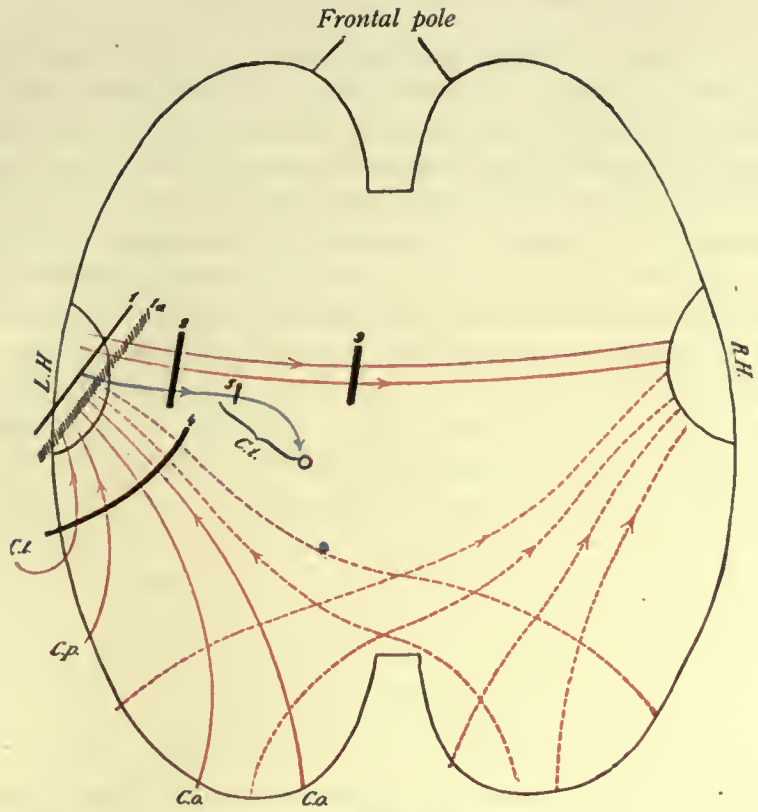



Fig. 114

Horizontal Scheme of Apraxic Disturbances. *H. Liepmann*, in *Curschmann's* "Lehrbuch der Nervenkrankheiten," Berlin, 1909, J. Springer, p. 493.

*L. H.*=Centrum of the right hand in the left brain.
*R. H.*=Right brain centrum of left hand.
*C. c.*, *C. p.*, *C. t.*=Cortical origin of the occipital, parietal, and temporal association-fibres to the centre of the hand in the left brain. The corresponding association-tracts to the hand-centre of the right brain; also the tracts running from the right hemisphere to the left, shaded in red to designate their subordinate significance. The connections of the corpus callosum between *L. H.* and *R. H.* are marked by two prolonged red lines. The blue line, leaving the plane of the figure at the end of the arrow, represents the projection fibres of *L. H. C. i.*=capsula interna.
The route for purposive movements of the right hand runs from *C. o.*, *C. p.*, *C. t.*, over *L. H.* through the blue line to the cells of the anterior horn of the cervical cord. For purposive movements of the left hand the route is principally from *C. o.*, *C. p.*, *C. t.* over *L. H.* through the corpus callosum to *R. H.*; a by-way leads through the lines shaded red to *R. H.*
1=The focus completely destroying *L. H.*; paralysis of the right and dyspraxia of the left hand.
1a=Slighter lesion of *L. H.*, not leading to total paralysis, but destroying the amnesic property of *L. H.*, limb-kinetic apraxia of the right and dyspraxia of the left hand.
2=Paralysis of the right and dyspraxia of the left hand.
3=(Focus in the corpus callosum.) Dyspraxia of the left hand.
4=(Focus behind the hand centre in the parietal lobe.) Ideo-kinetic apraxia of the right and dyspraxia of the left hand. Foci located in the left hemisphere farther back and diffuse processes frequently cause ideatory apraxia.
5=Focus in the capsule; causes paralysis of the right hand without occasioning dyspraxia in the left.

*Pick*, and closer analyzed by *Liepmann*. In these instances the limb-kinetic and the connections between the limb-kinetic and the ideatory design are not affected—the ideatory design alone is wrong. These disturbances resemble derailments during absent-mindedness. All single movements are successfully performed, imitation is also good, but as soon as the patient wishes to execute a more complicated movement, all kinds of motions become at once confusedly interchanged and dissimulation results in the individual parts of the particular movement. The patient, for

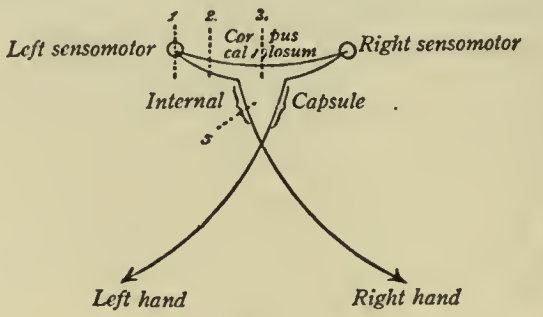



Fig. 115

Frontal Scheme of Apraxic Disturbances of the Left Hand; from *H. Liepmann's* "Drei Aufsätze aus dem Apraxiagebiet." Berlin, 1908, S. Karger, p. 38.

1 = Cortical lesion. 2 = Supracapsular lesion in the medullary layer. 3 = Lesion in the corpus callosum. 5 = Capsular lesion.

instance, may strike a match on the cigar, or he may try to cut the end off the cigar on the match-box, and so on. Ideatory apraxia is frequently observed in diffuse chronic diseases of the brain, such as progressive paralysis, extensive arterio-sclerosis, and senile dementia. It seems to be especially produced in foci at the point of transition from the left parietal to the occipital lobe.

Apraxia is principally found in foci affecting the left hemisphere, the right hand is therefore mainly affected.

*Liepmann's*[1] studies have further shown that in severe apraxic disturbances of the right hand, there usually occur slight dispraxic disturbances of the left hand. From this we conclude

[1] "Die Linke Hemisphäre und das Handeln." Münch. med. Wochenschrift, 1905, and "Drei Aufsätze aus dem Apraxiegebiete." Berlin, Karger, 1908.

that the left hemisphere exercises a leading influence over the right half of the brain and the left hand in complicated movements, especially in the execution of those movements that are performed from memory. Consequently, if corresponding foci in the left hemisphere cause apraxia of the right hand as well as paralysis of this member, apraxic symptoms will then usually assert themselves in the non-paralyzed left hand; this will be principally noticeable when the patient attempts to perform movements from memory or by imitation. Under these circumstances he is unable to threaten, wink, throw kisses, salute, to drink, nor can he perform the motion commonly called "long nose" with his right hand. He is also unable to count money correctly or to strike a match properly or light a cigar, use the toothbrush and similar movements. If these movements are performed before him he cannot imitate them. Furthermore he is unable to execute the movement of catching a fly, knock at the door, play the grind-organ, etc. Since the corpus callosum transmits impulses travelling from the left to the right hemisphere during action, large foci within the former will give rise to dyspraxia of the left hand without involving the right in any way. In these instances its middle third comes especially under consideration. In fact, tumors or softening of the middle third of the corpus callosum have in a number of instances caused isolated dyspraxia of the left hand.

Dyspraxia of the left hand with paralysis or apraxia of the right usually occur only where the paralysis is brought about by supracapsular foci and not where the focus is within the capsule or beyond it. The latter foci cannot possibly give rise to dyspraxia of the left hand because the fibres of the corpus callosum are intact. However, a focus in the corpus callosum may cause isolated dyspraxia of the left hand.

Speaking of localization collectively, it may be stated that the foci within the cortex or medullary layer of the central region, will principally cause paralysis of the right hand and dyspraxia of the left. Large foci in the left parietal lobe give rise to apraxia of the right and dyspraxia of the left hand, while foci in the corpus callosum cause dyspraxia of the left hand only. When foci in the right hemisphere affect the intrahemispheral fibre-tracts of the corpus callosum or the centre of the hand in

the right brain, they are likely to cause limb-kinetic apraxia of the left hand alone. In left-handed individuals all of these conditions are reversed. In their case the right hemisphere is dominant.

Foci affecting the arm-centre (1) of the left side proper, or its projection-fibres, together with those of the corpus callosum (2), rob the arm-centre of the right side of the brain of this conductivity and simultaneously paralyze the right upper extremity, causing paralysis of the right and dyspraxia of the left hand. Where the focus has only slightly extended (see 1a, Fig. 114) the right upper extremity becomes paretic or apraxic.

Foci affecting the capsule and the body of the corpus callosum proper have the same effect as (2), but to a greater degree (5+3).

A focus that would extensively affect, in a particular place, the corpus callosum alone (3) would occasion left-sided dyspraxia by robbing the right-sided centre of the hand of its paths through the left, while the right hand is not necessarily apraxic or paralyzed.

On the other hand, a focus that affects the internal capsule (5) spares the fibres of the corpus callosum and therefore causes only paralysis of the right hand and does not interfere with the usefulness of the left.

The following case serves as an example for the combined occurrence of aphasic and apraxic disturbances.

## OBSERVATION V, 1.

*Fibro-Psammo-Sarcoma of the Left Lower Parietal Lobe. Symptoms Began with Disturbances in Writing, Figuring, and Reading—Later on Also in Speaking and with Apraxic Disturbances. Cerebral Puncture for Accurate Localization; in Immediate Connection Therewith Acute Cerebral Compression, Followed by Paralysis of the Vagus. Death, Despite Immediate Extirpation of the Tumor.*

M. L., merchant, thirty-eight years of age, had, outside of sciatica, always enjoyed good health. In the beginning of July, 1910, he noticed some difficulty in writing and figuring, and later on in reading. While writing he was obliged to suddenly

stop; he could not continue, and he also selected wrong letters. This condition became progressively worse, so that at the end of September he found himself much handicapped in the transaction of his business. He also experienced difficulty in finding the proper words he wished to speak; this was especially marked when he became excited. Not only was he conscious of his condition, but those about him had also observed it. He left out words in his correspondence and not infrequently substituted other expressions for those he intended to use. About the beginning of September a trembling of the right arm was added to the existing symptoms, and the patient would occasionally complain of a sensation of pressure in the left eye. At the end of October well-developed disturbances in reading, writing, and figuring were noted. The speech became labored and hesitating, and the patient frequently thought of words in vain. He could read for himself tolerably well; he evidently understood everything, but reading aloud caused him great difficulty. The disturbances in writing were much more marked, especially writing from dictation. He was unable to read numbers in succession and he added very poorly. He had, for instance, trouble in finding the word "elephant," although the animal had been described to him. Its name, the patient told us, soared before him. He was sometimes unable to write down the simplest words, or he would do so with great difficulty, even such words as "is" or "yes."

In November the patient vomited a number of times. In the beginning of this month the ophthalmoscopic examination, made by specialists, showed nothing pathologic, a commencing bilateral papillitis, with grayish-red discoloration of the papillæ and swelling, however, was found on the 22d of November. The veins were tortuous, dilated, and small-pointed hemorrhages were observed at the papillary borders. On the 6th of December the findings on the right side were the same, while on the left the choked disc became more marked. The acuteness of vision was $\frac{5}{5}$ R., and a little over $\frac{5}{10}$ L. At the end of December the choked disc reached a height of R. 2 D, L. 3 D. Moderate concentric narrowing of the visual fields on both sides. The left choked disc was more marked than the right throughout the disease. There was no diplopia at any time. Outside of the very slight narrowing of

the visual field above referred to, there at no time existed hemianopsia; not even an indication of loss of psychologic perception of visual objects.

His Excellency, *Erb*, sent the patient on the 6th of December, 1910, with the following letter to *H. Oppenheim* and myself. "There exists an admixture of aphasia (by no means purely motor but of a more amnesic nature—a sort of dysphasia with rapid fatigue), dyslexia and alexia, agraphia, difficulty in figuring, partial amnesia, etc.—but nothing of a sensory aphasia. The cranial nerves and the extremities of the right side show only traces of beginning disturbances (slight exaggeration of the patellar reflex on the right side); a trace of astereognosis of the right hand; peculiar tremor of the extended hand, no hemianopsia, etc. Since a few weeks severe headaches have set in (left parietal; now more in the frontal region); occasional vomiting and rapidly progressing choked disc ($1 > r.$) have been noted (ophthalmoscopic examination inclosed), so that we are doubtlessly dealing with a tumor. I suspect the tumor (or whatever the condition may be) to be located particularly in the region of the gyrus supramarginalis and angularis, and I hope that the affection is one amenable to surgical intervention. At any rate, on account of the choked disc, operation is urgently indicated."

The patient was not inclined to submit to an operation because his subjective symptoms were at that time very slight (at times practically *nil*). His headaches left him.

The following is taken from *Oppenheim's* observation:

Repeated careful examinations of the sense of smell of the patient (medium-sized male, thin, somewhat pallid) were always negative. The pupils reacted promptly. The corneal reflex was lively. Throughout the entire period the patient was under observation, there existed a slight weakness of the right orofacialis. The uvula deviated somewhat to the right. The patient occasionally complained of slight buzzing noises in the left ear; but the acusticus (examined a number of times by otologists) showed nothing abnormal. The middle ear was also sound. No pathologic conditions were found in the cranial nerves. In December, the periodic, severe, left frontal headaches had im-

proved. The patient occasionally complained of deep-seated pain in the left eye. A peculiar motor-restlessness of the right arm was observed that was evidently caused by slight muscular contractions of the biceps, then, again, in the pectoral muscles. At times slight elevations and descents of the arm were observed; at other times again slight movements in the fingers and thumb were noted. These contractions were always strongest in the region of the right shoulder. The left extremity remained perfectly quiet. Sensory disturbances could not be demonstrated. A few days preceding the puncture the patient was from time to time unconscious of being touched on the right hand with the brush.

The motor power of both arms was about the same. Ataxia did not exist. In the right arm and lower extremity, suggestions of spasticities were found, but this was not always the case. The patellar and Achilles tendon reflexes were always livelier on the right than on the left side. Of the abdominal reflexes only the left lower could be elicited. No pathologic reflexes were found during the numerous examinations made. The slight stereognostic disturbances of the right hand found in October were increased in November and regressed again in December. Objects placed in the hand of the patient on the 28th of December were recognized with difficulty, but equally on both sides. The sense of position of the right thumb was found uncertain, and the movements of the left thumb to the left were also frequently incorrectly indicated.

The urine remained free from albumin and sugar.

### *Disturbances of Speech, Writing, Reading, Figuring, and of Praxia*

These disturbances were constantly on the increase during the course of the disease. Marked fluctuations were also noted.

The first symptom noted by the patient and those about him was an inability to find the proper words; this was especially the case when he became excited. In the beginning of November there was a *deficiency of words.* When asked to recite the strophes of certain songs, he confounded about every fifth word with another, and in spite of prolonged reflection he was at no time able to recite more than fifteen words in succession. When

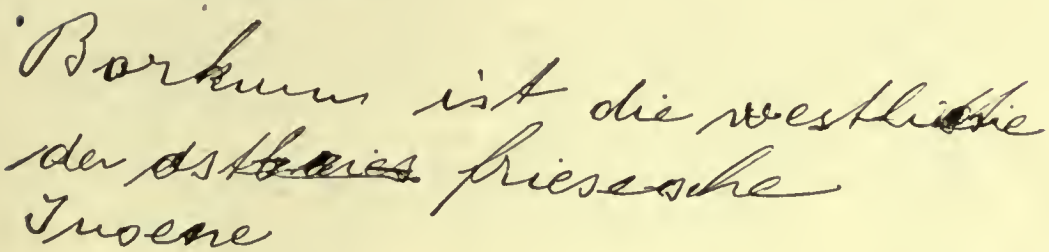
repeating words spoken to him, he frequently changed them. For instance, "comb," instead of "come." He also added words that did not belong to the sentence at all, and he frequently interjected the word "and." When he was asked to repeat words he often made mistakes. In general conversation he was also noted to interchange words—"eye," instead of "ear," etc.

The patient was aware of having made mistakes, but he found it impossible to think of the right word and use it at the proper time. His spontaneous recitations were very poor in words. When relating past incidents, as giving his history, the educated patient related it very poorly. On the 23d of December he was even unable to describe simple occurrences such as the recent sending away of a letter and other simple acts. This was due to an amnesic aphasia that had recently made its appearance. After this, a distinct improvement was noted. At the end of December he was able to speak a few complete sentences. In January the word deficiency had greatly improved.

In the beginning of the disease the *understanding of speech* was unaffected. It was about the 11th of December when disturbances of speech became apparent. When simple questions were asked of the patient he understood them tolerably well; but when three or four questions were put to him in succession, he understood the last one poorly, and not infrequently the third question conveyed to him a hazy picture. In the further course of the disease, the understanding of even simple words became difficult; yet there were intervals (end of December and beginning of January) when a succession of sentences asked were well understood by the patient. Marked disturbance of the understanding of speech could at that time not be demonstrated.

*Disturbances of spontaneous writing* were noticed early in the disease. The patient observed that he made mistakes in writing letters; this was also noted by his relatives. In the beginning of November spontaneous writing was very much disturbed. The patient had to think for a long time before he was able to put down even a simple sentence. While he uttered the sentence, he was about to write correctly, he substituted wrong words for those he intended to express, and put them in the wrong place; during this time frequent and marked perseverations were noted. After a fortnight much improvement had taken place

and the misconstruction of words had vanished. However, in the middle of December, they recurred in great severity. A few days later there were only a few misconstructed words and less perseveration. This condition continued. In the beginning of January there was marked paragraphia with misconstruction of words. Still greater were the disturbances of *dictation-writing* (except in the middle of December). Letters were frequently left out by the patient, or after putting them down he struck them out; for instance:



At the end of November and 16th of December *copying* was almost free from faults. The patient, however, made frequent corrections. There were letter perseverations. He could read letters well at all times. He also understood short written requests; this was shown by their correct execution. Prolonged examinations, however, revealed a certain dulness and retarded interpretation.

In the beginning of the disease, reading in a whisper caused the patient no difficulty whatever. Reading of difficult passages from the newspapers were only partly understood by those listening. There existed a slight *dyslexia*, but no pronounced alexia. These by themselves insignificant disturbances in the understanding of reading were fluctuating, but were undoubtedly less pronounced in the beginning of January. It was at that time difficult to decide whether we were dealing with real disturbances in reading or whether they could be attributed to sensory disturbances of speech.

In the beginning of the disease *reading aloud* was much disturbed. In the beginning of November the patient read about every tenth word wrong. When he attempted to correct himself, he became more and more entangled. Sometimes he would, after

much perseveration, succeed in pronouncing the right word. In the middle of December his condition was about the same. At the end of the same month words were frequently interchanged. However, an improvement in reading aloud could at that time be noted, which continued until the day of the operation.

*Translation* of simple and short sentences into French, Latin, and Italian were tolerably well performed. It is noteworthy that in the Italian language he translated best.

*Disturbances in figuring* were present during the entire later course of the disease and to an experienced merchant they were striking. Addition and subtraction were generally more affected than multiplication, while rapid multiplication tired the patient in an extraordinary manner. He finally was even unable to add up two simple examples of addition from memory. He generally figured better with paper and pencil, but an example of subtraction, as the following, was accomplished as shown below:

$$\begin{array}{r} 735 \\ -476 \\ \hline 9 \end{array}$$

On the 23d of December he multiplied correctly and from memory $3 \times 16$, but he was unable to add $14+16$ on paper.

*Drawing of figures*, etc., was accomplished poorly.

The *apraxia* was inconstant and of fluctuating intensity. At the end of October, Excellency *Erb* was able to find a distinct apraxia of the left hand. During the examination made by *H. Oppenheim,* on the 11th of December, the patient executed with his left hand motions of threat and salutations incorrectly. He could not make a "long nose" with either hand. He winked correctly only once. On December 14th the movement of drinking was performed badly with both hands. The motion of turning the handle of a coffee-grinder was executed equally well with both hands. With the left hand the patient counted money poorly, and with the right hand a little better. The handling of objects (toothbrush) was performed better because the apraxia was of lesser degree here. On the 20th of December the presence of this particular disturbance could not be demonstrated at all. Three days later it was again distinctly present, taking place on the left. Then it began to lessen again, so that at the beginning

of January it was barely noticeable. Still, the fact that the patient touched with the little finger of his left hand the tip of his nose when asked to insert it into the ear is significant, and in a sense points to an apraxia.

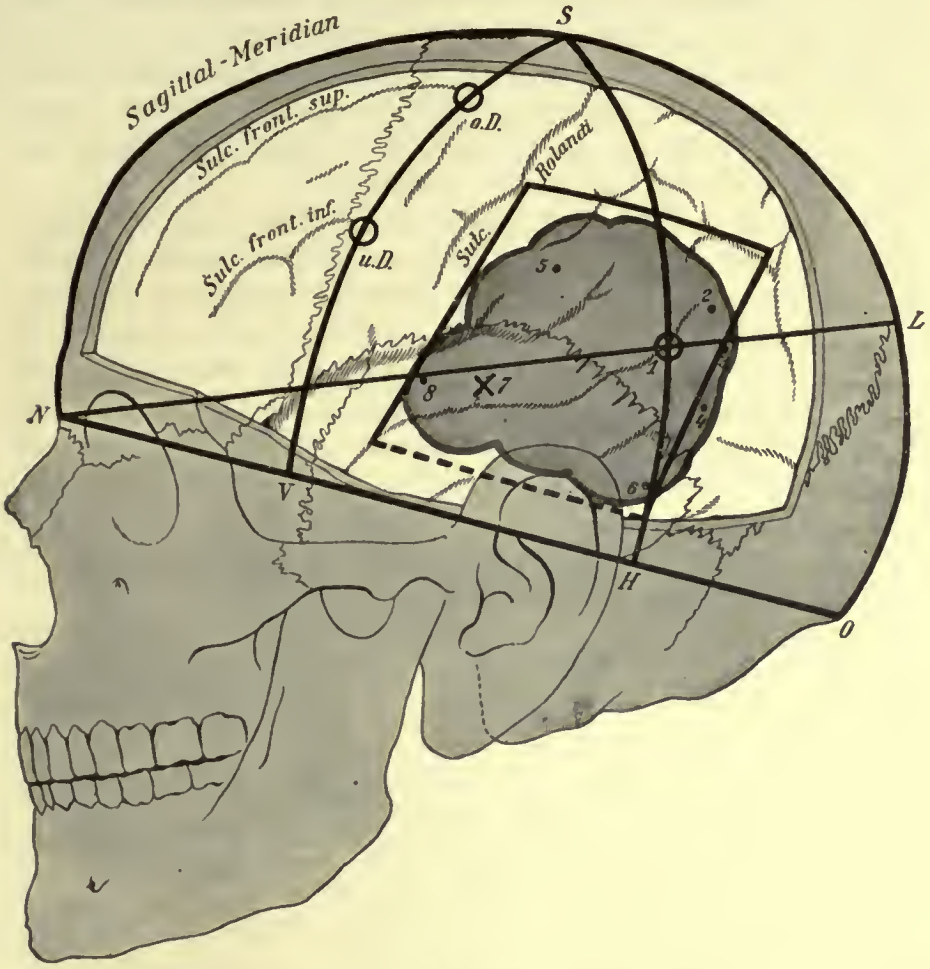



Fig. 116

Here we see the scheme of *Kocher's* craniometric lines (see Vol. I, p. 233, Fig. 53) into which the points at which punctures were made were drawn. The only ones of these that yielded positive results lay at No. 7 x. The hatched part in the drawing corresponds to the extent of the tumor. The incisions made at the operation outline it fairly well.

As already stated all symptoms of aphasia, alexia, and apraxia regressed more and more toward the end of 1910. The examination on the 5th of January, 1911, showed no important defects

either in the form of a sensory, amnesic, or motor aphasia. The patient was now able to read much better. A distinct apraxia could no longer be demonstrated. Spontaneous writing was still paragraphic throughout and figuring was also disturbed. The patient multiplied $6 \times 13$ as 54; this result he got after much hesitancy, and he found it impossible to finish the example from memory. When asked whether he recognized the numbers uttered before him by the sound of the speaker or from a mental picture of the particular number, he replied that "only as a mental picture of the number."

Tired of the long observations and after going through a course of inunctions without improvement in the choked disc, the patient now consented to a proposed operation. For purposes of better localization, and complying with the requests of the patient and his relatives, with the patient under superficial chloroform anæsthesia, I performed cerebral puncture, on the 9th of January, 1911. After consulting with *Professor H. Oppenheim*, we concluded that the portions of the brain to be considered in the punctures were the left temporal lobe (in its posterior third), especially its upper convolutions, and the gyrus angularis of the parietal lobe.

*Kocher's* lines and the line of *Kroenlein* for locating the central fissure were drawn on the shaved skull of the patient. Suction for brain cylinders was performed in the following places:

1. Point of intersection of the linea limitans with the linea nasolambdoidea; 1 cm. distant from the dura.

2. Fifteen millimetres above and posterior to point 1; in all probability into the gyrus angularis; 1½ cm. deep.

3. Fifteen millimetres behind point 1, on the linea nasolambdoidea; 2 cm. deep.

4. Two centimetres posteriorly to and below point of intersection 1; 1½ cm. deep.

5. Three centimetres in front of and above point 1, 20 mm. sagittally behind the central fissure, probably in the gyrus supramarginalis; 1½ cm. deep.

5 a. At the same place, but somewhat deeper—about 2 cm.

6. In the linea limitans, 3 cm. below point 1; over 2 cm. deep.

7. Eighteen millimetres posterior to and below the foot-point of the *Rolandic* fissure, consequently in the posterior part of the operculum or in the upper temporo-sphenoidal convolution; richly over 2 cm. deep.

7 a. Through the same drill-canal, but more posteriorly and below, toward the posterior end of the I or II temporal convolution, extending to a depth of about 1 to 1½ cm. into the brain.

8. At point of intersection of the linea *Rolandica* with the linea naso-lambdoidea; 1½ to 2 cm. deep.

Only punctures at points 7 and 7 a were positive; from all other points nothing at all could be aspirated. The particles obtained from suction were friable, grayish-white in color, and translucent—hence not of the appearance of brain-tissue. Immediate microscopic examination showed these to be composed of œdematous tissue permeated by a few round cells, while pigment was not found. Masses of detritus were also found in the lymph-spaces. These extended in some places for a considerable distance. In the fifth crush-preparation of puncture point No. 7, an aggregation of slightly oval, large, vesicular cells were found. No intercellular substance could be recognized. Proliferations of these cell masses were in some places seen to extend into the cerebral substance. The brain-tissue near these masses looked disintegrated and arranged in strata. Oval, spherical, and very large cells of sharp contour were found intermingled with an aggregation of small round cells. We were therefore dealing with a sarcoma.

After completing the punctures (11 A.M.) the patient was pale and unconscious. His pulse was 62, fairly full and of good tension. His respirations were 25. On the days preceding the operation, his pulse was 72 to 80 per minute. Three hours later the patient was still unconscious and his pulse-rate fell to 58 beats per minute. Operation was contemplated in the event that the patient should not react soon. However, about three o'clock of the same afternoon the pulse of the patient rose to 72, the respirations slowed down to 20 per minute, and reaction commenced. This caused me to wait and watch developments. At four o'clock the respirations went up again to 26, his pulse was 56, and every trace of reaction disappeared. I decided to operate at once. While the patient was being prepared, his pulse

shot up to 160 beats per minute (4.15 P.M.), it became irregular, his respirations were more frequent, and he was profoundly somnolent.

The operation was performed without an anæsthetic, and it did not last over twenty minutes. The anterior incision was made somewhat posterior to the central fissure. The posterior immediately behind the linea limitans, meeting the latter at an angle. The osteoplastic flap was about 8 cm. wide and 7 cm. high. After incising the strongly tense dura, it was possible to deliver the tumor from its cerebral bed with ease. It was well encapsulated and grown onto the inner surface of the dura. It was pulled up and enucleated. The loss of blood was insignificant. All cerebral convolutions exposed to view were dry and perfectly flat. The tumor lay exactly in the opening made by the trephine, reaching in front as far as the posterior central convolution and it extended behind to the occipital brain and below to the upper part of the temporal lobe. Its upper border was at the sulcus intraparietalis. The neoplasm was of hard consistency and the size of a large fist of a child. It measured 60 mm. in thickness in its frontal diameter (from dura to median limit), and in vertical height 60 mm. Its sagittal length was 75 mm. At no place in the surrounding convolutions were there any evidences of puncture or hemorrhages. The patient died shortly after the operation without regaining consciousness.

Sagittal section of the tumor showed that it had been entered by all eight punctures, in every direction; they could of course not penetrate into the underlying normal cerebral tissue on account of its thickness (60 mm.). The explanation for the negative results from suction lies in the hardness of the tumor, regardless of the fact that the puncture at point 7 struck a softened cerebral area. Eight punctures were found in the dura, removed together with the tumor.

The neoplasm, a fibro-psammo-sarcoma, was composed of a network and was made up in part of connective-tissue cells with spindle-shaped nuclei, while in other parts the cells were larger, oblong, and irregular, with pale, round nuclei. Concentrically lamellated cell masses were seen in many places.

If all symptoms of this case be collectively taken into con-

sideration, we find that the slow, gradual progress of the disease, together with the rapid onset of choked disc (always more marked on the left than on the right side), distinctly pointed to the presence of a neoplasm within the cranium. In this instance the striking aphasic disturbances appeared to be a characteristic sign of tumor. That this is a fact in similar cases has been pointed out by *L. Bruns.*

With reference to localization there could in the first place exist no doubt that the left hemisphere was the one affected, because the patient was right-handed. Secondly, the fact that the aphasia was one of the earliest manifestations of the disease —in fact it occurred at a time when hardly any other symptoms were present with no changes in the fundus oculi—clearly indicated that the tumor was located, and in all probability originated in the *aphasic territory.* And, in order to arrive at a more exact localization, it must be taken into consideration that we were dealing with amnesic aphasia depending upon damage to the tract leading from the sensory to the motor centre of speech. Interruption of continuity in any part of these tracts causes a difficulty in finding words (paraphasia) and injury to the repetition of speech. Slight participation of the sensory centre of speech does not annihilate repetition of speech and the understanding of the same, but it impedes the incitation of conceptions of the recollection of sound-pictures. It is remarkable that the large-sized tumor in this case did not affect the sensory centre of speech to a greater extent. This may have been due to its peculiar growth and extension posteriorly. The same fact may also explain the interchange of words instead of their misconstruction. Optic-acustic connections have undoubtedly been interrupted. The disturbances of reading and writing pointed to an involvement of the gyrus angularis. The

*Apraxic Symptoms*

pointed to the possibility of supracapsular neoplasm. The intentional execution of symbolic movements was especially affected. The apraxia in this case was undoubtedly of the *ideo-kinetic* type, regardless of the fact that toward the end of the observations suggestions of limb-kinesis were present. Remarkable and of great importance was the fact that the apraxia was predominat-

ing in the left hand while the right was only eupraxic or participating slightly. The ability of the right arm to move was just as little affected as the left, so that a concealment of an apraxia on the right side was out of the question.

In this case the large tumor has evidently exercised direct *pressure on the corpus callosum.* This circumstance should, in the sense of *Liepmann,* lead to dyspraxia of the left hand without paralysis or substantial dyspraxia of the right hand. From the position of the tumor we are able to judge that it no doubt destroyed a number of cortico-temporal as well as one or the other cortico-occipital tracts in their course. Had all respective tracts been destroyed, ideo-kinetic apraxia of the right hand would necessarily come to the foreground; as a matter of fact this hand, compared with the left, was essentially eupraxic. At any rate, the limb-kinetic centrum of the central region was only sympathetically involved to a slight extent. However, this case is a rare one, for the reason which it represented an instance of left-sided apraxia without right-sided paralysis.

The *astereognosis* of the right hand which was constantly on the increase in intensity from October to November and then regressed in December and finally disappeared, also spoke for a participation of the left parietal lobe or of the middle third of the posterior central convolution situated in front of it. The actual position of the tumor proved the correctness of this assumption.

The slight spasms noted in the later course of the disease, mainly in the right half of the body, furthermore, the slight but nevertheless noticeable participation of the right facialis, pointed to certain damage of the corresponding centres and tracts (distant action or neighborhood symptom). This was also true of the trembling observed in the right arm almost from the beginning of the disease.

The tumor in all probability originated from the arachnoid or from the inner surface of the dura. It will be recalled that at the operation it was found broadly united with the latter. This circumstance seems to have caused the headaches in the beginning of the disease and their existence can be attributed to the connection of the neoplasm with the dura. Regardless of the cortical position of the tumor, *Jacksonian* spasms were

not noticed in this instance. This was due to the fact that the tumor was situated posteriorly and at some distance from the anterior central convolution. On the other hand, the primary seat of the neoplasm in the lower parietal lobe gave rise to early morbid manifestations of reading and writing. Such comparatively slow growing fibro-sarcomata may, as many experiences taught me (compare Observations I, 5, p. 328; IV, 1, p. 590; VI, 1, p. 640), attain a considerable size. The clinical manifestations they produce in these instances are very slight. The neoplasm gradually presses the cerebral convolutions apart or displaces them.

The cortical origin of this case is also responsible for the absence of hemianopsia. While it is a fact that the visual radiation runs in the depths of the gyrus angularis, it is also true that it had time to accommodate itself to the slowly growing tumor, which finally became very large.

The fact that the important symptoms upon which we based our local diagnosis were markedly improved while the patient was under observation (beginning of December to January) was for the patient of ominous significance. The improvement in the condition of the patient may have been brought about by the absorption of the fluid from within the tumor and its vicinity by the action of the mercury imparted to him in the form of inunctions. Lues did not exist. As I have stated in Volume I of this work, personally, I am much disinclined to perform cerebral puncture, but the patient was tired of the long period of observation and was yearning for a positive diagnosis; hence my decision for puncture. When we consider that in cases which are surgically analogous to the one under consideration, the patients, as a rule, make good recoveries after undergoing radical operations for the extirpation of the neoplasms, I cannot but think that the cerebral punctures in this instance have undoubtedly caused the death of the patient. Tumors of large size and solid consistency, even if not in the posterior fossa of the skull, carry with them the following danger.

Every cerebral puncture, no matter how carefully performed (even with the finest possible cannula), when it strikes the tumor it necessarily depresses it somewhat, or carries it forward; suction then pulls it up again. If as a result of the tumor the intracra-

nial pressure be high, as in our last case (shown by the flattened condition of the cerebral convolutions), comparatively slight traumatizations, such as are inflicted by cannulæ for purposes of puncture, may not only aggravate the condition of an already forcibly compressed brain (œdema), but may lead to direct death of the patient. Simple lumbar puncture, with draining off of small quantities of cerebro-spinal fluid, are known in similar cases to have caused immediate death of the patient. The rapid changes in the pressure conditions are responsible in these cases for the disastrous results. Penetration of the cannula into the cerebral substance will cause the latter to yield and permit the instrument to enter it readily; disastrous consequences will therefore not follow. The same is true in cases of soft tumor (gliomata).

In the case just described all punctures terminated in the substance of the tumor which was 6 cm. thick. Very minute examination showed that the cannula did not impinge against the cerebral tissue, nor were there any hemorrhagic spots that could have augmented the occurrence of acute cerebral compression. In view of these elucidations it will be seen at once that cerebral puncture as a method of localization and diagnosis is to be regarded as an extremely dangerous procedure. I cannot too forcibly emphasize my contrary attitude and condemnation of the prevalent view in vogue among internal medical men who extol the harmlessness of this method. In our case after once the acute cerebral compression had set in and the vagus became paralyzed (heightening of pulse-rate from 56 to 160 beats per minute) even the immediate extirpation of the tumor was unable to effect a change for the better.

### Optic Aphasia

Morbid foci, situated at the boundary between the temporal brain and the occipital lobe or in its anterior section, may occasion optic aphasia. This represents a form of amnesic aphasia. According to *Liepmann*, the loss of spontaneous speech, in cases of *amnesic aphasia* or *verbal amnesia,* is not total: "The finding of words is very difficult; however, if the word is offered to the patient, it is at once recognized by him as the correct term, and he repeats it correctly and with ease. This form of the disease is

found under various circumstances. It is always the case when one of the stations, which the process of speaking has to pass before it reaches the motor centre, is slightly injured." In the subdivision of amnesic aphasia, we are designating as optic aphasia (optic-tactile aphasia of *Liepmann*) those cases where the names of objects are not found by the patient, even though the facial and tactile senses help to bring them to the consciousness of the patient. It is singular, however, that as soon as a sound issuing from a trumpet is heard by the patient he will at once recall the right word.

*Deviation Conjuguée*

(see p. 530) is observed in focal diseases of the parietal lobe (gyrus angularis), when its function is destroyed toward the side of the focus. In the event of an irritation only it affects the side away from the focus. Corresponding rotation of the head may be connected with it or be absent. The explanation for this lies in the fact that the fibres connecting the optical field of the cortex in the occipital lobe with the visual centre at the foot of the second frontal convolution traverse the gyrus angularis.

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I have already cited a case of solitary tubercle in the central convolutions, which produced manifestations of tumor (see Observation III, 6, p. 560). Aggregations of such tubercle masses in the brain, may, as in any other part of the body, soften, then suppurate, and finally create the anatomic picture of abscesses. As a rule, nothing is changed in the clinical picture, be it a case of solitary or suppurating conglomerated tubercle. An example follows.

## OBSERVATION V, 2

*Two Subcortical Tuberculous Abscesses in the Upper Parietal Lobe. Extirpation; Tamponade. Cerebral Prolapsus. Local Healing After Plastic Operation. Death as a Result of Progressive Pulmonary Tuberculosis.*

Patient, twenty-eight years old, states that until he was twenty-seven years of age he always enjoyed good health. In the beginning of November, 1905, he suddenly took ill with

paræthesias in the right hand and spasmodic contractions of the fourth and fifth fingers of the same hand. These manifestations were repeated on the following days, and at that time extended to the hand and arm. The spasms were especially marked in the middle of November, and after the patient was unconscious for a number of hours, they affected the entire body. The physician treating him at that time found besides the motor and sensory symptoms of irritation just alluded to, ataxia and disturbances in the muscular sense and in the sense of position of the right hand as well as a reduction in the sensibility of the skin. Since the middle of December, after a period of apparent tranquillity in the disease, the condition of the patient gradually and progressively became worse. There gradually developed a motor ataxia of the entire right side, which was especially marked in the right arm. The diminution in sensibility was gradually increasing. The earliest and most marked of these were the senses of position and stereognosis, followed by those of touch and pain. The same manifestations were also noted in the right lower extremity, but to a lesser degree. Since the beginning of March, 1906, there existed severe parietal headaches on the left side, stupefaction, and an indication of amnesic aphasia. The convulsive seizures on the other hand were not as severe as before, and were unaccompanied by loss of consciousness.

The examination by *H. Oppenheim* (March 19, 1906) revealed the following conditions: There existed a pronounced paresis of the right lower branch of the facial; lateral position of the eye-bulbs was accomplished with difficulty, but without apparent disturbance of motion. At the examination no diplopia was found. It was stated, however, that the patient had some time ago suffered with attacks of transient double vision. Fundus oculi normal. No hemianopsia. Examination of the other cerebral nerves proved also negative. The patient showed indication of amnesic aphasia. Asked to name the metals he could only recall gold, silver, and lead. Naming of ordinary objects caused the patient no difficulty whatever. His spontaneous speech as well as connected speaking were good, except the word "Nassau," where he was treated at a sanitarium. This word he could not recall. No gross errors were found in writing, yet he

would leave out a word from time to time or lose his line. He emphasized the fact that the comprehension of what he read caused him difficulty. He read sentences submitted to him readily.

Neither spasms nor pareses were found upon examining the motility of the right arm. The tendon reflexes could be elicited with distinctness. There existed an ataxia of static and locomotor nature. The sensibility was much disturbed in all its qualities. The patient could not recognize a large knife placed in his hand. Contacts were not perceived by him at all. Pricks with a needle were not felt as well on the right as on the left side; they were also wrongly located. Thermæsthesia and the sense of position were considerably affected. The right lower extremity was decidedly paretic and still more ataxic. The finest contacts were not perceived, but the sensibility was retained in all its qualities. The right patellar reflex was more lively than the left. Abdominal wall and cremasteric reflexes were present on the left side; absent on the right. There were no other deviations in the reflexes examined. There was distinct sensitiveness of the left parietal region on percussion. The patient complained of pain in the left side of the head and of a sense of weakness on the right side.

*Professor H. Oppenheim*[1] referred the patient to me (March 23, 1906) with the following report:

"The trouble began with motor and sensory disturbances of irritation in the right arm. These were of a *Jacksonian* character and were accompanied by ataxia and bathyanæsthesia of the same member (fingers). There was also a gradual development of a motor ataxia of the entire right side, especially in the right arm. This was accompanied by a slight (doubtful) paresis and spastic symptoms of slight nature (some ankle clonus, etc.). There was also a considerable diminution of the sensibility in the right arm and the right lower limb. The earliest of these sensory manifestations to develop were the sense of location and the stereognostic sense followed by diminution in the tactile sense and the sense of pain. No hemianopsia. No choked disc. In the last few weeks considerable pain developed in the left

[1] "Beiträge zur Diagnostik und Therapy der Geschwülste im Bereich des centralen Nervensystems." S. 11. Berlin, 1907, S. Karger.

parietal region. There was also stupefaction with indications of amnesic aphasia. Sensitiveness on percussion of the left posterior parietal region present.

"Probable diagnosis: Tumor; location, with great probability, in the middle portion of the posterior central convolution and in the adjacent part of the parietal lobe. The absence of motor disturbances of irritation and hemianopsia speak against tumor of the internal capsule (*carrefour sensitif*). It cannot be asserted with certainty whether the tumor is seated in the cortex or subcortically, but very likely not much in the depth below it.

"Character: Gumma (?) improbable because of no amelioration of symptoms despite vigorous antisyphilitic treatment. In all probability sarcoma, glioma, or tubercle.

"Operation is advised because of the rapid progress of the disease. Place: Posterior central convolution and adjacent region of the parietal lobe, at a level corresponding to the position of the centre of the arm—arm and leg zones."

On March 24th the patient was trephined in such a manner that the fissura centralis formed the anterior boundary of the cleft created in the skull. The parietal eminence lay about the middle of the valve. The tensely stretched dura did not pulsate. In its anterior part it displayed a peculiar discoloration, as if something of a yellow color were situated underneath it. After the first operation not much change was noted in the condition of the patient. An examination made by *Oppenheim,* on the 29th of March, showed a certain degree of sensory aphasia. The condition of the right arm as well as the lower extremity remained unchanged, with the exception that the *Babinski* reflex could now be elicited from the right lower limb.

The second act of the operation was performed on April 2d. Efforts were made to avoid the sinus longitudinalis by opening into the dura in such a manner that the base of its flap faced the median line. The strongly protruding and non-pulsating brain was adherent to the dura in the region of the tumor. The arachnoid in this situation was of a reddish, velvety appearance. There was a portion of the exposed surface that was grayish-blue and yellow in color. It protruded evenly and permitted no recognition of the structure of the cortex. It was located on

the anterior part of the cerebral surface, exposed to view. Its vertical measurement in the upper median region was about 55 mm. (See Vol. I, Plate XXII, page 182.) This mass was sacculated and more yellow in appearance in its upper than in its lower portion. The main two sacs were on the surface of the tumor outlined by a constriction that corresponded to a bridge of tissue between them. So far as could be judged, the portions of brain involved by the mass were, the middle and upper portion of the posterior central convolution and the upper part of the parietal lobe contiguous to it. A strip of bone about 1 cm. in width had to be removed from the anterior angle of the cleft. It was now seen that the anterior incision into the scalp corresponded exactly to the position of the central fissure. In some places the mass was tense and elastic, at others fluctuating, and at its borders it was of hard consistency. In width it exceeded twice the sagittal extent of the normal posterior central convolution. In order to bring to view its upper limit the dura had to be pushed back with gauze sponges; and this exposed a number of veins coming from the sinus longitudinalis and a field of *Pacchionian* granulations. One of the veins of the sinus bled profusely. On account of suspected suppuration, protective tamponade of the subdural space was carried out. (See page 104, and also Plate XI, Fig. b, of Vol. I.) Puncture of the lower half of the mass with an aspirating syringe, almost immediately under the cortex, yielded 5 cm.$^3$ of yellow homogeneous pus. Both abscesses were split; the lower one (on the surface of the brain) was apparently wider; it was only 26 mm. deep and as large as the terminal phalanx of the index finger. The upper one was as thick as a plum and 50 mm. in depth. The extirpation of the bridge between the two cavities converted them into one. As a result of the differences in the level of the bottom of the two cavities a sort of step remained after removing the partition. A large quantity of pus of the same character as that withdrawn with the syringe was evacuated from the abscess. The walls of the abscess cavity were lined with a thick sulphur-yellow membrane and were thick to the touch. Were it not for the collapsed condition of the patient, I should have excised them at once, for they were veritable pure cultures of tubercle bacilli. After inserting a drain into the upper (deeper) cavity, the surroundings

were tamponed with vioform ganze and the osteoplastic flap loosely reposited.

On the 7th of April the drain was removed from the large abscess cavity and the tampon inserted at the time of the operation was substituted by a smaller one. While the patient was thus being dressed at the time when the vioform gauze protecting the normal brain from the borders of the wound was being removed, clonic twitchings commenced in the right facial region and in the right arm, especially in the muscles of the shoulder, triceps, and in the extensors of the right hand. Inspiratory hiccough of a spasmodic nature was heard at the same time. The lower limb remained free from contractions. After removing the tampon from the forepart of the field operated upon, the twitchings at once ceased, and the muscle tonus of the right arm appeared relaxed to such an extent that the completely flaccid arm could be moved passively in all directions. The anterior central convolution had evidently been pressed upon by the tampon, the dragging out of the gauze acted as an irritant and precipitated the epileptiform attack which, as soon as the front portion of the tampon was removed, at once ceased.

After nine more days, during which the general condition of the patient became aggravated and the cardiac action weak (accompanied by remittent fever) the tuberculous new formations were removed without the use of an anæsthetic. After the dressings were taken off, a globe-shaped prolapsus was found that entirely filled the opening in the skull. Both abscesses formed a large smeary cavity, which measured 45 mm. in height, and 34 mm. in width. It was divided in the middle by dirty dèbris. An area of cerebral tissue of about 15 mm. (immediately surrounding the abscesses) was found hard and nodular and evidently damaged by the tuberculous process, while the rest of the contiguous cerebral structure was of normal consistency. The entire focus was enucleated with the closed scissors. It measured 62 mm. in height, 46 mm. in width, and 28 mm. in its greatest thickness. (See Vol. I, Plate XXIII, Figs. a and b, page 183.) The excision was performed mainly in the white medullary substance. Its cut surface was apparently normal. In some places it was of slightly yellowish color and of jellylike and œdematous appearance. The cerebral surface, outside of being slightly

hyperæmic, was to all appearances normal. Three yellowish areas, each the size of a finger-nail, could be discerned on its surface. For the sake of safety they were excised flatly; during this the consistency of the brain was found to be normal with the exception of being slightly yellow and œdematous. After preliminary tamponade with vioform gauze, the places of excision were thoroughly packed with a 20 per cent. iodoform gauze, the reason for this being the tuberculous nature of the disease.

Following this (third) operation the general condition of the patient had markedly improved. His pulse also became better. He was of happy frame of mind and took interest in his surroundings. At the change of dressings on the 14th of April, a very soft cerebral prolapsus, about one and a half times the size of a full grown fist, was found protruding from the wound. It was not unlike a double chin seen in obese persons. (See Plate XXIII, Fig. c.) The excised part represented a flattened, somewhat depressed area, from the middle of which clear liquor was issuing. The dura flap was shrunken to an extent of 38:52, and was lying immediately on the surface of the prolapsus cerebri. The appearance of the granulating surfaces of the wound was so good that further tamponade of its undermined edges was dispensed with. The skin was reposited directly over the prolapsus in front and behind at the upper border on the dura covering it. The remaining uncovered portion of the prolapsus was as large as the palm of a hand. It was now covered with vioform gauze and the osteoplastic flap replaced over it.

In the following three weeks the prolapsus rid itself of the smeary deposits which were clinging to it in a number of places, but in size it receded only very slightly. The flow of liquor from the middle of the exposed surface continued as profusely as before. The bandages and dressings over it soon became thoroughly saturated. Attempts at diminishing the flow was followed by a sharp reaction, accompanied with high fever. On May 4th, the edges of the secondary suture of the operation-wound were freshened, with the patient under the influence of chloroform-oxygen. The surface of the brain was seen to granulate satisfactorily. The epithelium on the osseous valve and of the borders of the wound had curled inward, thereby preventing healing. The skin, from all borders of the wound,

was therefore dissected back sufficiently and mobilized to cover the entire prolapsus. The valve was now reposited over the protrusion and held in position on all sides of the scalp by a number of retention sutures. The union, however, was effected in such a manner that a space the width of a finger exposed the prolapsus all the way around. (See Vol. I, Fig. 38, page 183.) The exuberant granulations were removed from the borders. At the change of dressings it was seen that the prolapsus had receded. The wound healed and the skin flap showed good union.

With reference to the symptomatology at that time, there occurred, after the extirpation of the tubercular masses, right-sided hemiplegia and an aphasia that was more noticeable than before the operation. Beginning with the end of April the clinical manifestations at the pulmonary apices progressively increased. They were accompanied by hectic fever, the expectoration became more profuse, and on the 20th of June, 1906, the patient succumbed to exhaustion.

The autopsy showed extensive phthisis pulmonum that was responsible for the death of the patient. The tuberculous abscess in the left parietal brain had healed. The minute cerebral findings (*Chief Physician Dr. E. Heymann*) were as follows: The brain, together with the portion of the skull to which it was attached and a part of the hairy scalp, were removed *in toto*. The trephined opening in the skull was completely covered by the indurated scalp, and the wound had nicely cicatrized. After the cicatricial adhesions were separated from the borders of the trepanation cleft a defect of the cerebral cortex was uncovered. It was the size of the palm of a hand. It lay in the convolutions of the left parietal lobe and extended forward to the posterior central convolution and continued posteriorly onto the convolutions of the occipital brain. Frontal section through the region occupied by the defect showed considerable dilatation of the left lateral ventricle of the left cerebral hemisphere. On the right the dimensions of the ventricle were normal. The wall of the left lateral ventricle was lined with smooth ependyma throughout. An entrance into it during the operation is therefore precluded. The white substance (thickness of from $\frac{1}{2}$ to $1\frac{1}{2}$ cm.) surrounding and supporting the ventricle was soft but not discolored. No tubercular deposits, masses, or abscesses were found in any portion of the brain.

## Neoplasmata of the Occipital Brain

The occipital lobe rests directly on the tentorium cerebelli. Its median surface, lying against the falx cerebri, is sharply divided from the parietal brain by the fissura parieto-occipitalis.

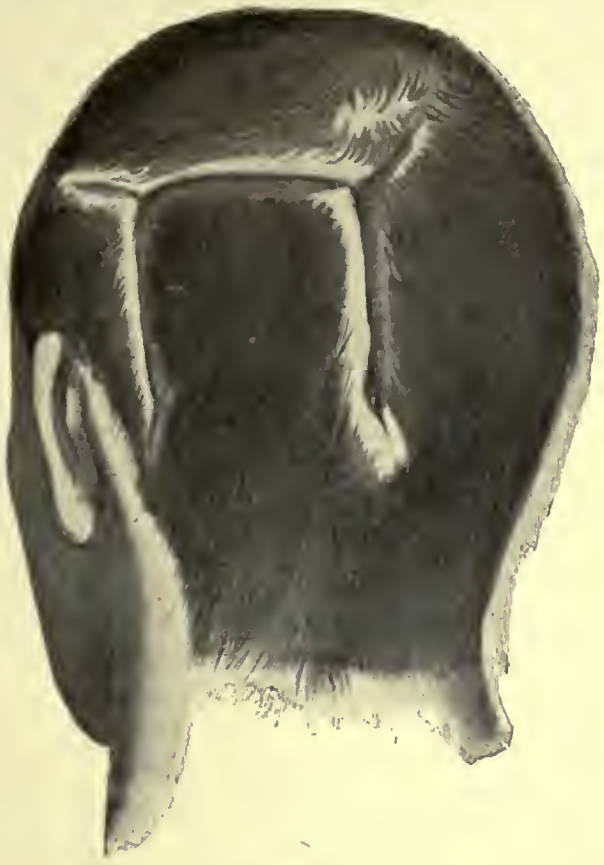


Fig. 117

The transition of its convex surface to that of the parietal and temporal lobes is very gradual. (Compare Fig. 94, page 505, and Fig. 95, on page 507.) The occipital brain is exposed by trephining and opening the skull (Fig. 117) by an osteoplastic flap, the base of which corresponds to a line immediately above

the prominentia occipitalis externa, and which extends from the median line horizontally outward to the level of the posterior border of the mastoid process. Its convex and median surfaces may also be rendered accessible. In that event it is frequently necessary, after the dura flap has been fashioned, to apply double ligatures and then sever numerous large veins coursing from the sinus longitudinalis to the pia mater, or to carefully push them aside.

## Symptomatology

### Hemianopsia

The most important symptom of tumor of the occipital lobe is *crossed homonymous hemianopsia.* If this disturbance be present (in left-sided disease) an absence of the right half of the visual field of both eyes is noted to a greater or lesser extent, and vice versa. Hemianopsia may result from an interruption in any part of the visual tract running from the tractus opticus to the cortex of the occipital lobe; this is the result of an immediate destruction of the visual fibres by the tumor or only of an interference with their conductivity by a neighboring neoplasm. Since the interpretation of this symptom is not always an easy one, I shall discuss it in detail. Because of its importance from many points of view, I will first cite a case published[1] together with *H. Oppenheim,* which is very interesting in this connection.

#### OBSERVATION VI, 1

*Removal of a Tumor from the Left Occipital Lobe. After the Operation, Complete Disappearance of the Right-Sided Hemianopsia and Other Disturbances. Cure after Five Years.*

The clinical report of *Oppenheim* follows:

The patient, a merchant of thirty-five, had, outside of occasional nervousness which he attributed to overwork, never been ill before. In March, 1906, he became ill with pains in the back

[1] *H. Oppenheim* and *Fedor Krause.* "Tumor of the Occipital Lobe of the Brain Cured by Operation," Berl. Klinische Wochenschrift, 1906, No. 51.

of his head, which were at first intermittent (every second or third day) and were then followed by attacks of violent pain in the occipital region, the back of his neck, and along his spine. They did not yield to ordinary methods of treatment. The patient tried to rid himself of his affliction by a sojourn to Lugano, but he returned worse than ever. On the 25th of April *Oppenheim* had an opportunity to examine him for the first time. The examination of the nervous system was then entirely negative. The discovery of a slight enlargement of the spleen and the intermittent character of the pains indicated the exhibition of quinin, which for some time seemed to relieve the patient. However, the results from this therapeusis were only transient. The pains soon recurred with the same or even greater violence than before, and at the next examination, a few days later, *Oppenheim* discovered a hemorrhage into the retina of the right eye. He then and there suspected tumor of the brain. Soon afterward a retinitis optica of the right eye developed, while the other eye remained undisturbed. At the height of an attack of pain the pulse was slow.

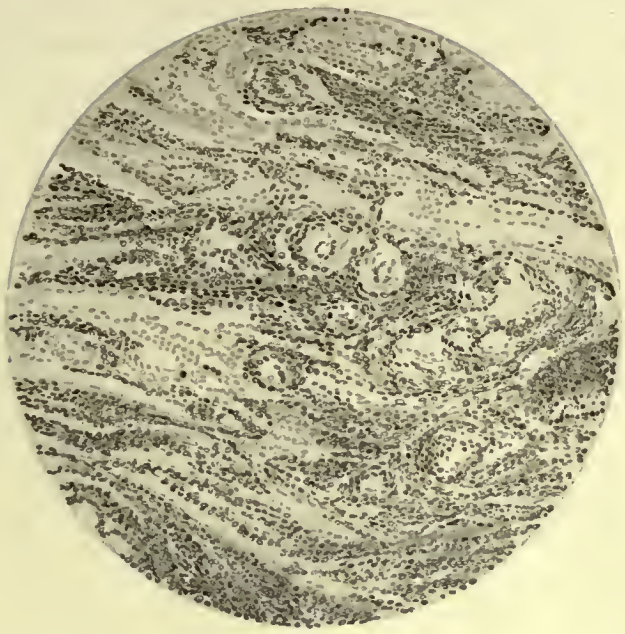
Within a few weeks the symptomatology of the case created the following clinical picture: Headaches, dizziness, vomiting. The patient was obliged to remain in bed. Bilateral choked disc, more pronounced on the right side with many retinal hemorrhages. This was associated with a right-sided hemianopsia, which at first was partial but later became complete. At the same time, or may be before, the patient complained of optic illusions toward the right. There also existed disturbances in reading and writing that were partly explained by the visual disorder. They also had the character of agraphia and alexia. *Oppenheim* now made a diagnosis of tumor in the region of the left occipital lobe. Since courses of the iodides and of mercury gave only temporary relief, surgical intervention had to be seriously taken into consideration. This was the more urgent because of the marked disturbances of the right side of the body in the form of a slight hyperæsthesia, hemiataxia, and hemiparesis which appeared about the end of May.

About the 8th of June, *Oppenheim* formulated his diagnosis and submitted the following therapeutic suggestions: "Probable

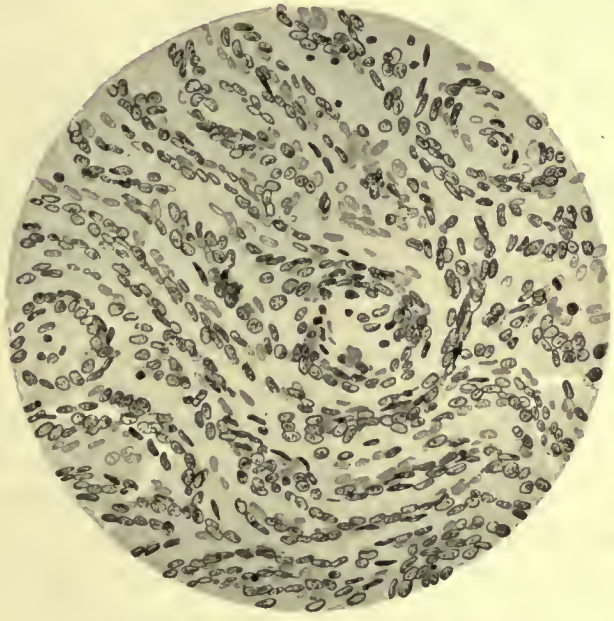
neoplasm. Seat of tumor, in all probability, in the medulla of the left lobus occipitalis. The deep-seated and bilateral headaches indicate that the tumor had extended close to the tentorium. Since the iodides and mercury have been tried and all other measures were unsuccessful, operation is advised. The difficulty of a local diagnosis, the dangers of the operation, and the very slight chances of cure should be taken into consideration. I don't think it is certain, nay, even probable, that it will be possible to reach the tumor, to say the least of its radical removal. However, there still exists a possibility, if the case should prove to be one of cyst. In operating, the trephine should expose the region under consideration to a great extent. The entire posterior section of the convex surface of the left lobus occipitalis should be bared as far back as the posterior pole of the lobus temporalis and the surgeon should be enabled to reach medianward to nearly the cuneus (if only with the palpating finger) and also basalward to the portion of the occipital lobe resting on the tentorium cerebelli. However, in order that the defect in the bone be not made too large, the fenestrum can, if need be, enlarged subsequently."

On June 9, 1906, I performed extensive osteoplastic trepanation in the left occipital region (see Fig. 117). The base of the flap corresponded to the level of the sinus transversus; it measured 75 mm. The median, vertically ascending longitudinal cut corresponded exactly to the sinus longitudinalis and measured 75 mm. in length. The lateral longitudinal incision was also of the same length. The left sinus transversus and the lower portion of the sinus longitudinalis were free. The dura was tensely stretched and showed no pulsations. A convex flattened elevation of darker color was seen on its lower median surface. After the osteoplastic flap had been replaced the wound was sutured. The second step of the operation (that of extirpating the tumor) took place on June 25th. The anæsthetic used was oxygen chloroform. The operation is described in Vol. I, on pages 75–77, to which the reader is referred. (See also Plates V and VI, Vol. I.)

The neoplasm was enucleated from the cerebral substance with the finger. It had the form of a peach split lengthwise.



Fibrosarcoma of the Brain: Low Power.



Fibrosarcoma of the Brain; High Power.

Fig. 118

It measured 32:55:58; a few hours after the operation it weighed 50 gr. Its almost circular base faced the dura and measured, on the average, from 5 to 6 cm. in diameter. Posteriorly the neoplasm was fairly united in its centre with the dura. Defects

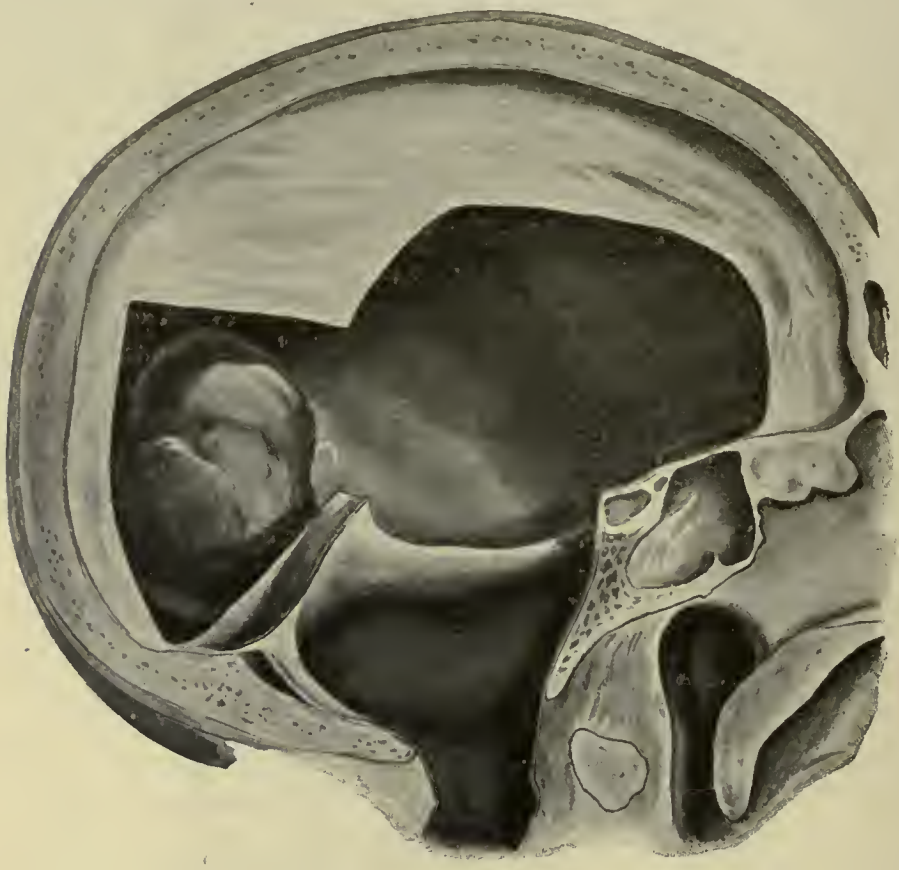


Fig. 119

of substance (about the size of half a dollar), the result of operative ablation of the dura, were distinctly visible. The convexity of the tumor, that is, the surface that had pressed the neoplasm forward, was covered with a yellowish, thready texture. On the whole, the surface was smooth and had the form of half a sphere. A mass of veins of various sizes was coursing on its surface. On the whole, the tumor presented the appearance of a portion of brain covered with pia. In some places there was

also an indication of fissuring. Its consistency was that of a fibroma, consequently considerably firmer than that of the brain substance. The dura, that had prior to the enucleation been detached and then excised, was much thickened and hard. After it had been wiped dry of blood coagula its posterior surface looked smooth and metallic; its inner surface, corresponding to the tumor, showed blood-tinged, thickened adhesions.

Fig. 119 shows the interior of a skull in which the dura and all its prolongations have been preserved. After hardening, the extirpated tumor was placed in the position it had occupied in the patient.

The microscopic picture (see Fig. 118, page 643, *Chief Physician, Dr. E. Heymann*) shows under low magnification strands of short spindle-cells arranged in rows with an intercellular substance that is poor in cellular elements. The cell connections ran fairly in one direction and were intersecting each other, so that pointed aggregations of nuclei could be seen on the slide; they encircle each other, the result being heaps and circles of nuclear masses.

High-power magnification accentuated the hyaline character of the intercellular substance which was poor in fibrous and cellular elements. The entire tumor is extremely poor in vessels. The cell-nuclei in the individual heaps and strands are small, pointed, oval, or oblong, and correspond to nuclei of fibroblasts.

The diagnosis was fibrosarcoma.

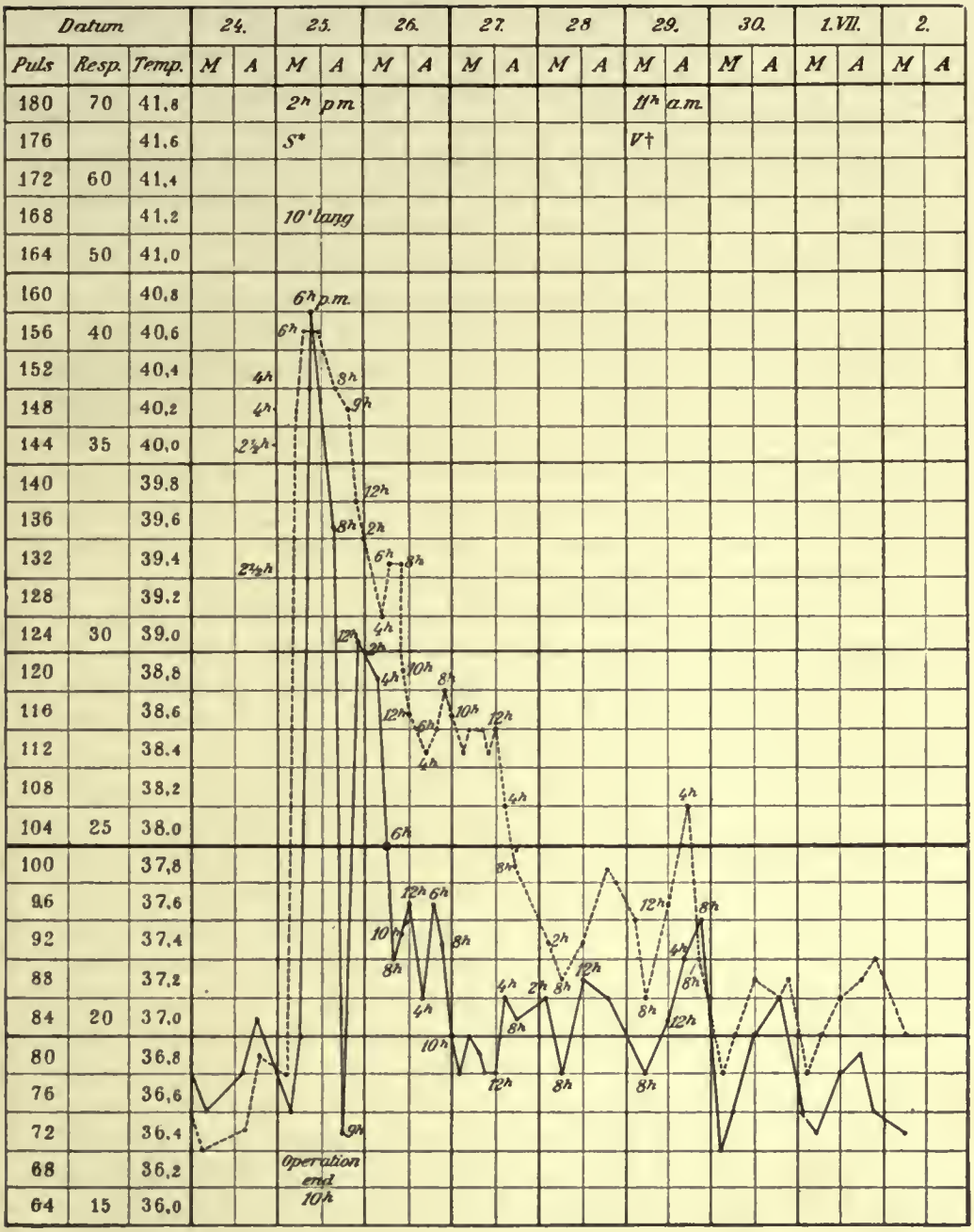
The patient remained in bed three weeks. Fig. 117, page 639, shows the manner of fashioning the flap. It was sketched twenty-six days after the second step of the operation. I had to remove a rim of bone about 1 cm. wide, all the way around the cleft, to gain sufficient room to work in the opening of the skull. As a result of the method employed the bone-valve was at first united by soft parts only; six months later, however, it was entirely immobile.

The result of the operation was striking and remarkable. On the day of the operation the ataxia of the right arm as well as the disturbances of the sense of position and of stereognosis, had almost completely disappeared. The headaches, dizziness, and vomiting disappeared and the stupefaction gave way to clear mental activity. The patient could now eat well, so that his

state of nutrition and strength became very much improved. At the examination made fourteen days after the operation, *Oppenheim* found that the choked disc of the left eye had completely disappeared, only a trace of it remained in the right eye. All clinical abnormalities vanished from the right side of the body. Eight days later not only the ophthalmoscopic findings were negative, but the visual illusions above referred to had also disappeared. On the 19th of July *Professor Silex* found the hemianopsia and choked discs gone. Three to four weeks later, he found old hemorrhages in the right eye. He was still able to recognize evidences of a passed inflammatory process in the papillæ.

On the 14th of August, *Oppenheim* found the patient fully recovered. He still had some difficulty in reading (he read somewhat more slowly than was usual for him). It also had to be admitted that the visual field on the right side was still a trace narrower than on the left. However, these manifestations were so slight that they paled into insignificance compared with the ultimate brilliant result. The cure was still more complete; so that at the beginning of September we found our patient actively engaged in his very strenuous business pursuits—he was a manufacturer. This bore evidence of his complete mental and physical restoration to health. Besides that, he had gained twenty-two pounds in weight since the operation. He was entirely free from disturbances of any nature. The objective findings could at that time be looked upon as perfectly normal.

Apart from the brilliant results obtained in this case (five years after the operation the condition of the patient was good; end of June, 1911), the temperature and pulse-curve shown in the following chart deserve consideration. The severe surgical attack was followed by marked disturbances (pulse, temperature) despite the fact that hardly a tablespoonful of blood was lost during the entire operation and that the enucleation of the tumor lasted only a few minutes. The sudden change in the pressure conditions had a tremendous influence over the brain. Immediately after awakening from the anæsthetic the patient felt very good. This was at eleven o'clock in the forenoon. At 2.30 in the afternoon his temperature was 39.4° and




*Temperature :* ——————

*Pulse :* - - - - - - - - - - -

* *S* = Chill.

† *V* = Change of dressing.

Fig. 120

his pulse was 146 per minute. At six o'clock the temperature rose to 40.8°, and the pulse to 158. At eight o'clock in the evening I was able to count his pulse-beat only at the carotid. He was not feverish.

This condition is usually spoken of as *brain fever*. As a matter of fact there existed only a rise of temperature and an acceleration of the pulse-rate in this case, while all other symptoms pointing to a cerebral disturbance were wanting. A more correct term for this condition would be *hyperthermia*. *Aronsohn* and *Sachs* have shown (1884) that a rise of temperature in the organism may be induced by puncturing the corpus striatum in rabbits. They therefore concluded that there exists a thermic centre, the mechanical irritation of which causes a rise of temperature (hyperthermia), but this may also be accomplished by injuries to other portions of the brain. At least in animal experiments, irritation of certain parts of the brain, in the region of the motor area, have repeatedly caused the temperature to rise. *P. F. Richter*[1] has proven experimentally that hyperthermia following puncture is mainly due to an inhibition of heat-radiation.

The condition of the patient was still critical. From time to time he lost his memory, although in the intervals he was of good-humor. He frequently asked for a drink. He did not vomit, however, and he felt subjectively well—as he expressed it, "grand." Threatening manifestations still existed, however, and, sure enough, they set in at nine o'clock in the evening with a lowering of the temperature to 36.3°, which rose again at midnight to 39.1°. In four days the pulse had gradually fallen to normal; the temperature also behaved likewise. Outside of a transitory irritability of temper during change of dressings (on the fourth day) the further post-operative course of the case was entirely satisfactory.

The fact that the choked disc, preceded by retinal hemorrhage, developed on the sound side first and remained here more marked throughout the disease, deserves notice. This was soon associated with hemianopsia that was in the beginning only partial, but soon became complete. The cultured and very attentive patient observed optic hallucinations in the blind half of the

[1] Experimental Studies in Pyresis and Antipyresis. "*Virchow's* Archiv," Vol. 123, 1891.

visual field. He would notice, for instance, a "pattern" in front of the eyes, that remained for a few minutes and then disappeared.

Such *optic hallucinations* were also noted after the first stage of the operation. They were at that time marked. They are to be looked upon as symptoms of irritation of the visual cortex. The patient complained of seeing colored patterns. The white bedding and the white apparel of the nurse looked to him like brown leather, or plush of motley color. These visual illusions lasted on the average from two to four minutes and then disappeared. He had the sensation as if all objects were beaming; as if persons were concave or convex. The nurse whom he asked to stand in front of him appeared to the patient in the crescentic form of the moon. Two days after the operation his forearms and hands appeared to him as if gayly tinted with blue and green, but this disappeared in a few minutes. I could not ascertain whether this hallucination was of hemianopic nature or not. No findings spoke for it being the case. For fully five days these hallucinations frightened and tortured the patient. They then began to disappear, at first in the daytime and then (in the following week) also at night. However, on the 7th of July, the patient still complained of micropsia—certain objects appeared to him (at a given distance) smaller than normal. Even with his eyes closed his imaginative faculty for objects was good.

Because of their direct relation to irritation of the visual cortex, optic hallucinations may indicate the seat of the neoplasm to be in the cortex of the occipital lobe. I recall the case of a man, thirty years old, who was afflicted with a sarcoma of the right occipital lobe that originated from the inner surface of the dura, who, before visual disturbances had set in, complained of the appearance of a "corrugated skin" in front of him, which moved to and from the visual field. These illusions lasted for about half an hour and appeared for a long time. As soon as these manifestations vanished, headaches on the right side were complained of by the patient. He saw no other figures. This was followed by the development of a total left-sided homonymous hemianopsia. Fourteen days after the extirpation of the tumor the patient called my attention to the fact that he could see and consequently read better, and that the lines blurred

no longer. The optic hallucinations had completely disappeared. Despite the fact that the hemianopsia was still complete, the patient was entirely unconscious of the existence of any visual disturbances. He assured us that his faculty for optic recollections did not suffer in the least. The choked discs found before the operation had at that time completely disappeared from the left eye. On the right side, however, a slight cloudiness still persisted, which, after a fortnight, had also completely disappeared.

In the patient of Observation VI, 1, the optic hallucinations following the operation showed only transient exacerbations. All other disturbances of the nervous system soon disappeared.

Since the total hemianopsia showed the first symptoms of regression as early as three weeks after the operation (having almost completely disappeared in the course of another month) we are justified in assuming that this remarkably favorable result was due to the preservation of the cortical visual centre and the visual radiation, and that the untoward symptoms were the direct result of pressure exercised by the tumor on these structures. It will be recalled that the neoplasm originated from the inner surface of the dura mater, and that it became attached to the posterior pole of the occipital brain later on. In its growth the neoplasm not only reached the great median fissure but it also extended toward the front and medianward. It created an enormous cavity within the brain, and it advanced deeply toward the cuneus.

The existing disturbances of reading and writing could partly be accounted for by the existing hemianopsia and in part by the *alexia* and *agraphia*. These two symptoms are observed in cases of neoplasm of the left occipital lobe in which the medullary layer of the gyrus angularis is involved. In this case we were dealing with neighborhood symptoms that could be explained by pressure or œdema, for soon after the operation these completely disappeared. The symptoms of *hypæsthesia*, *ataxia*, and *paresis* of the right side, that followed a few weeks after the onset of the choked disc, may be accounted for on the same basis. They were caused by an involvement of the peduncle (posterior) of the internal capsule, thus deeply extended the influence of the

neoplasm which was entirely limited to the occipital brain. In either event the disturbances within the internal capsule must have been much slighter than within the medullary fibres of the gyrus angularis, because those symptoms disappeared about fourteen days after the operation, while seven weeks later, *Oppenheim* was still able to demonstrate certain disturbances in reading and writing.

If the action of an occipital tumor extends frontalward to the region of the temporal brain, manifestations of sensory aphasia will then make their appearance, in which event the finding of words will be difficult.

### Course of Fibres in the Visual Tract

As a result of the decussation of the mesially situated optic-nerve fasciculi, in the chiasma opticum, the right optic tract supplies both halves of the retina on the right side and the left tract supplies both left halves. Since the respective portions of the retina always correspond to the opposite side of the visual field, the right tractus opticus contains the visual fibres of the left halves of the visual field, the left tract the fibres of the right half of the fields of vision. All hemianopsias that originate from the tractus opticus backward are found on the opposite side of the morbid focus. The reason for this is that the visual fibres commencing in the tractus run on the same side centralward as follows: its greater portion runs to the lower part of the thalamus opticus, thence to the corpus geniculatum laterale, they then continue as the tractus thalamo-occipitalis (*visual radiation*, only part of which enters into the make-up of the radiation of *Gratiolet*) on the outer side of the posterior horn, through the depth of the medullary layer of the gyrus angularis in the lower parietal lobe onto the median surface of the occipital brain. At this point they arrive in the so-called calcarina-region, that is, in the cuneus situated between the fissura calcarina and the fissura parieto-occipitalis (see Fig. 96 on page 509) and in the gyrus lingualis that skirts the fissura calcarina from below. The entire region contains the cortical optic field (optic projection field of *Flechsig*). Here are received the impressions transmitted through the eyes. Since the *cortical visual sphere* may possibly embrace the posterior portion of the

gyrus fusiformis, neoplasmata of the median surface of the occipital lobe may also give rise to complete hemianopsia of the opposite side, if the entire visual field be destroyed. If, on the other hand, the destruction of the visual sphere be only partial,

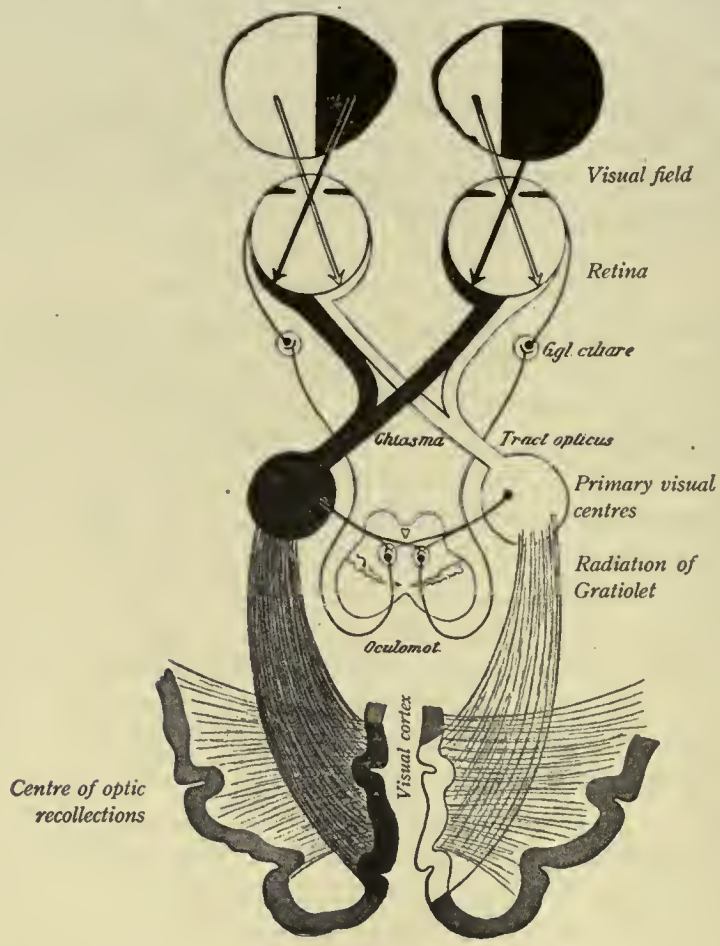



Fig. 121

Visual and Pupillary Reflex Tracts, from *Robert Bing*, "Compendium of Topical Diagnosis of the Brain and Spinal Cord." Berlin and Vienna, 1909, p. 175, Fig. 66.

smaller or larger sections of the respective halves of the visual field will be affected (*Quadranthemianopsia*).

Furthermore, the visual radiation may be affected in its course through the medullary portion of the parietal and occip-

ital lobes. Complete or incomplete hemianopsia will then result, depending upon the number of fibres destroyed. In a man, forty-four years of age, a firm glio-sarcoma of the white substance of the right cuneus, the size of a walnut, caused total hemianopsia on the left side. The same result occurs in cases of foci in the corpus geniculatum laterale.

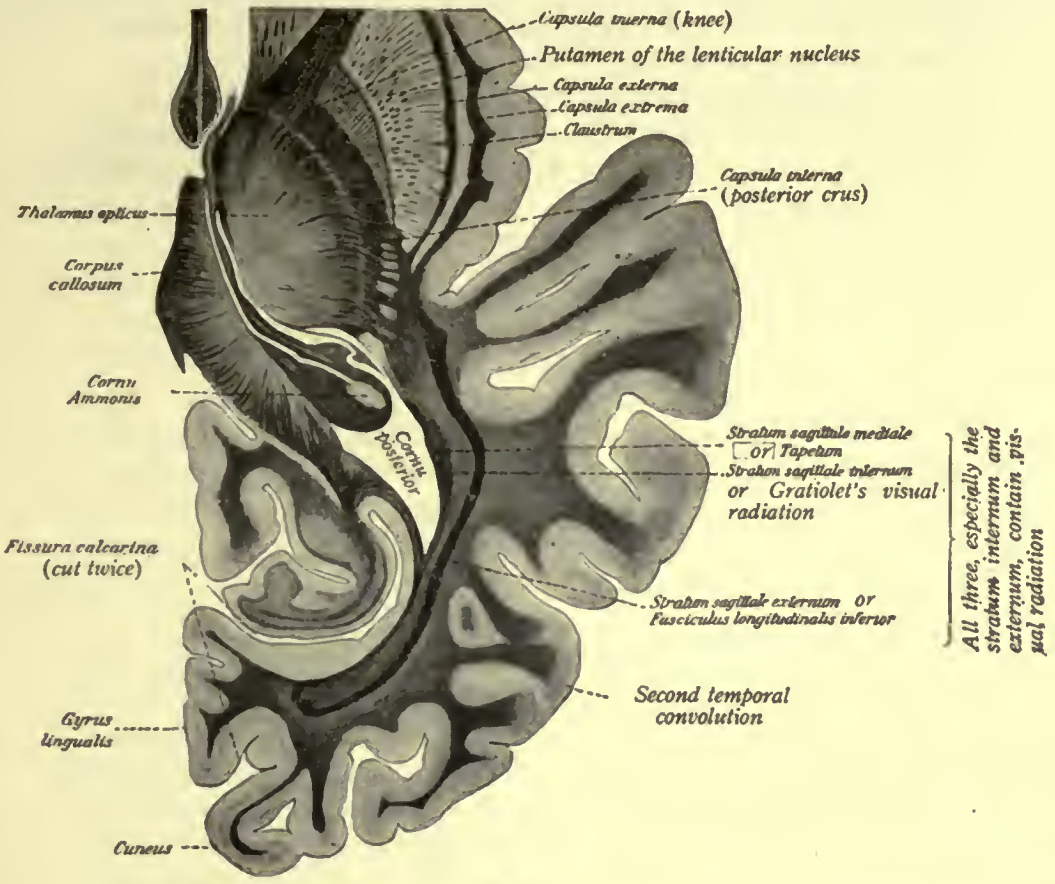



Fig. 122

Horizontal Section of the Brain, Showing the Position of the Three Sagittal Medullary Layers Containing the Visual Radiation.

After *J. Déjérine*, "Anatomie des Centres Nerveux," Paris, Rueff & Cie., 1895 and 1900, Fig. 292, p. 564. (Weigert preparation.)

As the optic thalamus represents the intermediary station for all sensory fibres, neoplasmata affecting it will simultaneously cause severe sensory disturbances of one lateral half of the body. Both symptoms (hemianæsthesia and hemianopsia) also occur in cases

of tumor of the parietal lobe. A differential diagnosis is therefore often very difficult. Diseases of the internal capsule, in the pedunculus posterior, cause gradually developing hemiplegia without marked symptoms of irritation and also hemianopsia, because of the fact that all hemisphereal fibres are limited in this situation to a very narrow space (see Fig. 103, p. 568). Finally, foci situated deeply in the medullary portion of the temporal lobe may cause the visual tract to become involved and hence occasion hemianopsia.

Since hemianopsia may result from foci situated in many places, all local manifestations must be carefully considered in trying to arrive at a correct diagnosis. To illustrate the difficulties frequently encountered in diagnosing these cases, the quotation of the following case will serve well.

## OBSERVATION VI, 2

*Hemianopsia with Disturbances of Sensation and Motion of the Same Side. Choked Disc. Diffuse Glioma of the Entire Medullary Layer of the Occipital Lobe without Involvement of the Cuneus. Involvement of the Lower Parietal and Temporal Lobe. No Operation.*

For the last four months, the patient, a man, forty-four years of age, complained of pain in both halves of the forehead, nausea, peculiar vomiting, bilateral choked disc (more marked on the right side), left bilateral hemianopsia, disturbances of sensation on the left side (pain and temperature) this especially in the upper portions of the body, slight weakness of the extremities of the left side, diminution of the left abdominal and cremasteric reflexes, swaying gait (to the right) and a certain diminution of the mental activity. The diagnosis of *Oppenheim* was as follows: Neoplasm of the lobus occipito-temporalis dexter. He reasoned thusly: "The absence of all symptoms of optic irritation speaks against involvement of the region of the visual centre. The parts of the brain to be mainly considered are the optic tracts in the medullary substance of the lower parietal and temporal lobes. There are no disturbances of co-

ordination or of stereognosis of the left arm. The diminution in sensibility was only slight and occurred later on. I am therefore inclined to think of tumor in the temporal region. I recommend first *Neisserian* skull-punctures, and if the results should prove negative the punctures should be repeated in the lobus occipitalis."

Concurring in these views, I carried out six cerebral punctures, near, below, and parallel to the linea naso-lambdoidea. I commenced vertically over point $T_1$ of Fig. 51 (p. 225 of the first volume). The punctures were made backward toward the lambdoidal line separated from each other at a distance of from 2 to 3 cm. Suction gave us brain-cylinders at most points punctured. Soon after the cannula was introduced at about the point of intersection of the linea limitans (*SH*) with the linea naso-lambdoidea (*NL*), and without the use of suction a brain-cylinder, about 1 cm. long, at once appeared on the surface—a slight venous hemorrhage had washed it there. This last puncture corresponded to the position of the occipital brain. Paraffin sections showed the meninges intact and the cortical structure normal. Sections of the medullary substance, quite near the cortex, showed extraordinary denseness of the glia nuclei; they were of large and smaller size and were arranged very irregularly, i.e., nucleus to nucleus. Fatty changes, necroses and hemorrhages were present in some places. The diagnosis was diffuse glioma of the medullary substance. A pressure-relieving trephining was done over the right parietal and occipital lobes. Despite that, however, the morbid symptoms rapidly became worse, asthenia supervened, and the patient died nineteen days later. The autopsy (*Professor Dr. Oestreich*) showed that the greatest portion of the right cerebral hemisphere was involved in the tumor-mass. The latter invaded to a considerable extent the white medullary substance extending backward toward the occipital lobe without reaching the surface. It also extended to the surface of the temporal lobe and into the island. In the right middle fossa of the skull the temporal lobe was intimately grown to the dura mater; the separation of this adhesion exposed tumor-masses that were attached to the cortex cerebri. The central convolutions were also permeated by the tumor without it being visible on the

surface. The anterior section of the frontal lobe was entirely free from tumor.

At the periphery the tumor was whitish and cicatricial. It was somewhat hard and not clearly defined from the healthy structures surrounding it. Its central portions were in many places discolored yellow, somewhat watery and showed fatty degeneration.

The internal organs were free from metastases and offered nothing of importance.

*Oppenheim* sent me the following detailed report: "The brain hardened in formol for twenty-four hours, showed on sagittal section that the medullary layer of the occipital, lower parietal, and temporal lobes were almost completely permeated by the tumor. The lateral and basal regions of the lobus occipitalis were principally affected. The cuneus had fairly escaped. The tumor thence extended through the lower parietal lobe and through the entire temporal lobe, projecting to very near its point. The basal-nasal parts of the neoplasm forced their way to the cortex of the occipito-temporal lobe. The tumor measured sagitally 13 cm. and 7 to 8 cm. in height. It looked like a mottled mass of smeary, grayish-red-yellow color. The rest of the brain was very soft. I therefore abstained from more minute examination. Numerous large and small hemorrhages, ranging in size from a pea to a hazel-nut, were found in the brain-stem, especially in the pons and cerebellum."

The cerebral punctures have in this instance not only helped us to make a correct diagnosis but have also warned us against an operation which, in view of the enormous size of the tumor, would have been futile to attempt.

The visual fibres course from the cortex of the cuneus (see Fig. 121, p. 652) to the convex surface of the occipital lobe and to that of the lower parietal lobe (gyrus angularis); here (on this convexity) we are to look for the optic-recollection-pictures. The latter fibre-tracts are association tracts. On their integrity depends the ability to correctly judge visual-field sensations, optic recollections. If they are disturbed, the conception of form and the sense of space (appreciation or conception of space and locality) are destroyed. The patient can see objects, to be

sure, but he cannot recognize them (*optic agnosia, loss of psychological perception of visual objects*). This is usually associated with amnesic aphasia and alexia, and also with agraphia. This visual disturbance occasionally occurs when the disease is limited to one side only; as a rule, however, it develops fully when both sides are involved or, if unilateral, the focus is large enough to influence the occipital lobe on the other side, by pressure.

In *optic aphasia* (see Fig. 95, p. 507, No. 14, blue) the patient is unable to name correctly the objects he sees. He finds their proper designation, however, when he feels, smells, or tastes them. This is frequently associated with alexia. The patient is unable to read letters and words and is unable to copy, but he can write spontaneously or from dictation. These two symptoms occur as early manifestations (right-handedness of the patient presupposed) in neoplasmata located in the medullary layer of the left occipital brain. This is explained by the fact that the association tracts of speech, running from both occipital lobes to the left upper central convolution, lay in close proximity to one another. In their absence, and in the absence of other symptoms pointing to disease of the left occipital lobe, we may conclude that the morbid focus is located cortically. This has been successfully proven by *L. Bruns.*

In hemianopsia following neoplasmata of the occipital lobe a certain visual paralysis toward the blind half of the visual field has been observed. *v. Monakow* explains this manifestation by the existence of a second centrum for the movements of the eyes (besides the one situated at the foot of the middle frontal convolution). This is located in the visual sphere proper, which enhances greater reflectory movements of the eyes by light.

In rare instances the hemianopic disturbance does not lead to total blindness of the respective retinal halves, but causes hemianopsia of lesser intensity of the sense of color only.

Comparatively trivial damage to the posterior surface of the occipital lobe may cause hemianopsia, for the cortical visual sphere extends from its median surface, for a short distance, to the occipital pole and to the lower occipital convolution. A very convincing case follows.

## OBSERVATION VI, 3

*Perforating Sarcoma of the Dura Mater at the Sinus Transversus. During Extirpation the Occipital Pole was Exposed. Tamponade; Later, Osteoplastic Covering. Lasting Hemianopsia.*

A sarcoma of the dura mater cerebralis developed in the case of a merchant, twenty-four years of age. The neoplasm was situated midway between the protuberantia occipitalis externa and the right mastoid process, at about the level of the sinus transversus, and had perforated the bone at this point. A tumor the size of a Borsdorf apple was exposed after removing the surrounding portions of cranial bone. On account of its union with the neoplasm, the right sinus transversus had to be removed, together with the dura, after double primary deligation of the former. The dura was extensively exposed, so that at the conclusion of the operation, after the tentorium cerebelli had been entirely taken away, on the right side, the posterior pole of the right occipital lobe of the cerebrum and the right hemisphere of the cerebellum, in its upper part, lay freely exposed. The tumor originated on the outer surface of the dura. The bone covering it was extensively destroyed, while its under surface remained perfectly normal. The exposed portions of the brain were also of perfectly normal appearance. The extirpation (January 11, 1902) was extensive and severe. The covering of the large defect in the bone and soft parts had to be performed at a subsequent operation, January 20th. (Compare chapter on "Closure of Large Defects in the Osseous Skull," Vol. I, pp. 202–209, and Figs. 42 and 43.) The wound was first tamponed with iodoform gauze.

Careful examinations of the visual fields were made before the operation, because of the location of the tumor at the posterior pole of the occipital lobe. All outlines were found normal. It was striking to note the inability of the patient, whose head was restricted in its movements by the bandages, to recognize persons approaching his bed from the left side. This was seventeen days after the operation. He only perceived them when they stepped to the front. The superficial examination with the fin-

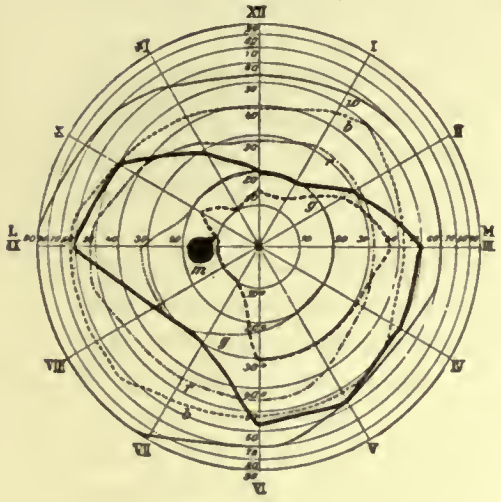
Fig. 123

Scheme of Visual Field, after *Hirschberg*.

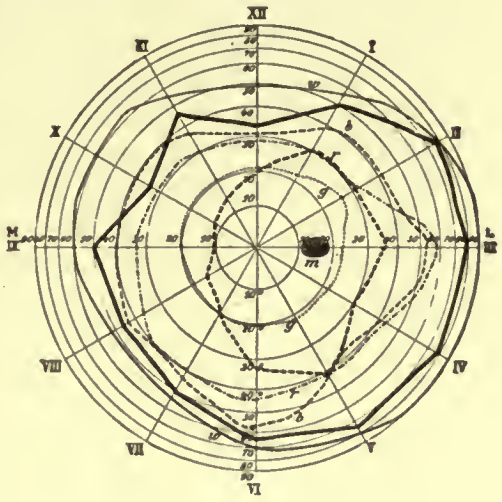
Normal { ——— Outline for white; - - - - - - " " blue; -.-.-.-.- " " red; ..... " " green } Tested with square pieces of paper 10 mm., side twelve inches distance.

COD = Campus oculi dextri. COD = Campus oculi sinistri.

COS



COD

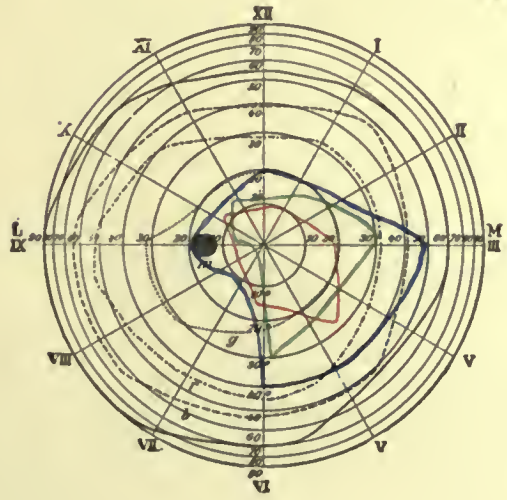


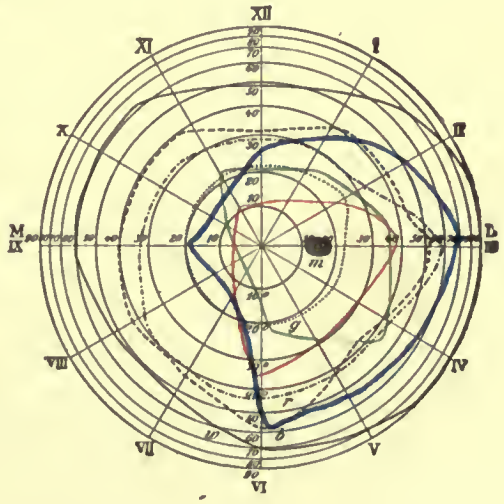
——— Visual field for white.

- - - - - - - - - - Visual field for following forms:

which were recognized in the outlined areas.

Fig. 124





gers showed a left-sided hemianopsia. The condition of the patient had improved on the 31st of January (twenty days after the operation) sufficiently to enable us to make perimetric examinations with white objects. The following was found on repeated examinations:

Scheme of visual field 1 (Fig. 123): The heavy outline shows the boundaries of the perception of white. The dotted line shows the boundaries for the recognition of white panes, quadrants, and crosses.

Scheme 2 (Fig. 124) shows outlines of various color perceptions. For these there existed an almost complete hemianopsia. The outlines crossed somewhat the middle line. This was also true of the recognition of white forms. For white there existed only a limitation of the visual field.

There were fluctuations in the findings of the daily examinations. These were explained by the fatigue resulting from their execution being slightest at the beginning and most marked at the conclusion of the examinations. Eliminating the element of fatigue, considerable improvement over the previous ocular conditions could not be demonstrated at the time the patient was discharged from the hospital—four months after the operation (May 14, 1902). The exposure of the posterior pole of the lobus occipitalis and its coming in contact with the iodoform gauze as well as the handling of the parts during the operation for the closure of the large defect (January 20th), in other words, the mechanical and chemical damaging of the surface of the brain-tissues led to hemiamblyopia, or to an incomplete bilateral hemianopsia.

### Cortical-Blindness and Pupillary Fibres

*Cortical blindness* (better *cerebral blindness, H. Liepmann*) results when both cortical visual spheres at the cuneus or the visual tracts in the medullary portion of this region are interfered with. This is the case in neoplasmata originating from the falx cerebri. It is characteristic in this form of blindness for the pupils of both blind eyes to contract by irritation with light.

The reason being that all fibres of vision running from the tractus opticus backward do not end in the thalamus opticus.

In part they run (*pupillary fibres*) to the anterior corpus quadrigeminum. (See Fig. 121, p. 652.) These fibres also run to the nucleus of the oculomotorius and bring about the contraction of the pupil which results in a reflex manner by illumination of the retina. The connection of the anterior corpus quadrigeminum with the nucleus of the oculomotorius being double, illumination of the retina will also cause the pupil of the other eye to participate in the reflex contraction (consensual reaction). Now then, if a visual tract of a hemisphere suffers interruption from the connection-fibres just described in its course centralward (backward), through focal conditions, exclusive illumination of the retinal halves which are insensitive to light (a test very difficult to execute) will result in pupillary contraction, despite the existing hemianopsia (*hemianopic pupillary reaction, Wernicke*). Otherwise the opposite would result—hemianopic pupillary inactivity, that indicates a diseased condition of the visual tracts, peripherally to the corpus geniculatum laterale and in the tractus opticus.

### Tubular Vision

In cases of complete hemianopsia the corresponding half of the visual field is only seldom absent to such a degree that its border-line traverses vertically the fixation-point. This occurs only occasionally in instances where the entire tractus opticus is destroyed. As a rule, in central foci especially, the point of acutest vision—the macula lutea and its surroundings—if spared (tubular vision). A patient afflicted with simple bilateral hemianopsia will therefore not lose his eyesight completely; with his visual field contracted to the extreme he will be unable to find his way in getting about.

## OBSERVATION VI, 4.

*Perforating Sarcoma of the Dura Mater. Exposure of Both Occipital Lobes. Loss of Both Visual Fields with Retention of Central Vision. Death from Cerebral Softening.*

A grinder, twenty-eight years of age, came under my care at a time when my experiences with the patient of Observation VI, 3 (operated on fifteen months ago), were still vividly before

me. As in the case of the latter, a sarcoma originating in the dura had broken its way through the bones of the skull and caused a semi-spherical bulging in the region above the right sinus transversus. From its external appearance, this case was an exact picture of the former. The condition was diagnosed by some one to be an atheroma; an incision was made into it when its true sarcomatous nature was discovered. The patient complained of dull headaches. The nervous status and the ocular findings were normal. There were no deviations from the color-tests of the visual fields. The neoplasm was laid bare on the 10th of June. The skin superimposing it was dissected off and parts of the cranial bone bracing it were removed. It was semi-spherical in shape and of the size of a Borsdorf apple. At a moment when abandonment of the operation was out of the question, it became necessary to also ligate the sinus transversus of the other side. (This was not necessary, it will be remembered, in the other case.) The sarcoma had unfortunately extended from the right side, beyond the middle line over to the left side. I was also obliged to bare the left transversus to a length of nearly 3 cm. The sinus longitudinalis had also to be dealt with in similar fashion to a height of 3 cm., measured from the confluens sinuum. The conditions resembled those depicted on Plate XLVII, Fig. a.

Both transverse sinuses, together with the sinus longitudinalis, were treated with double ligatures and severed between these 1 cm. away from the tumor. (See Vol. I, pp. 34–38.) The lumina of all sinuses were free from thrombi. After separation from the tentorium cerebelli (right and left) and from the falx cerebri above, complete removal of the sarcoma was accomplished. Severe hemorrhage was encountered only when the sinus rectus was being divided, but this was controlled with gauze pressure. After the extirpation was completed the upper sections of both cerebellar hemispheres and the posterior surfaces of both occipital lobes lay prolapsed in the wound. They were irregularly squeezed in places and showed on the surface bloody suggulations. During the latter part of the operation the pulse ran up to 160 beats per minute, and at times it completely disappeared from the radial artery. After tamponing the wound and completed suture of the skin, the pulse was 140. Half an hour after

the application of the bandage and final dressings the patient asked for a glass of beer and soon afterward he wanted to eat. The pulse was at that time 120 and distinctly palpable. The operation was completed at twelve o'clock, and at 2 P.M. the patient complained that he could not see well. There were distinct defects in the visual fields. The serious condition of the patient did not permit a thorough examination.

On the day after the operation the general condition of the patient was tolerable. There was a bilateral loss of peripheral vision. He was perfectly conscious and stated that everything looked so "closely confined as if I were looking through a blowpipe" as he characteristically expressed it. Examination of both visual fields established the fact that he retained central vision only. His asthenic condition however did not permit further examination. The pupils were narrow and did not react. Both bulbs deviated to the right of the median line. On the 12th of June both pupils appeared somewhat wider, but did not react as yet. The bulbi were now in the median line. Consciousness of the patient became cloudy and the asthenia increased. The principal complaint of the patient was that his vision was continually limited to a very narrow space. On the 13th of June both papillæ appeared cloudy and their outlines were blurred. A small arch that was still tolerably defined could be seen on the temporal border on the left side. All examinations of the patient had to be omitted on account of his weakness. On the 14th of June, four days after the operation, at seven o'clock in the evening, death supervened under increasing cloudiness of the consciousness.

The post-mortem examination (*Professor Dr. Oestreich*) showed hemorrhagic crushing of the occipital and small brain, œdema arachnoideæ, pachymeningitis ossificans and thrombosis of the sinus longitudinalis.

Large trepanation cleft in the back of the head; cranial vault somewhat wider than usual; it is of medium thickness and beset on its inner surface, in the region of the sinus sagittalis, with rough places of bluish-white color (osteophytes). Particularly atrophic places could not be found on the inner surface of the dura which was moderately tense and transparent. Anterior portion of the sinus longitudinalis contains a small quan-

tity of foamy blood. At the highest point of the convexity a thrombus commenced which extended to the point of ligation; it is not adherent to the wall of its confines, it is dark red in color and in some places of lighter hue than in others. The surroundings of the sinus longitudinalis show extensive vascularizations that correspond to the osteophyte formations spoken of above. Cerebral surface moist. In the region of the operculum on the left side, somewhat to the front, between the dura and the arachnoid a small quantity of blood was found which was very thin—almost of a fluid character.

Cerebral substance anemic on both sides, more so on the right than on the left. The posterior pole of the occipital lobe was soft, mushy, and permeated with hemorrhages. The cerebral destruction does not continue beyond the fissura parieto-occipitalis. Cerebellum, in its upper posterior portions, on both sides, softened and hemorrhagic.

Spinal cord and its coverings free. Only the following findings in other parts of the body are worth mention: Right and posterior aortic valves adherent to one another. Endocardium of the left ventricle shows numerous suffusions and the myocardium was of brown-red color.

The bilateral hemianopsia in this case was caused partly by the trauma from the operation, and partly by the interruption of the circulation in the sinus rectus during the exposure of both sides of the occipital brain and also from the softening of both occipital lobes. This experience teaches that we should not attempt ligation of both transversi nor of the sinus rectus. Even if such a patient should recover from the operation (which is unlikely), the effects on the eyesight would be altogether too severe.

Especial attention was paid to the findings of the post-mortem examination, which showed that the softening extended upward to the fissura parieto-occipitalis. All cortical spheres of vision were therefore sympathetically affected. Despite that, however, central vision was preserved for the first two days following the operation. The pupillary reaction was extinguished on account of the contraction resulting from the nocturnal doses of morphin administered to the patient. Re-

action to light should have resulted at least on theoretical grounds.

### Bilateral Cortical Projection of the Macula Lutea

The fovea centralis retinæ has a special cerebral innervation which remains intact even after the cortical visual centres have been destroyed. *Henschen* and *Wilbrand* base their assumption of the existence of an isolated path of conduction from the retina to the visual cortex in the region of the fissura calcarina on their anatomic studies supported by clinical observations. According to these authors there exists in this place a "cortical retina," i.e., a projection from the retinal half of the same side. Based on a new observation, *Henschen*[1] concludes that the macula is located in the floor of the iris calcarina. Whether this projection extends more to the front or toward the back, is uncertain. However, it is reasonable to state that a structure as deep-seated as the one under consideration would undoubtedly be well protected from superficial processes of softening. *Wilbrand* believes the macula lutea to have double cortical connections; that is, the macular visual fibres radiate to both hemispheres. So then, according to these investigations, each macula projects fibres to both hemispheres either through a direct double arrangement of the macular fibres or, which is more probable, by dichotomous division. It has not as yet been definitely settled, however, whether the fibres of the macula divide in the chiasma (*Wilbrand*) or in the caudal end of the corpus callosum (*Heine*).

### Cerebellar Symptoms in Neoplasmata of the Occipital Brain

In rare instances a tumor of the occipital brain will exercise strong pressure on the tentorium cerebelli and through it on the cerebellum without causing characteristic symptoms (hemianopsia). Consequently certain cerebellar symptoms may develop in these cases and lead our diagnosis and operative endeavors astray. A good example is the following.

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[1] *S. E. Henschen* Über inselförmige Vertretung der Macula in der Sehrinde des Gehirns. "Medizinische Klinik," 1909, No. 35, p. 1323.

## OBSERVATION VI, 5

*Tumor of the Right Occipital Lobe near the Tentorium Cerebelli. Most Symptoms Pointed to a Morbid Focus in the Left Posterior Fossa of the Skull.*

A left-handed woman, forty-one years of age, took ill in June, 1907, with weakness of both lower extremities. These were associated with unusually violent headaches, at first in the region of the left parietal bone and later on in the entire head or the back of the head. There was also vomiting and decrease of the visual power. A diagnosis of neurasthenia was made and the patient treated accordingly. On account of its increasing weakness the right lower extremity was seen (in August) to drag while the patient was walking. In October choked disc was found and the patient was subjected to an inunction cure and a course of iodides and thyreoidin tablets. Five weeks later excruciating migrainelike headaches were complained of, and soon thereafter she became unconscious. This unconsciousness lasted for a number of days. An attack, similar to the last one, occurred again in December. Feeding was impossible on account of the continued emesis. As time went on the walk of the patient became progressively more uncertain. Besides the disturbances already mentioned the following conditions were found in January, 1908. Paresis of the right facialis, the right arm and the right lower extremity; inarticulated speech of varying intensity; exaggerated patellar reflex on the right side; bilateral optic neuritis with moderate swelling in the stage of recession; strong reduction of the acuteness of vision of the right eye, which was also true of the left eye, but to a much lesser extent; visual fields normal and no trace of hemianopsia. For the last six months there were urinary disturbances in the form of difficult urination, enuresis, and finally incontinence.

The patient was sent to me on the 6th of February, 1908, with a diagnosis of slowly developing, benign, probably superficial neoplasm of the left parietal lobe toward the motor region. Besides the symptoms already mentioned we found the speech of the patient to be slow, hesitating, and of the kind frequently noted in cases of increased intracranial pressure. Symp-

toms of aphasia were not present. The cerebral nerves showed the following deviations. The acuteness of vision was much reduced on both sides. With the left eye the patient was able to count the number of fingers correctly, at a distance of 3 metres; with the right she was barely able to name the number at a distance of 2 metres. The discs of both eyes were markedly choked without hemorrhages; exudates were also absent. The pupils were equal on both sides. They were of medium width and reacted well to light and convergence. The corneal reflexes were strongly reduced. This was not so marked on the right eye, but in the left the areflexia was certainly pathologic. Hemianopsia could not be demonstrated.

At rest no marked differences could be noted between the two halves of the face, but when moving, there was a distinct paresis of the right facialis that varied in intensity. At one time a slight paresis of the left oro-facialis was noted. On questioning the patient it was brought out that she frequently swallowed the wrong way.

The musculature of the right arm appeared somewhat weaker than that of the left (patient was left-handed). Corresponding with this there was a reduction of muscular power. When elevating the right arm it tired more easily than the left. With the hand in an extended position, especially when the fingers were spread, a tendency to involuntary movements toward the right could be noted. The hand rotated from a position of supination to one of pronation, while the fingers began to twitch and a picture resembling choreiform motions was created. On the right side the movements of the fingers were somewhat retarded. In purposive motions with the right hand, greater or less uncertainty was seen—evidently a combination of ataxia and tremor. For example: If the patient attempted to touch certain parts of her face with the left hand, she did so at once and with precision, but when using the right hand, the same movements were accomplished with difficulty, for she would then pass the finger over a certain point three or four times and then work its way to the point she wished to touch. While trying to accomplish these movements, she stated that she knew well the point she wanted to reach but could not do it with the "lame" hand. Complicated movements, such as buttoning and unbuttoning while

accomplished with the right hand, were performed better with the left. Distinct restriction or abnormal movements of the right arm, hand and fingers however did not exist. On the 12th of February, 1908, there was a general aggravation of the symptoms (increased headaches, frequent vomiting, stupefaction, slight rise of temperature); this was followed by a slight tremor of the left hand and a passing of the spot by the index finger in the index-touch-nose test.

Upon examination all sensory qualities of the upper extremity were shown to be perfectly normal. Irritations were properly and quickly located. Careful examination showed the stereognostic sense of both sides to be perfectly normal. The sense of position in the smaller as well as the larger joints was also normal. While the periosteal and tendon-reflexes of the right upper extremity fluctuated somewhat in intensity, they were on the whole exaggerated. The abdominal walls were flaccid, and no reflexes could be elicited from them.

The musculature of the right lower extremity was somewhat atrophic. Disturbances of motion did not exist. It appeared, however, that the coarse power of both lower extremities was reduced a little—somewhat more in the right than in the left limb. The patient stepped with a certain degree of hesitancy, and the right leg was seen to drag somewhat when walking. However, it cannot be stated that the disturbances in walking were marked. There was no stiffness (spasticities) in the right lower limb. The sense of touch, the sensation of pain, and the location of irritated points remained normal in both lower extremities. However, we discovered disturbances in the temperature sense in the left lower limb, a few times. Occasionally the patient perceived the application of heat normally and at other times she said it felt cold. This disturbance was most marked on the left tibia. Again the patient would perceive the tests here also normally.

The skin, tendon, and periosteal reflexes of the left lower extremity were normal. The right patellar reflex was exaggerated. Patellar-clonus, however, was absent. The Achilles-tendon reflex was very lively, and after testing it twitchings frequently followed. Ankle-clonus was elicited with ease. The right dorsal leg-phenomenon (tibio-periosteal reflex), and the

signs of *Babinski* and *Oppenheim* could always be demonstrated. The dorsal foot-reflex (*Bechterew-Mendel*) was normal on both sides.

No eggs of parasites were found in the fæces.

From the findings generally, *Oppenheim* made the following diagnosis: "Cerebro-spinal disease. Chief process located in the left hemisphere of the cerebrum. There is much that speaks for the left posterior fossa of the skull. A large part of the symptoms may be accounted for by the concomitant hydrocephalus. Pure hydrocephalus improbable. The conditions mainly to be thought of are: (a) lues cerebro-spinalis, (b) sarcomatosis cerebro-spinalis."

*Neisserian* punctures of various places of the cerebrum and in both hemispheres of the cerebellum as well as puncture of the ventricle proved negative. Following these punctures the symptoms became very much aggravated. The patient remained somnolent for two days and suffered from involuntary evacuations of the bladder and bowel. After awakening she kept her head turned to the right; the bulbi were in the right canthus of the eyes. When the patient attempted to look to the left side, she was successful to bring her bulbi (under nystagmuslike twitchings) to the median line only; beyond this she was unable to move them. The speech was, as before, slow and hesitating. It was not aphasic, however, neither were there any defects in the articulation. After the punctures the deglutition became aggravated and she was unable to swallow solid food.

The acuteness of vision had considerably diminished so that the patient was finally unable to count the number of fingers held before her farther than a distance of 20 cm. The pupillary reaction to light and convergence were as before. There was complete areflexia of the cornea on the left side and hyporeflexia on the right. On opening the mouth the jaw deviated somewhat to the left. At that time no differences in the innervation of the facialis could be demonstrated. There was deficient elevation of the palate during phonation; this was decidedly worse in the left half. The palatal and pharyngeal reflexes were absent on both sides. The tongue was protruded straight and could be moved well.

The coarse power of both upper extremities was distinctly

reduced. The pressure with the hand was weaker than normally, but equal on both sides. Motor-ataxia could now be demonstrated in both hands with uncertainty at the index-touch-nose test and awkwardness of the right hand. The patient was unable to keep her fourth and fifth fingers in an extended position, and from a position of extension the hand at once returned to one of flexion. The tendon-phenomena of the right arm were somewhat exaggerated. This was not the case in the left arm. The general sensibility and the stereognostic sense of both upper extremities were not disturbed. The function of locating contacts in the hands was reduced. There existed a moderate but distinct weakness of both lower extremities. This was perhaps somewhat greater on the left than on the right side. The patient was unable to stand up, she sank back and could not walk even when supported. Sensory disturbances could not be demonstrated. The reflexes behaved as before.

The progressive aggravation of the condition of the patient urgently indicated an exploratory or decompressive trephining. Of these indications, *Oppenheim* expressed himself as follows: "The sum total of the manifestations point to a neoplasm in the left fossa cerebralis posterior. Since the symptoms here may be explained by pressure of the tumor on the pons, the radical operation should be performed in this locality. It should be kept in mind, however, that part of the symptoms have followed the cerebellar puncture and are therefore to be attributed to that cause. However, exploratory trepanation in the region of the left cerebellum is indicated. Participation of the medulla oblongata in the morbid process cannot be excluded."

Both cerebellar hemispheres were exposed in typical fashion on the 26th of February, 1908, in one sitting. The dura did not pulsate. The three points of puncture were visible on the surface of the left cerebellar surface after the dura had been reflected. A few minutes later the cerebellum began to pulsate. Morbid foci could be found neither on the cerebellum nor on the vermis. Palpation showed uniform consistency. Inspection of the upper, lower, and external surfaces of both hemispheres were found (after proper retraction with the cerebral spatula) to be everywhere normal. The posterior surface of the

petrous portion of the temporal bone showed also no tumor. Anatomic section through the left cerebellum disclosed nothing of a pathologic nature. Puncture into the hemisphere of the left cerebellum proved negative. The osteoplastic flap was reposited and sutured into position.

Following the operation, the condition of the patient did not change in the least. She succumbed to pneumonia ten days later. Outside of hemorrhagic infiltration into the left posterior fossa of the skull, the section of the cranial cavity (*Professor Dr. Oestreich*) showed normal meninges. A few days later, *H. Oppenheim* sent me the following report of the brain hardened in formalin: "On the median surface of the right hemisphere, near its posterior pole, a neoplasm, the size of a pigeon's egg, was found, which was walled off and had formed a nest, as it were, within the brain substance, from which it could be removed without difficulty. Its seat principally corresponded to the cuneus in the posterior part of the precuneus. The fissura calcarina was also embraced in the region subjected to compression. The sections of brain corresponding to this area were not only simply displaced, but they were destroyed, since the medullary substance of the floor of the tumor-bed lay freely exposed. The neoplasm was adherent to the median surface of the dura. Judging from its position it was necessarily united with the tentorium. Immediately under the neoplasm and divided only by the tentorium there lay the upper surface of the right cerebellar hemisphere. Both hemispheres of the cerebellum (in their posterior and basal sections) appeared flattened and covered with hemorrhagic deposits (result of the operation). The ventricles of the brain were not dilated. The pons appeared flattened. This may have been a post-mortem change. Frontal section made through it showed nothing abnormal.

The microscopic examination made by *O. Vogt*, in the Neurobiologic Institute of Berlin, showed a destruction of the fibres of the right hemisphere radiating into the dorsal lip of the fissura calcarina. The destruction by the tumor-mass could not have been an old one, because no secondary degeneration of the primary optic centres could be demonstrated by the *Weigert* process of staining. According to the information of *Vogt*, the patient should have suffered, immediately preceding her death,

from hemianopsia of the lower quadrant of the left half of the visual field. However, we were not able to corroborate this finding on account of the very poor vision and the extremely critical condition of the patient.

*Weigert's* stain of the spinal medullary sheath disclosed no pathologic changes in the spinal cord.

# Neoplasmata in the Posterior Fossa of the Skull[1]

## Boundaries and Contents of the Posterior Fossa of the Skull

The posterior fossa of the skull is principally bounded by the occipital bone. At its base lays the foramen occipitale magnum. Its anterior wall is formed by the pars basilaris ossis occipitalis, or the clivus *Blumenbachii*. Its posterior wall is formed by the basal half of the occipital hollow. The latter extends internally to the sulcus transversalis, which corresponds to the protuberantia occipitalis externa, on the outside. The lateral walls of the posterior fossa of the skull, running obliquely to the front and inward, are made up of the posterior surfaces of both temporal bones (petrous portion) and its roof is made up of the tense tentorium cerebelli which stretches between the occipital brain and the cerebellum.

In this space bounded by bones on both sides, in the back, and in its greatest part below, and closed up above by a tense membrane are contained, close to one another, the nervous structures that unite almost all important nerve-fibre tracts that issue from the brain and play an important rôle in the various bodily functions. On the clivus *Blumenbachii* rests the medulla oblongata, the pons, and a portion of the cerebral peduncles. The pyramidal shaped space still remaining is filled out by the cerebellum that overhangs the pons and medulla oblongata like an awning. Toward the front facing the middle fossa of the skull and above the cerebral peduncles are located the corpora quadrigemina. All these cerebral masses are so arranged that they enclose a space situated toward the foramen occipitale, which is known as the floor of the fourth ventricle, or the rhom-

[1] I am highly indebted to *Dr. Emil Heymann*, chief physician of the surgical division of the Augusta Hospital, for very valuable aid rendered in the elaboration of this chapter.

boid fossa. This continues forward and becomes the aquæductus cerebri or *Sylvii*. The roof of the fourth ventricle is made up of the velum medullare anterius and posterius. The latter are superimposed to the front and above by the superior vermis of the cerebellum and below by the inferior vermis. The lateral wall of the fourth ventricle is made up of three pairs of cerebellar peduncles; the first, the brachia conjunctiva or crura cerebelli ad cerebrum; the second, the crura cerebelli ad pontem (running to the pons), and the third, the corpora restiformia or crura cerebelli ad medullam oblongatam, running to the medulla oblongata. Besides these structures, the posterior fossa of the skull contains also the places of entrance and points of exit of the last ten cerebral nerves or their nuclei, or at least parts of these nerves.

Close above the anterior boundary of the foramen occipitale magnum the arteriæ vertebrales perforate on both sides the dura mater; and on the under surface of the medulla oblongata and the pons they unite to form the arteria basilaris, which distributes its numerous almost rectangular branches to supply the adjacent portions of the brain. Here are finally contained the transverse sinuses that gather the greatest portion of the blood from the posterior fossa of the skull. The left sinus is, as a rule, situated more deeply than the right. Laterally and to the front they course to join the sinus sigmoideus, which in turn empties into the large vena jugularis interna.

From the confluens sinuum (torcular *Herophili*), (the point of junction of the sinus sagittalis (longitudinalis) with the sinus transversus and the sinus rectus), the sinus occipitalis runs downward in the narrow falx cerebelli. It divides below and braces the posterior half of the foramen occipitale and opens on both sides in the foramen jugulare together with the sinus sigmoideus into the internal jugular vein.

### Introductory Remarks on Physiology

The pons is the anatomic medium through which all motor and sensory tracts pass from the brain to the spinal cord, and *vice versa*. The corpora quadrigemina contain the nuclei of the nerves that control the movements of the eyes and the nerves of hearing of the opposite side. Caudalward, in the floor of the

rhomboid fossa, we find the nuclei of the rest of the cranial nerves, from the oculomotorius to the hypoglossus. Between these, we also find the nucleus of the nervus vestibularis, which is irritated by changes in the position of the head and back, and also the nervous elements of the nucleus of the vagus and the hypothetical centre of respiration.

It is the task of the cerebellum to regulate in a reflex manner the equilibrium of the various movements. The greatest portion of all sensory spinal tracts end in the cortex of the vermis of the cerebellum, and only a small part of it runs directly through the lemniscus to the cortex of the cerebrum. There also exists a direct connection of the fibres between the nuclei of the sensory cerebral nerves (glossopharyngeus, vagus, vestibularis and trigeminus) and the cerebellum (roof nucleus of the vermis). The cerebellum, especially the vermis, stands in immediate connection with almost all tracts of the spinal cord, so that the reflex path is accomplished in a number of ways. To be more exact, we may mention four sensory tracts that carry impulses to the cerebellum: 1. From *Gower's* cerebellar-lateral-column tract of the cord, the muscle and joint senses travel (sense of position) from the lower extremities to the cerebellum. 2. In *Flechsig's* cerebellar-lateral-column tract of the cord, the same functions from the trunk and neck. 3. From the posterior-column tract, the same sensations from the upper extremities. 4. The nuclei in the floor of the fourth ventricle, especially the nucleus of the nervus vestibularis (*Deiter's* nucleus) transmit the incoming impressions of change of position through its connection with the cerebellum (nucleus tegmenti of the vermis).

The influence of the cerebellum on the motor cells in the anterior horns of the spinal cord, begins its path, at first in the fibre connections with *Deiter's* nucleus, which in turn are connected with the anterior columns of the cord and with the nuclei of the ocular muscles as well as with the nucleus of the trigeminus. A second connection of the cerebellum with the motor tracts is to be found in the substance of the superior peduncles under the corpus quadrigeminum (anterior cerebellar peduncles, brachia conjunctiva seu crura cerebelli ad cerebrum) through fibres that run to the red nucleus and optic thalamus. It is to be remarked, however, that in all fibre-connections with the

cerebellum, we are not dealing with large tracts that run directly to their point of destination, but that the efferent reflex-crus is made up of a number of neurons. *Bruns*,[1] in his treatise on the subject, points out that the cerebellum is the zenith of two reflex arches. The cortex of the vermis of the cerebellum especially maintains its irritability from the four sensory tracts described above. The motor tract of this reflex arch runs over *Deiter's* nucleus and the other mid-stations to the anterior horns of the spinal cord from whence it exercises its regulating influence over the motility of the trunk and the extremities as well as over the ocular muscles. According to *Bruns*, this reflex arch is subordinate to another arch that connects the cerebrum with the cerebellum. This reflex arch is joined by the tracts that run from the cerebellum through the anterior cerebellar peduncles to the cerebrum and by the cerebro-pontine tract that continues from the pons to the cerebellum.

From its connections with the sensory tracts in the spinal cord and its continuation with the many motor centres, is explained the peculiar function of the cerebellum, which is unlike that of the central region. The cells of the cerebellar cortex, of the large cerebellar nuclei (the nucleus dentatus, for instance), and especially of the vermis, are brought into activity through impulses transmitted to them from the muscles and joints, through the sensory spinal tracts, which impulses are again transferred to the motor nuclei of the nerves by increased psychic activity (cerebral cortex). This explains the double function of the cerebellum (sensory and motor organ). It acts neither independently nor spontaneously, but requires impulses that are transmitted to it from the periphery in the manner just described, only after which its function commences. As already stated, all irritations and influences of the cerebellum are brought about by increased activity of the psychic functions. However, the senso-motor sphere of the contralateral convolutions play an important rôle in equalizing disturbed cerebellar function. According to *Luciani*,[2] loss of cerebellar activity gives rise to only comparatively few morbid manifestations. It manifests itself in atonic, asthenic, and astasic neuromuscular symptoms. The

[1] *Bruns*, "Die Geschwülste des Nervensystems," II Aufl., p. 161. Berlin, 1908.
[2] *Luciani*, "Physiologie des Menschen," 1907, Vol. III, p. 496.

degree of muscular tension begins to decrease first (at rest and during action). This is followed by diminution of the applied energy of a given movement, and lastly, by a disturbance in the rhythmic succession of individual impulses which are required in the performance of a particular motion.

### Résumé of the Material Studied

When we consider the all-significant anatomic and physiologic variations common to the organs contained in the posterior fossa of the skull, it becomes at once evident that any process which restricts the space in this locality will necessarily cause manifold morbid manifestations. At no time can a single symptom or only a few of these point to the existence of a neoplasm in this region, as is the case in the island of *Reil*, in the central region or in the occipital brain. On the contrary, the slightest restriction of space in this region, softening of structures, or impairment of function of a part, will, as a result of the close proximity of the tracts and the complicated influence of the cerebellum and the nuclei of the cerebral nerves on each other, give rise to a whole series of morbid manifestations. It is therefore impossible to divide clinically the various forms of tumor according to their location in the posterior fossa of the skull, as we were able to do (with some difficulty, of course) in the case of the cerebrum. The symptomatology as a whole requires here at first a rather general consideration.

According to my material that comprised, until the end of July, 1911, seventy-five individual observations, the following processes were encountered: Foremost stood the solid tumors at the cerebello-pontine-angle that originated either directly from the acusticus, from the arachnoidea of this region, or from the posterior surface of the petrous portion of the temporal bone. Twenty-five of such tumors were seen. Then follow seventeen cases of neoplasmata of the cerebellar substance proper and of the vermis (gummata and solitary tubercle inclusive),, also six cases of tumor-formation in the vicinity of the pons, aquæductus, and walls of the ventricles. To these must be added eleven instances of space-restricting fluid-accumulations (cerebellar cysts, arachnitis chronica with meningitis serosa and cysticercus of the fourth ventricle). There were four cases of intra- and

extra-cerebellar abscess; ten cases of pseudo-tumors and instances of uncertain diagnosis, and finally two cases of metastatic tumor.

## Symptomatology

All manifestations resulting from tumors, cysts, and other space-restricting processes in the posterior fossa of the skull may be divided into three main groups: 1. Those resulting from general increase of cerebral pressure. 2. Those resulting from local compression. 3. Those consequent to the influence on adjacent nerves and portions of the brain (neighborhood-symptoms).

### Symptoms of General Cerebral Compression

These are the same as in any other space-restricting process in any part of the cranial cavity. To these belong headaches, vomiting, choked disc, dizziness, heightened arterial pressure, and stupefaction. Yet certain peculiarities which were pointing in our cases to the posterior fossa of the skull deserve elucidation.

*Headaches* are complained of in all cases without exception. In my cases, they were said by the patient to usually affect the back of the head and the back of the neck. Not infrequently they were located in the frontal region of the opposite side or in the parietal area. They varied in mode of onset as well as in severity. While in some cases they were perceived only as a dull sensation of pressure, in other instances they assumed the form of very violent cephalalgia or even spasmlike seizures that would recur periodically a few times in a day and fearfully torture the patient. Particularly severe attacks were observed in a patient, fifty-one years of age, whenever he wanted to cough, sneeze, or swallow a few times in succession. He would then sit up in bed, keep his chin fixed against his chest, and he could in no manner be brought to abandon this extremely flexed attitude. Attempts to put the head back into position were met with great resistance, and the patient resented such attempts with loud cries of pain. These attacks would last about a quarter of an hour, and repeated themselves about ten times in a day. They were at no time associated with nausea nor dizziness. The rest of the symptoms pointed to a tumor at the

left cerebello-pontine-angle, the correctness of which was corroborated at the operation. In other patients again, every change of position (or change from lying to standing) was accompanied by the most excruciating headaches so that the patients would change the position they were in only with extreme reluctance and they would seek most carefully to avoid even the slightest movement. These headaches would frequently set in most intensely while the patient was asleep or immediately after awakening in the morning. They would then disappear for a number of hours at a stretch during the day.

*Vomiting* is the second symptom complained of. This, however, is not as frequent as headaches. In five patients it was completely absent, while a few others complained of nausea, eructations, or an inclination to vomit accompanied by profuse sweating. The vomiting was mainly of a cerebral character. In a few patients, it was, for a long time, the only symptom of heightened cerebral pressure, and in others again it was accompanied by headaches, so that the patients were treated for disturbances of the stomach and were sent to various watering-places. Other symptoms of pressure and focal manifestations occurred much later, so that suspicion was aroused of the existence of a brain-tumor. It was frequently noted that with the development of the other symptoms the vomiting spells became less numerous and milder in character, and they occurred together with the headaches on rising in the morning, while during the rest of the day the patient did not suffer.

*Optic neuritis* and *choked disc* were found in all patients suffering from tumor at the cerebello-pontine-angle. A case of tumor of the pons and an instance of neoplasm of the corpus quadrigeminum, in which there was absence of choked disc throughout, is especially worth noting. It existed as a rule, in both eyes, and was accompanied by hemorrhages and fatty changes of the retina in only a few advanced cases. The existence of optic atrophy depended upon the duration of the disease. On the other hand, I have removed very large tumors from the cerebello-pontine-angle that caused the severest possible damage from pressure and in which there existed only a very mild, occasionally unilateral, optic neuritis. Complete absence of any change in the fundus oculi was observed in only one case;

this was, in our experience, an exception. I am unable to offer an explanation for this variation. We were also unable to ascertain whether the choked disc began on the side of the tumor exclusively or whether it predominated on that side. The patients did not, as a rule, attach much importance to the headaches and vomiting from which they were suffering. They sought medical advice only when

*Failing of the Power of Vision*

set in. Unfortunately, the visual disturbances were at that time indicative of the long existence of the pressure manifestations and that the disease had considerably progressed. Not only the visual fibres alone, but important vital centres and tracts of the pons had at that time suffered considerably. The patients stated that their visual disturbances began with the observation of bizarre shades passing their visual fields when reading or writing. Some of our patients did not consult a physician despite the visual disturbances, the headaches and vomiting from which they were suffering for months or even years. This explains that almost all neoplasmata of the cerebello-pontine-angle have grown to considerable dimensions and have done much damage by pressure on neighboring structures. According to the statements of some patients it appears certain that in some instances the visual power was retained for months and even years after the first signs of heightened cerebral pressure were manifest. In cases where the choked disc had progressed into the atrophic stage, visual disturbances asserted themselves in a very short time. In one instance total blindness had set in within a period of three weeks. It should be stated that some patients related the occurrence of sudden blindness which quickly vanished and they soon fully recovered their visual power again. *Epileptic amaurosis* (*Jackson*) may be brought about by any tumor of the brain, no matter where located. Total blindness, that sets in suddenly and then completely disappears after a few seconds or minutes and which may be repeated a number of times in a day, is explained on the basis of sudden increased cerebral pressure and the anæmia of the visual centres due to such rise of pressure.[1]

[1] *J. Hirschberg*, Über Sehstörungen durch Gehirngeschwulst. "Neurologisches Centralblatt," 1891, No. 15.

*Disturbances of respiration and heightened arterial pressure* were not observed before the operation. The latter manifestations especially do not seem to occur in tumors developing slowly even though the medulla oblongata be compressed. In the few patients in whom slow pulse was noted, its cause could be explained by the existing arteriosclerosis, because outside of the slow character of the pulse no other characteristics of high pressure were present. Whether the acceleration of the pulse-rate, not infrequently observed, was due to a pressure paralysis of the vagus could not be decided. However, even in sudden elevation of intracranial pressure, in which all other disturbances were present, rise of arterial pressure and *Cheyne-Stokes'* respiration were not observed. This is even the more remarkable since in these cases the pons and medulla oblongata were sympathetically affected. On the other hand, the pulse and respiration behaved entirely different after operations; of this, a few remarks will be made later. To the general symptoms of cerebral compression also belong

*Stupefaction*

This symptom was not always present. When it suddenly set in it was of ominous significance. Such patients usually succumbed in a very short time. The stupefaction in these instances at first led to a condition of lethargy that finally terminated in coma.

Other *psychic disturbances*, especially a peculiar digression from the usual behavior of the individual, was observed in a number of our cases. Whether these symptoms could be attributed to the general cerebral pressure, or whether the morbid condition of the cerebellum was responsible for their occurrence I should not like to decide at present. A great many of these patients complained of weakness of memory and other disturbances in their powers of recollection. There was a patient, for instance, who was generally well versed and who answered all questions tolerably well. Still he had forgotten the small multiplication table. After thinking for a long time he would say, "I certainly should know this." Most striking were the repeated observations of how easily the patients tire at the slightest mental and physical effort. When figuring they would

make striking errors. One patient, a woman, was for a very long time in a jovial mood, while her power of comprehension was at the same time decidedly dull. At the post-mortem examination, there was found, besides a tumor at the cerebello-pontine-angle, a very slight degree of hydrocephalus internus. It is assumed that the psychic disturbances mentioned may be brought about by considerable accumulations of fluid in the ventricles of the large brain and through general cerebral pressure.

While general psychic depression was never observed, a peculiar euphoric disposition was a striking feature in a series of patients, although they were fairly cognizant of the gravity of their affliction. Two patients were in a most lively state of psychomotor exhilaration. One of these talked continually, laughing and coining jokes. Another fellow was in the happiest frame of mind. Even months after the extirpation of the neoplasm from the cerebello-pontine-angle, he still insisted that he felt "magnificently well." This patient recovered, but he created the impression by his talkativeness of one mentally affected.

## Focal Manifestations

One of the most important local symptoms of space-restricting processes in the posterior fossa of the skull is

### Vertigo

This was absent in only one case. During the general dizziness all possible states of weakness, faintness, noises in the ears and in the head, sensations referred to the stomach and the heart, black spots in front of the eyes, etc., were complained of by the patients.

Real *cerebellar and vestibular vertigo* is characterized by a subjective sensation of turning of the body of the patient or of the objects about him. There is another form of genuine vertigo, but in this form the patient has the sensation of losing his balance. While the vertigo of turning points to an irritation of the vestibular nerve or its nucleus, therefore being a specific symptom of involvement of the cerebellum and its vicinity, general vertigo (loss of equilibrium) is due to an interruption of

the reflex mechanisms that are active in maintaining the equilibrium.

Persistent and very tormenting turning-vertigo was found as a subjective sensation mainly in those patients who were afflicted with intracerebellar and intrapontine foci. In neoplasmata of the cerebello-pontine-angle, it would occur only paroxysmally and would then be of transient nature. It would be precipitated when the patient attempted to sit up in bed suddenly or when he turned around the axis of his body. Turning-vertigo of long duration was observed in none of our patients suffering from cerebello-pontine neoplasm. Under the term "*vestibularis attacks,*" *Ziehen* has described cases of turning-vertigo that occurred in connection with disturbances of coordination (nystagmus, double vision, vomiting, and violent headaches). These vestibularis attacks were only seldom encountered in our observations; the other type of vertigo, on the other hand the loss of the sense of equilibrium, was an almost characteristic disturbance. The latter manifested itself by a staggering walk or swaying while the patient was standing, or he would perhaps lose complete control over his body.

*Grainger Stewart* and *Holmes* claim that in cases of extra- and intra-cerebellar tumors, rotation-vertigo is different from the sense of rotation perceived by the patient himself. According to these observers the objects surrounding the patient suffering from neoplasmata in the posterior fossa of the skull (intra- as well as extra-cerebellar tumors), turn during the attack of dizziness toward the unaffected side. In tumors located outside of the cerebellar substance, the sensation that the body of the patient turns from his sound side to that in which the neoplasm is located is said to predominate. In tumors of the cerebellar substance proper, the turning of objects surrounding the patient predominates over the sense of rotation of the patient's own body. In the last few years our observations were directed to establish something tangible, something definite out of the statements of the patients with reference to their sensations during an attack of vertigo. Those individuals who could not explain or describe their sensations during an attack were instructed as to what they should observe. Despite the fact that a great number of these patients were intelligent people,

their statements with reference to the vertigo were indistinct and incomprehensible, and we could, therefore, not corroborate, in our series of patients, the findings of *Grainger Stewart* and *Holmes.*

While vertigo is a subjective sensation of the patient, which results from a disturbance of the afferent sensory tracts leading to the cerebellum, lesions of its efferent apparatus were manifested clinically principally by pure motor disturbances which were collectively spoken of as

### Ataxia

This manifests itself by a certain disordered course of the otherwise regularly working muscles and their antagonists, without a paralysis of any particular muscle group being present. This disordered function is noticed when the patient is walking, sometimes when he is using his upper extremities, and not infrequently when the body is at rest, i.e., when he is standing or sitting. The gait of cerebellar ataxia resembles that of the staggering of a drunken individual (Marche de l'ivresse). At standing or sitting, it has an unsteady swaying character. Ataxia is only seldom absent in space-restricting diseases of the posterior fossa of the skull. Occasionally it is but slightly developed; at other times only a suggestion of it is present, and in many cases again, it is remarkably in the foreground, so that it forms the most conspicuous and striking local manifestation of the entire clinical picture. Occasionally ataxia occurs without vertigo, and again, attacks of vertigo may exist for a long time without the slightest ataxia being demonstrable. In advanced cases both of these morbid manifestations are well developed. It is evident that the ataxic disturbances are undoubtedly aggravated by an existing vertigo. The cerebellar-ataxic gait differs from that of the tabetic, in that in one there is a non-restriction of movement and an overcorrection at walking (cock's tread), while in the other there is a lack of proper attitude and a certain weakness at stepping as well as an inability to bend the body forward while advancing in the same direction. Of course the complicated arrangement of the cerebellum accounts for this peculiarity in gait when certain portions of its structure are affected by morbid processes. In our cases, the deviation

from the proper direction and the staggering to one side were occasioned by the damaging of a particular cerebellar half or its pontine peduncles. Forward staggering, or falling forward, or the total inability to accomplish harmonious action of the various parts of a limb so that the body can be properly moved away from a certain position, points to a destruction of the vermis. For such high degree of cerebellar ataxia *Babinski* coined the term *Asynergie cérébelleuse.* At attempts to walk, the lower limbs are moved forward, to be sure, but the trunk cannot be retained in position and threatens to fall over. If the patient attempts to sit up in bed without helping himself with his hands, the head is raised and the lower limbs suddenly jerk upward, while the trunk remains flat.

In the absence of all these manifestations, or if they could not be easily recognized, we were still able to elicit ataxia while having the patient perform complicated movements that require finer coordination and exact balancing. For instance, patients could not walk backward without immediately falling to the ground, or it was difficult for them to retain a straight direction in walking forward while they were holding their arms at a horizontal level. When attempting to stand on one leg, they would sway to and fro, or they would frequently fall down; especially was this true when this test was undertaken with the limb that corresponded to the affected cerebellar side. These patients would at once tumble over when attempting to retain a position with the upper part of the body strongly bent forward. When at the bedside of his patients *H. Oppenheim* was frequently able to demonstrate to us that a number of these ataxic signs occurred only after the patients would change their position, so that the pressure of the neoplasm on the cerebellum acted in a different and more harmful manner.

Ataxic disturbances in the upper extremities principally corresponded to the side of the diseased cerebellum. When the patients were asked to find a certain spot with the point of the index finger, they would usually touch somewhere near the selected point, after numerous attempts. Frequently, but not always, the hemiataxic disturbances also extended to the lower extremity of the same side. Cases that resembled tabetic ataxia could be easily diagnosed by the total

absence of the usual tabetic spinal manifestations and in almost all of our observations the complete absence of disturbances in the sense of position. For that matter, no sensory disturbances of any kind could be demonstrated. This fact represents an antithesis to the manifestations of tumors of the pons.

A hemiataxic disturbance, which was only very seldom absent (the most frequent accompaniment of cerebellar ataxia), was

*Adiadochokinesis*

With this term, *Babinski* designates the inability to quickly execute movements and contramovements. Quick pronation and supination of the forearm, shaking of the hands, piano playing movements and quick flexion and extension of the elbow-joint were the usual tests applied in eliciting this pathologic manifestation. With the limb corresponding to the side of the seat of the tumor, the movements were usually accomplished with difficulty and with awkwardness, while the arm and hand of the sound side retained their dexterity.

With this, not all ataxic manifestations are exhausted. According to *Luciani* cerebellar ataxia is composed of three complexes of manifestations. These are: neuromuscular asthenia, atonia, and astasia. *Luciani* designates the inability to react to a stimulus with a certain movement with usual force as asthenia (muscular asthenia caused from nervous asthenia); the rapid premature exhaustion of the antagonists in the execution of a certain movement he calls atonia (cock's tread). Astasia he designates the incomplete suspension of individual irritations that cause movements (trembling and swaying). In some cases, one of these symptoms was more distinct than the others. Hemiasthenia was not only found in those cases in which there was a lesion of the pyramidal tract, but it was also present in those instances where the neoplasm or abscess had affected a cerebellar hemisphere. Atonia was also occasionally very distinctly marked, in which instance it extended over almost all muscles and joints. Astasic disturbances were frequently developed to a striking degree and would then show themselves prominently in the form of tremors and tottering.

According to *Grainger Stewart* and *Holmes*, the action of the antagonists may be tested by holding a given joint tense

in a certain position, and the force so retaining it is suddenly released, whereupon the limb tested will respond by an excessive movement in the direction of tension, without being restrained by the antagonists, as is normally the case. This reaction depends upon the degree of hypotonia in the extremity tested. For instance, if the extension of the flexed forearm be forcibly resisted, a sudden release of the restraining force will cause the limb to jerk up into an extreme position of flexion. In normal muscle-tonus, the reaction would be very slight indeed. This is due to the restraining action of the normal antagonists. This will also happen if the patient be requested to flex his extended knee at the hip-joint while this movement is being resisted by a downward pressure on the knee; if hypotonia be present, the knee will fly up, if the pressure upon it is suddenly released. *Seiffert* described this condition in the Pathology of the Cerebellum, as "the resistance phenomenon of hypotonia." He also pointed out the marked difference of this reaction between hypotonic limbs and extremities afflicted with spastic paralyses.

### Motor Disturbances

Besides many ataxic manifestations, pure motor disturbances have also frequently been observed. Total flaccid paralysis of one-half of the body, as described by *Mann*, was never observed in our cases prior to the operation, but it occurred a number of times immediately after the removal of a cerebello-pontine-tumor. On the other hand, spastic manifestations could quite frequently be demonstrated. In these cases of neoplasm spastic paralyses of the extremities of the opposite side of the body, in which the reflexes were highly exaggerated, frequently amounting to clonus and the *Babinski* and *Oppenheim* phenomena were usually present. This may be explained by the pressure exercised by the tumor on the pyramidal tracts (before their decussation) or on the pons. I recall the case of a boy fifteen years of age, in whom all the symptoms of tumor at the cerebello-pontine-angle were present and in whom a spastic paresis of the extremities could be demonstrated on the side of the neoplasm. From this *Oppenheim*[1] concluded that we were dealing with "a

[1] "Beitrag zur Diagnostik und Therapie der Geschwülste des Centralnervensystems," Berlin, 1907, Karger (p. 33).

tumor extending to the pons, medulla oblongata, and cerebellum that compressed the corresponding cerebral nerves with its proximal pole and interfered distally with the pyramidal tracts after they had crossed."

The same patient was our only example for the occurrence of *epileptiform spasms* in cerebellar disease. Epileptiform spasms on the same side of the body in connection with cerebellar foci have been described by some authors. In these cases, the pathology usually consisted of abscess formations resulting from mastoiditis and not of neoplasmata.

To these motor disturbances of irritation, there also belong, according to *Oppenheim*, *forced position*, and *forced movements*. However, in our cases, these manifestations were only rarely observed. The rigidity of the neck was at times developed to a considerable degree. It should be mentioned, however, that in all of these cases in which opisthotonus was present there existed considerable hydrocephalus, which may have also been responsible for the forced position of the patient.

Patients of this class will keep their heads rigidly in the position which will cause them the least annoyance. As stated above, any change from this fixed position is fearfully avoided by the patient, because they incite headaches, vomiting, vertigo, and other torturing manifestations. This was also true in all of the cases of tumor that were accompanied by marked hydrocephalus. These patients would involuntarily select a position in which the tumor would exercise the slightest pressure upon sensitive neighboring organs. All forced positions of the head that were observed before and after operative interventions are explained on the same basis. A number of patients suffering from neoplasmata of the cerebello-pontine-angle would spasmodically bore their faces into the pillow corresponding to the side of the tumor without the trunk participating in this rotation. Frequently they would turn the head toward the side of the tumor and some to the back, so that the ear came near the shoulder. At other times again the patients did not observe an aggravation of their symptoms upon passive correction of this position.

Now, with reference to the

### Sensory Disturbances

resulting from the distant action of tumors, we could never find any abnormalities in the tactile sense of the trunk and of the extremities. The frequently observed sensory disturbances in the face, as we shall see later, were due to a number of other causes. Disturbances in the sensory conduction occurred only when the neoplasm exercised pressure on the crossed pyramidal and lemniscus tracts, or when the region of the foramen occipitale magnum was subjected to much compression. Increased tension in the hydrocephalic fluid extending to the spinal canal was also responsible for this condition, and would rarely also give rise to paræsthesias. This could be demonstrated easily and to good advantage in the case of the child afflicted with Cystic Sarcoma of the right cerebellar hemisphere (described under Observation VII, 5), in whom there was a marked reduction in the senses of touch and pain. Another patient who was operated on for the removal of a tumor from the right cerebello-pontine-angle, complained, for a long time, of formications and painful sensations in the left lower extremity and the scrotum. A lady, fifty-one years of age, perceived paræsthesias in the extremities on the side from which the tumor had been extirpated, which, however, soon disappeared. Paralyses did not occur in this case.

Disturbances in the sense of position went hand in hand with the other morbid manifestations which had a tabetic semblance. It is easily explained why tabetic ataxia with disturbances in the sense of position were observed when the pressure upon the pyramids was very marked. In foci of the pons proper the pyramidal tracts become involved. In these cases, spastic pareses of the opposite half of the body, sensory paralyses with astereognosis, and disturbances in the sense of position could be demonstrated.

## Participation of the Cerebral Nerves

In all our observations, there was an involvement of the cerebral nerves. They either depended upon bulbar focal manifestations or they occurred in the form of neighborhood symptoms

resulting from neoplasmata of the cerebellum and the cerebello-pontine-angle. It is noteworthy, that in the latter instances, the bulbar manifestations were strikingly slight in comparison with the extraordinarily strong compression to which the pons, the medulla oblongata, as well as all other cerebral nerves involved had been subjected. A few specimens have shown that the entire half of the pons and the medulla oblongata have been completely pressed flat and that the other half had been subjected to a considerable displacement as well as flattening. These patients perished in a very short time with symptoms of acute bulbar paralysis, even though the tumor was enucleated with ease. In other cases again, bulbar symptoms were developed to a marked degree, especially in those instances of tumor of the cerebello-pontine-angle that extended more basalward toward the pons and the medulla oblongata. Lastly, all intrapontine tumors caused severe bulbar manifestations.

Now, with reference to individual cerebral nerves, the

*Nerves of the Movements of the Eyes*

were more or less involved in all cases of tumor seated in the posterior fossa of the skull. The **nystagmus,** the tremor of the eyes at rest or on looking to the side, forms, together with the ataxic disturbances of the trunk and the extremities, one of the most important symptoms of space-restricting processes in the posterior fossa of the skull. It was entirely absent only in one patient with a solitary tubercle of the right half of the cerebellum and in another case of flat sarcoma developing in the right cerebellar half below the tentorium. However, in both of these cases, there were marked disturbances of the ocular muscles. Nystagmus cannot always be observed when the patient is reclining quietly on his back. In such cases, it may be elicited when the patient is made to get up and walk about or turn around, as we are accustomed to test for cerebral ataxia. *H. Oppenheim* has further shown that where nystagmus is absent when the patient is lying down it can be made to appear by directing him to lie on the side, in which case it will be observed toward the side on which the patient is reclining.

In the large majority of our cases, the nystagmus was usually associated with a **paralysis of the abducens** on the side of

the neoplasm. Frequently there existed at the same time a visual paralysis of both eyeballs toward the side of the morbid focus. Even in extreme lateral position of the eyeballs, when the patient was looking to the side, a rapid exhaustion of the respective ocular muscles could be demonstrated and the eyes soon returned, under coarse nystagmus, to their position of rest.

The nystagmus was either coarse or fine. It was observed best when the patient was looking in both directions. It was most marked when he was looking toward the affected side. It was most pronounced in pontine foci and in morbid conditions of the medulla oblongata, and in these instances it was already perceptible when the eyes were in median repose.

In all cases in which there existed an isolated paralysis of the abducens or a weakness of this nerve—especially in extracerebellar neoplasmata—the paralysis could be explained to have resulted from pressure exerted by the tumor, while conjugated abducens paresis, associated with nystagmus, spoke for an injury to the pons. Nystagmus may also be looked upon as an ataxic disturbance resulting from morbid cerebellar function. After surgical removal of neoplasmata the paralytic manifestations and the nystagmus frequently become much aggravated, so that complete strabismus results. This displacement of both eyes was occasionally associated with protrusion of the eyeballs which, of course, was explained by relaxation of the muscle tonus.

Other paralyses of the ocular muscles were only rarely observed. Where the tumor is located more to the front, especially in neoplasm of the corpora quadrigemina, paralysis of the oculomotorius was especially marked. It was in this connection of special significance as a focal symptom.

Disturbances of the acusticus and facialis were not as frequently observed as those of the ocular movements; they were never absent, however, in neurofibromata of the acusticus and in neoplasmata at the cerebello-pontine-angle.

In the region of the

*Oro and Oculo-Facialis*

all sorts of paralyses were observed, and in their mildest grades they appeared in the form of an effacement of the nasolabial fold of that half of the face that corresponded to the seat of the neo-

plasm. In cases of greater severity they appeared in the form of histrionic distortions. It should be pointed out in this connection, however, that the severity of the facial paralysis did in no way correspond to the size of the tumor. Total facial paralysis resulted only after the removal of the tumor, during which the facialis (often completely surrounded by the neurofibroma) was torn or severely mashed. In a whole group of cases a fine tremor of half of the face was strikingly in the foreground. During the examination of the patients, certain facial motions could not be executed with certainty. For instance, the angle of the mouth could not be retracted gradually but in jerks; the wrinkling of the skin of the forehead could only be accomplished with the help of the other facial muscles. These manifestations strongly recalled the neuromuscular astasia of the extremities.

### *The Nervus Octavus*

was associated with the other morbid manifestations in a most peculiar manner. As is well known, its function is, physiologically, a double one. First, as the nervus acusticus, it is the sensory nerve for the organ of hearing, and, second, as the nervus vestibularis, it transmits the stimuli received in the semicircular canal to the nuclear masses of *Deiter* and *Bechterew*.

Disturbances in the sense of hearing were never absent in cases of tumor of the cerebello-pontine-angle. These were at first called to the attention of the patient by deafness or states of acustic irritation. Again, unilateral difficulty in hearing developed in a whole series of cases without the patient being aware of his condition. This was called to their attention by examinations made by ear specialists and neurologists. *Bezold* described the following symptoms as being characteristic of unilateral cochlear disease: 1. Strong reduction of the sense of hearing to whispering on the affected side. 2. Upward displacement of the lower, and downward displacement of the upper audible sound-limit at aerotympanic test. 3. Continued increase of the duration of hearing from the lowest to the highest tone of the existing audible distance. 4. Negative result of *Rinne's* test for low pitch tuning-forks. 5. Lateralization toward the sound side (*Weber's* test). With the exception of No. 3, to the accomplishment of which *Bezold's* complete

scale is necessary, tests for one-sided central difficulty of hearing could be carried out with the aid of C and A tuning-forks and *Galton's* whistle.[1]

Besides paralytic manifestations of the nervus cochlearis various acustic disturbances of irritation were also observed in a number of patients. These were described as sounds of knocking, ringing, rustling, passing of electricity, telephoning, whistling and similar noises. With the increase of the deafness these noises disappeared.

Physiologic studies have shown that lesions of the nervus vestibularis are followed by the same sort of ataxic disturbances as are observed in diseases of the cerebellum. Vestibular ataxia manifests itself by a sense of giddiness, or swaying, or in other disturbances of motility, and is subjectively perceived by the patient as a sensation of rotation. Observations illustrating such disturbances have been described above. It is to be emphasized once more, however, that one of the principal tasks of the cerebellum consists of commuting all changes in the position and movements of our bodies, communicated to it by means of the semicircular canals, by correcting the disturbed equilibrium through the particular neuromuscular apparatus. This is accomplished in a reflex manner under rise of psychic activity.

The influence of the vestibular apparatus on other nerve-tracts extends in three directions. A part of its fibres lose themselves toward the cerebrum, after having passed from *Bechterew's* nuclear masses to the cerebellum and over the superior peduncles to the thalamus opticus. The second part of the vestibular fibres connect from *Deiter's* nucleus to the nuclei of the ocular muscles, while the third portion finally stands in relation with the large ganglion cells of the spinal cord. This anatomic fact alone explains the far-reaching influence of the vestibulum. The connection of the vestibularis with the nuclei of the ocular muscles is of special practical importance. From the action of the vestibularis on the ocular movements, or from the failure of such action, we are able to conclude whether there exist lesions of this nerve or not. *Ziehen* advocated the use of

[1] Compare *Th. Ziehen*, "Medizinische Klinik," 1905, No. 34, p. 851.

*Wanner's* rotating stool for the correction of nystagmus; this was done with the patients observed by him at his clinic, and with those referred to me for operation. A more convenient method of examination has been introduced by *R. Bárány,* which consists of an irrigation of the tympanic membrane with a stream of cool water; this results in a refrigeration of the current of endolymph and thus causes an irritation of the vestibularis. In cases where the vestibular apparatus is intact, the result will be caloric nystagmus—so called by *Bárány.* I shall, for the present, desist from entering into a discussion of this test, because the experimentation with it has not as yet been concluded. For particulars, the reader is referred to the monograph on the subject by *R. Bárány* and *K. Wittmaack,* "*Functional Tests of the Vestibular Apparatus.*" [1]

It has already been stated that in the greatest majority of our cases the nystagmus was more marked when the patient was looking to the side toward the neoplasm. This was the case in tumors of the cerebello-pontine-angle, as well as in intrapontine foci.

In a few other cases of tumor of the cerebello-pontine-angle we were able to demonstrate, besides the subjective sensation of vertigo, other manifestations of irritation. *Ziehen* has called attention to the occurrence of paroxysmal attacks of vestibular irritation (compare Observation VII, 7) which he designated as *vestibular attacks.* They are recognized by the following symptoms:[2] "1. Onset of intense sense of vertigo and very strong vestibular ataxia (if the latter be present it becomes markedly aggravated). 2. Spontaneous nystagmus, i.e., nystagmus occurring even without movements of the eyes. 3. Intense headache, extending mainly to the neck (back)." Acustic manifestations of irritation, vomiting, transient diplopia or amblyopia in the eye of the same side, may complete the clinical picture. *Seiffer* mentions the similarity of these vestibular attacks with the Syndrome du noyau de *Deiter Bronniers* and the vertiges epileptiques *Durets.*

Paralytic manifestations of the

[1] Verhandlungen der Deutschen otologischen Gesellschaft, XX. Versammlung in Frankfurt a. M., 1911. Jena, bei Gustav Fischer.

[2] *Th. Ziehen,* Medizinische Klinik, 1905, No. 35, p. 875.

*Glossopharyngeus, Accessorius and Hypoglossus*

have also been noted in a number of cases under our observation. They were recognized by an obliquity of the soft palate, weakness in elevating the shoulder or the arm, and a deviation of the protruded tongue toward the side of the tumor. Disturbances of deglutition were especially marked in pontine foci and in neoplasmata that extended to the base of the pons or under the medulla oblongata; swallowing in the wrong direction was also very frequent in these cases. In some instances disturbances of speech completed the picture of the bulbar manifestations of paralysis. In such cases, during the usual tests of asking the patient to repeat difficult words or sentences, the speech was frequently nasal, slow, and dysarthric. In other cases again, the defective speech was hasty, incoherent, and sometimes entirely unintelligible.

*The Motor Branches of the Vagus*

were involved in one case of tumor of the cerebello-pontine-angle. The patient was a woman, thirty-one years of age. Hoarseness, due to a paresis of the nervus laryngeus, was noted before the operation. After the operation, which was entirely successful, the hoarseness persisted for a very long time and then gradually disappeared.

Of disturbances of the other cerebral nerves, a

*Beginning Paralysis of the Trigeminus*

was most marked and was almost never absent. In its early stages, it manifested itself in most patients afflicted with neoplasmata of the posterior fossa of the skull, as a reflex anæsthesia of the cornea. The diagnostic value of this phenomenon has been pointed out and taught by *Oppenheim* for many years past. It was absent only once in a case of a tumor which was mainly located in the fissure between the pons and medulla oblongata. Anæsthesia of the cornea could also be demonstrated in neoplasmata of the pons and the cerebellar hemispheres. In the greatest majority of cases it affected the side corresponding to the tumor; very rarely it involved both eyes. In one instance of tuberculosis of the pons, the contralateral cornea was anæs-

thetic, while the cornea of the same side reacted very lively. In this particular instance the reflex anæsthesia of one cornea and the conjunctiva could have led to erroneous conclusions with reference to the seat of the trouble, were it not for the fact that all other symptoms pointed to the other cornea. In cases where amaurosis had already supervened, not much importance could be attached to the bilateral reflex anæsthesia.

*Oppenheim* has further called attention to the fact that the anæsthesia, or at least a distinct hyporeflexia of the cornea, can be demonstrated in some cases only when the patients change their position. This he also demonstrated a number of times in our patients. In the beginning of the examination no reflex anæsthesia could be found; as soon, however, as the patient reclined on the side corresponding to the side of the tumor, the reflex at once disappeared. The corneal reflex appears to be an extraordinarily delicate symptom of slight paralysis. In patients who had undergone operations for the extirpation of tumors it did not reappear for a long time, while the other sensory manifestations disappeared.

Disturbances of irritation and paralyses of the trigeminus were present in some form or other. A whole group of patients would complain of paræsthesias which they described as a dull sense of tension in the cheek or as a sensation of burning in half of the tongue. In other instances, a true trigeminus neuralgia developed. This occurred even as the first symptom of the disease, so that the patient had a number of teeth extracted. On the other hand, in one particular case (see Observation VIII, 1), a tumor, situated more basally under the pons, had involved the entire *Gasserian* ganglion without the patient complaining of the slightest neuralgic symptom.

Objectively the paralyses of the trigeminus could be demonstrated in the reduction of the sensation of various qualities; these consisted of either a reduced sense of pain on one side, or a lack of perception of contacts with the brush, or with a dull needle, or as a thermanæsthesia. While paralyses in the region of the muscles of mastication were observed infrequently, they were nevertheless present in a great many cases.

One more important disturbance of the trigeminus should

finally be mentioned. After extirpation of neoplasmata of the cerebello-pontine-angle, I have seen

*Keratitis Neuroparalytica*

develop in a number of cases.

In two patients it set in twenty-four hours after the operation. A brief discussion of this manifestation is desirable for practical reasons, as well as for the reason that a number of authors (*Frazier*, *Spiller*, *van Gehuchten*) have pointed out that trigeminus keratitis can be avoided if the *Gasserian* ganglion be not completely removed, but the trunk of the nerve simply divided, as was practised by *Victor Horsley*, in 1891, with unfortunate outcome. This procedure would undoubtedly result in an interruption of conduction and thus effect a cure of the typical trigeminus neuralgia, the cause of which was in the periphery of the nerve-trunk. Physiology teaches us that once a sensory root is destroyed no regeneration can take place. This obtains as well in division of the posterior roots between the cord and spinal ganglia, or in removal of these ganglia, as in the division of the trigeminus trunk, or total extirpation of the *Gasserian* ganglion. Nevertheless, the latter operation is less dangerous and is therefore to be preferred.

In the above-mentioned cases the cerebellum was mechanically injured, displaced to one side and the trunk of the trigeminus severely pulled upon. Only in a very few cases have I advanced over the upper border of the petrous portion of the temporal bone into the middle fossa of the skull, i.e., to the *Gasserian* ganglion. I will leave these cases here out of consideration because it is likely that the trigeminus trunk, as well as the *Gasserian* ganglion were involved sympathetically. A keratitis developing in these cases, would therefore throw no light upon the present controversy. The case of a patient, thirty years of age, in whom a tumor of the cerebello-pontine-angle had been easily removed, is especially noteworthy in this connection. A very important diagnostic sign in the case of this woman was a preexisting areflexia of the cornea of the corresponding side. Five days after the operation, she developed a pronounced keratitis which healed slowly under atropin, boric acid instillations, and protective eye-glasses. However, as soon as the glasses were discon-

tinued (for twelve hours only) the cornea became inflamed again, and this state of affairs persisted for fully a year after the operation.

My observations consequently teach that the assumption that only injuries of the *Gasserian* ganglion jeopardize the eye, while trauma or resection of the trunk of the trigeminus are not followed by keratitis neuroparalytica, is erroneous. I wish to emphasize the fact that I am speaking of human beings only and my clinical observations exclusively. Should animal experiments in this respect prove the contrary, the result so obtained would, as far as the surgeon is concerned, be valueless. At any rate, *C. Sultan*, in his experiments on dogs, has shown that division of the trigeminus trunk is followed by keratitis; of five animals thus operated upon, only one escaped it.

The danger for the eye in the human being is not nearly as great as it is in the animal. With the exception of one single instance, keratitis following extirpation of the *Gasserian* ganglion (no matter how severe in form) was in all my cases cured under proper treatment (rest in bed, boric acid, protective eye-glasses). This single case of failure was that of the wife of a miller who, in spite of a severe hypopyonkeratitis, could not be induced to exchange the dusty atmosphere of the mill for that of the hospital. In the first period following the extirpation of the ganglion, the danger of keratitis is greater than in the subsequent period, regardless of the fact that the anæsthesia of the eye persists. I recall the case of a lady who was operated on by me, January 31, 1893. She was, at that time, sixty-eight years of age, and is to-day, at the age of eighty-six, in the best possible general health. Immediately after the extirpation she developed a keratitis neuroparalytica that soon healed. She used no protective measures, and has not suffered from any form of corneal inflammation since that time. I could relate quite a number of similar observations.

### Changes in the Intracranial Pressure After the First Stage of the Operation

As already set forth in the first volume, my preference is for operating in two stages. Immediately after the mobilization of the osseous parts of the occipital region, changes in the pressure

of the stagnating liquor within the dural canal become manifest. After the first stage of the operation, the patients will inform us (almost without exception) that they are relieved from their greatest torture—the headaches. The subjective sense of well-being not infrequently develops to such an extent that the patients consider themselves cured. In a few instances, the power of vision improves during the days intervening between the first and second steps of the operation. Though exact tests for the acuity of the visual power were, for apparent reasons, impracticable, patients who have lost their eyesight to such a degree that they could see nothing but a slight beam of light, would, three or four days following trephining, be able to count the number of fingers held before them and to recognize objects. In a few other instances, the decrease in the intracerebellar pressure could further be demonstrated by an increase in the frequency of the pulse and the disappearance of its high tension. The changes in the pulse were noticeable immediately after the flap of bone had been displaced downward, and its quality continued the same until the second step of the operation. The regular disappearance of the headaches, the improvement of the visual power and the pulse could not have been produced by the quantity of blood lost during the operation, because quite frequently no greater amount than a tablespoonful of blood was lost, and severe hemorrhages were observed only very rarely.

This, therefore, goes to prove that a decrease in the tension of the liquor takes place also without opening the dura. It is, however, inconsiderable and, above all, does not last for a long time, because at the second step of the operation, the dura was seen to protrude into the cleft in the skull as forcibly as during the first operation. The elastic dura yields much the more when the cleft in the bone is made large and when the presenting wedge-shaped crista occipitalis is also reflected downward; this permits the dura of the second cerebellar hemisphere to also dilate.

It seems to me that during the first stage of cerebellar operations as much reduction of pressure as possible should be aimed at. While attempts in this direction have, until now, yielded no uniformly good results, it is nevertheless a fact that neoplasmata of the cerebello-pontine-angle and the general cerebral

pressure subject the pons, as well as the gray nuclei in the floor of the rhomboid fossa and the opticus, to more or less damaging compression, and our efforts at decompression should therefore be continued. The autopsy findings after the extirpation of these tumors almost always showed the same picture. The pons was displaced to the opposite side, often flattened to the shape of a ribbon, and the contiguous structures appeared softened and permeated with fluid. To be more precise, I believe that the sudden changes in the pressure, resulting from the extirpation of the tumor, are frequently responsible for the death of the patient, who perishes from respiratory paralysis. This is brought about by an œdematous infiltration of the nuclear masses of the so-called respiratory centre, which is situated in the posterior part of the rhomboid fossa.

By resorting to artificial respiration we frequently succeeded in keeping the patients alive for hours after respiratory paralysis had set in. In the beginning the frequency and the tension of the pulse changed only slightly; in a number of cases the pulse-beat continued full and regular as long as the respirations were mechanically supported. Despite the fact that active respirations were entirely wanting, two patients retained consciousness to such an extent that they answered questions put to them by nodding with or shaking of their heads. They also moved their eyelids, yet it appeared as if the muscles of the face and the tongue were completely paralyzed. In the case of a girl twelve years of age (see Observation VII, 2), the first spontaneous, slight inspiration occurred only after artificial respiration had been kept up for three-quarters of an hour. The respirations now became stronger and more profound, and we were successful in sustaining the life of the child through the second stage of the operation that ultimately led to a cure. To this class of cases also belong those instances of general cerebral compression in which (occasionally during a change of position) suspension of respiration will occur suddenly and cause the death of the patient before we get a chance to decide upon an operation.

To sidetrack the dangers of cerebral compression, and forestall the possibility of a sudden change of pressure in the region of the respiratory centre, the liquor was drawn off by puncture

of the ventricle during the first stage of the operation. Through a special aperture made, or after enlarging the osseous cleft above the sinus transversus, a cannula was introduced into the posterior horn, and the liquor drained off, until the dura of the cerebellum and of the occipital pole was seen to recede. The fourth ventricle was also frequently punctured without opening the dura. The result of these punctures has, on the whole, been unsatisfactory. The patients complained after these operations of great exhaustion and of frontal headaches. The pulse usually increased in frequency and the temperature rose. In a number of instances, confusion followed soon after this procedure, and in other cases increased nystagmus and vertigo were noted. Furthermore, at the second stage of the operation the dura appeared just as tense as before. In no case was there drainage of liquor in the interim, which showed that the wound had promptly closed.

In other operations upon the cerebellum, in which cerebral compression was threatening, we aimed at establishing drainage by scarifying the dura of the cerebellum in a number of places. But the results were satisfactory, because soon after the scarifications, the strong pressure forced the cerebellar mass into the wound of the dura and, acting as a valve, prevented drainage from the subdural space. Finally, in a woman who had nearly completely lost her eyesight as a result of congestive atrophy, a flap of dura was formed at the first stage of the operation which was followed as a result of the changed pressure conditions by softening of the entire cerebellar hemisphere thus exposed, so that the extirpation of the tumor from the liquified cerebral structure at the second stage of the operation was rendered uncertain, and could not be carried out with the necessary cleanliness.

In how far

*Puncture of the Corpus Callosum*

(see special chapter) will do away with the great dangers of increased liquor tension will have to be learned from further experiences. At present I cannot report on it favorably.

## Cysts in the Posterior Fossa of the Skull

Of all the operations in the posterior fossa of the skull, surgical treatment of cysts in this locality have yielded the best results. The prognosis is best for true cysts of the cerebellum and arachnoidal newformations belonging to the same class. Cystic neoplasmata, on the other hand, mainly belong to the infiltrating sarcomata and are much more unfavorable than circumscribed tumors.

### Traumatic Cysts

While most true cysts observed were limited to one hemisphere, I have in Vol. I called attention to the occurrence of similar newformations in both cerebellar hemispheres following trauma. The following interesting case illustrates this well.

### OBSERVATION VII, 1

*Fall on the Back of the Head, Followed by the Development of Two Cysts, One in Each Cerebellar Hemisphere. Severe Symptoms. Exposure of the Entire Cerebellum. Splitting of the Cysts. Cure Since the Last Four and a Half Years.*

The patient, a man twenty-three years of age, had, until three years ago, enjoyed perfect health. At that time (1904) he received, while at service in the field artillery, a kick in the head from a horse. He fell to the ground in a faint and remained unconscious for some time. Outside of a wound behind the left ear no other results followed. In the beginning of August, 1906 (eighteen months later), while at work in his wood-turning shop, he fell from a pile of wood backward and landed with his head on a wooden block. Since that time the patient was troubled with a dull, occipital headache, which he mainly perceived when bending forward. Three weeks after this fall he vomited once without cause; he complained of marked vertigo and was obliged to lie down. He remained in bed for a few days and after getting up again, he was able to walk only very slowly and with great caution, because he would otherwise stagger and threaten to fall. He also had a sense of fear that

his head was going to collide with something. During the night between the 24th and 25th of August, 1906, he vomited a number of times in succession. As long as the patient remained in bed, while he felt exhausted, he was not especially ill. A week later, he wanted to get up, but could hardly walk on account of the dizziness. Soon after this the patient complained of pain in the back of the head and of loss of appetite. His condition remained the same until he was admitted to the House of Deaconesses, in Dresden, on the 5th of October, 1906. There were neither disturbances of sight or hearing, nor was there a decline in the mental faculties.

The examination at that time showed the following: A large man, powerfully built. Outside of a square, slightly visible scar on the auricle of the left ear, no signs of antecedent injury could be found. There was slight choked disc on the right side, while on the left, only the nasal border of the papilla was blurred. When the patient was looking outward toward the left side, distinct nystagmus could be seen; this was also the case, but to a lesser degree, when he was looking upward. The visual field showed slight concentric constriction. When the patient was sitting, especially when he bent his head forward, he perceived slight dizziness. When he stood up he swayed strongly to and fro; when he closed his eyes, he fell. The cremaster-, adductor-, Achilles-tendon-, and patellar reflexes were exaggerated on both sides; there also existed bilateral ankle-clonus. Sensory disturbances, as well as ataxia, could not be demonstrated. The X-ray examination of the skull showed no deviations from the normal; there was, however, a suggestion of a breaking off of the anterior process of the atlas. Clinical symptoms to corroborate the latter were not present. The patient remained under observation for eight days, during which time the choked disc on the right side rapidly increased, while on the left, the papilla remained only blurred. He vomited almost daily and felt weak. One morning, a few days after his admission to the hospital, he suddenly perceived a sense of rigidity in the third, fourth, and fifth fingers of the right hand, and in the fifth finger of the left; the same sensation was also perceived by him in the left angle of the mouth. On the same afternoon these manifestations disappeared. On

the 13th of October, 1906, the patient was transferred to a neurologic clinic. He remained there for two months—from the 13th of October to the 15th of December, 1906. He went through a course of inunctions and potassium iodide. He continually lost weight and the choked disc became aggravated. The headaches and vomiting spells became finally more intense, and the pulse, that until that time had remained unchanged, sank to 48 beats per minute. The marked sensitiveness to pressure and percussion that had existed in the beginning in the region of the right parietal bone, now disappeared.

On the 15th of December, 1906, *Dr. Händel*, of Dresden, sent me the following history taken at the House of Deaconesses: "The symptoms of cerebral compression, the choked disc, and the vertigo and vomiting, point, in the absence of any local symptoms, to a tumor in the posterior fossa of the skull and of the cerebellum. The relatively slow development of the disease, with occasional remissions (even improvement of the symptoms), do not speak for a malignant tumor; they cannot, however, be very well connected with simple hemorrhage or hydrocephalus. For the side on which the affection is to be suspected, speak the history of trauma and sensitiveness to percussion which were localized in the right occipital region. I am therefore making a diagnosis of a space-restricting affection in the right posterior fossa of the skull, and believe that the alarmingly rapid development of the choked disc, the severe headaches and the general condition of the patient, strongly indicate trephining, if for nothing else but for palliation."

From the 15th of December, 1906, to the 9th of January, 1907, the patient remained again in the House of Deaconesses, at Dresden. Days of comparative freedom from symptoms interchanged with others of much suffering. The patient continually lost weight and the choked disc, vomiting, and headaches gradually increased. On the 8th of January, 1907, a slight abducens paresis of the right side was demonstrable.

The patient was referred to me on the 9th of January, 1907. He was admitted to the Hansa Sanitarium, where he continued under the observation of *H. Oppenheim* and myself. An examination on January 10, 1907, showed the sensorium free. There was marked bilateral choked disc, but no hemianopsia. When

attempting to look to the right or left the patient could not bring his eyes into the extreme lateral position. This defect was greater on the right side, especially for the abducens; all movements were performed under nystagmus. The patient was able to look upward and downward. The corneal reflexes could be elicited on both sides with facility. During speaking and articulation the right oro-facialis was somewhat more active; closure of the eyelids was equal on both sides. When the patient was gnashing his teeth, the left facialis was under greater tension. The left velum palati was completely paralyzed. The acusticus did not participate; the sense of taste was normal; the sense of smell was somewhat weaker on the left than on the right side. The patient could speak with difficulty; the words spoken, however, were usually distinct. Pain was perceived by the patient in the back of the head only. Pressure over the right occipital region was painful; posteriorly and to the right the percussion-sound was somewhat dull; percussion in itself caused the patient considerable pain. He lay in bed with his chin flexed on the chest and the head turned to the left. When permitted to get up, he stood with his legs spread; his hip and knee joints were flexed, his head hanging down. He showed a tendency to fall backward. There existed a typical asynergia; the trunk would, at times, be directed backward, while the legs would labor in a forward direction. This was associated with marked cerebellar ataxia. He stated that he did not have any vertigo when reclining. There existed a general hypersensitiveness to needle-pricks. The motility of the arms was retained; there was unquestionable but slight ataxia of the right hand. The patient got very thin. The power of both lower extremities was the same. The tendon phenomena of both lower extremities were extraordinarily marked; the toe-reflex was on both sides plantar; there existed, therefore, no *Babinski* nor *Oppenheim* reflex.

Three days later (January 13th) the clinical picture changed somewhat.

Patient perceived pressure and percussion in both occipital regions equally painful. The point of greatest pain was described by him to be in the median line of the back of the head. A few weeks before, the headaches were also perceived in the temples, but never in the frontal regions. Occa-

sionally he felt formications in both cheeks. When coughing or sneezing he never felt any inconvenience. The movements of the bulbs remained the same. The power of both hands was equal, and the ataxia had disappeared. The motor power was retained in both lower extremities, in the left perhaps a trace weaker than in the right. On this day the patient could, by assuming a forced position, stand up and even advance a few steps forward with his legs spread, and swaying, of course. While so doing, he tumbled twice to the left. The shoulders on both sides were forcibly elevated. The velum palati was, in those days, elevated equally well on both sides. The faradic irritability of the right half of the soft palate was reduced on the right side, as compared with the left.

The rest in bed during the last few days of treatment produced a lessening of the pressure exerted upon the basal nerves, and the brain had undoubtedly benefited by this decompression; there nevertheless persisted a striking weakness of the cardiac innervation through the vagus. When the patient was seated on a chair, while the accessorius function was being tested (levatores scapulæ and cucullares), the pulse suddenly jumped from 76 beats to 168 per minute; it lost all tension, while symptoms of fainting and the like could not account for its occurrence.

*H. Oppenheim* formulated his diagnosis on January 13, 1907, as follows:

"The clinical picture points to a cerebellar tumor; part of the manifestations speak for it being in the right hemisphere (especially the symptoms of the first examination). The neoplasm may be located for instance in the vermis and may extend from here to the right. Since, however, the seat of the tumor cannot be ascertained with any degree of certainty, trephining is recommended in the median line of the posterior fossa of the skull, thereby exposing both hemispheres, which is to be followed by puncture through the unopened dura. While the discovery of a pure hydrocephalus is improbable, its presence cannot be excluded with certainty."

Both posterior fossæ of the skull were opened on the 13th of January, 1907 (compare with exact description in Vol. I, Fig. 19); a cyst was punctured, the contents of which were very rich in albumin. On the evening of the day of the operation, the

patient complained of formications in both hands and in the right cheek. The urine was examined regularly, and neither sugar nor albumin were found. A certain degree of improvement was noted in the beginning; the patient slept well and he complained of no headaches. The restriction in the movements of the eyebulbs toward the side had decreased. Movements of the eyes toward the right were unaccompanied by nystagmus; toward the left, they were slightly restricted and associated with slight nystagmus. The velum palati moved uniformly, and the uvula stood straight. The pulse-beat was full and regular—88 to the minute. A distinct aggravation of the symptoms set in on the 25th of January; the symptoms of general cerebral compression became worse and reached a stage that compelled us (January 29th) to expose both cerebellar hemispheres. After the osteoplastic flap had been reflected, the dura appeared decidedly more tense than at the conclusion of the previous operation when the cyst was punctured; slight pulsations, however, could be seen. A flap with its base directed downward was now fashioned from the dura covering the right cerebellar hemisphere. Only a very slight quantity of liquor drained off; yet the veins of the pia were very turgid. The points of both punctures made at the first operation, one laterally and the other near the median line, appeared as small spots, sealed with minute blood-coagula.

On the median lower section of the cerebellum, near the falx cerebelli, a retracted flat area was noted, over which the thickened, whitish arachnoidea continued. The veins coursing along this area were accompanied by thickened strands of arachnoid (chronic arachnitis).

Since inspection and palpation of the right cerebellar hemisphere showed nothing that would indicate the presence of a tumor, the left hemisphere was exposed similarly. The quantity of liquor drained off was here the same as on the right side —very slight. The veins of the pia on the left side were of normal size and much less turgid than those over the right hemisphere. In order to expose the third area the sinus occipitalis together with the falx cerebelli were doubly ligated (above, close to the confluens sinuum) and then severed between two ligatures which were used as tractors to draw the

divided sinus apart (see Plate III, Fig. b). During this step of the operation a number of delicate adhesions to the right cerebellar hemisphere had to be detached. The vermis lay now exposed and showed no deviations from its normal consistency and color. When both cerebellar hemispheres were elevated with the brain spatula, only a moderate quantity of liquor issued from the spinal canal.

Two cysts, containing a clear yellow fluid, were discovered, one in each cerebellar hemisphere; they were split open (see Plate III, Fig. b). A serious secondary hemorrhage into the cyst cavity of the left hemisphere marred the post-operative course and necessitated a reopening of the wound that healed per primam, on the 9th of February—eleven days after the operation. This is reported in detail in the chapter on *Secondary Hemorrhage* (Vol. I, p. 164).

On the day of this (third) operation, the symptoms of acute cerebellar compression had disappeared. The patient felt subjectively well. He was able to move his eyes laterally under very slight nystagmus. A remarkable condition was observed in the speech of the patient; he kept his teeth gnashed together, while he was able to widely open his mouth at request. He swallowed liquids without interference. The pressure of both hands was strong and equal on both sides; they showed no ataxia. While the reflexes showed nothing of importance there existed a bilateral hyperæsthesia plantaris with very lively reflex of the sole of the foot.

On the 14th of February the outlines of the papilla were tolerably distinct; on the right still somewhat blurred. Headaches, dizziness, and vomiting occurred no more. There existed no ataxia or great weakness. The patient was able to lie on his side and, four days later, he could also sit up.

On the 23d of February both papillæ were, outside of slight pallidity, normal. Looking to the left was still slightly restricted with very slight nystagmus. The speech, the deglutition, and the movements of the lower jaw of the patient were normal. On phonation the velum palati was displaced somewhat to the left. The patient was remarkably thin, while his muscular power was good.

On the 4th of March, the wound was completely healed, the

valve not prominent and pulsation was only present in the right upper angle of the cicatrix.

On the 5th of March the patient was able to leave the bed, and on the following day he was led around the room, during which he still swayed slightly. On the 8th of March the vertigo had completely disappeared, and the patient was able to stand and walk without swaying and two days later he could turn around with closed eyes. At that time he complained of occasional pains in the supraorbital region which were of short duration.

On the 27th of March our patient left for his home, completely cured and without the slightest subjective or objective trouble. Lately his nutrition had extraordinarily improved—he gained ten pounds. The choked disc had completely disappeared, and he was able to read letters 1 mm. high, at a distance of 44 cm. on the right and 55 cm. on the left side.

Up to the time of the completion of this work (July, 1911), the cure of the patient was a permanent one.

The following case is one of probable traumatic cyst in the region of the vermis that extended from there to the front and reached into the territory of the corpora quadrigemina. The observation is also of great importance, because it offers an example of the threatening disturbances of respiration that form a common manifestation in affections of the cerebellum. We were successful in keeping such patients alive by artificial respiration for a number of hours. However, if the paresis of the respiratory centre is not rectified, it soon leads to paralysis and death of the patient; the lethal outcome is due to paralysis of the heart.

## OBSERVATION VII, 2

*Slowly Developing Manifestations of Cerebral Compression with Cerebellar Symptoms. Exposure of Both Hemispheres Followed by Complete Paralysis of Respiration that Lasted Three-Quarters of an Hour. Cysts in the Right Hemisphere and in the Region of the Vermis, 7 cm. in Length. Opening of Cyst; Duraplastic Drainage. Cure.*

The anamnesis of this patient with reference to heredity and antecedent disease showed nothing of importance. The girl,

twelve years of age, sustained a fall on the back of her head and was ailing since November, 1909. Severe headaches were the first manifestations associated with repeated vomiting. These symptoms reappeared eight days later and were then accompanied by distinct decrease in the pulse-rate (48 beats per minute) and pain in one of the upper extremities. Following this the patient recovered slowly, and resumed her studies in school in the summer of 1910. According to the statement of the mother the little girl frequently tumbled over on leaving the bed, and she also complained of diplopia. Since October, 1910, however, the patient again suffered from attacks of vomiting and headaches which occurred at intervals of eight days. Strabismus of the right eye was also said to have been observed.

Later, the entire condition of the patient became worse, and she was sent to *Professor Oppenheim.*

His examination on January 18, 1911, showed atrophy of the optic nerve of the right eye; this was also present in the left eye, but to a lesser extent; there was also marked choked disc on both sides. The power of vision on the left side was reduced to counting of fingers at a distance of 3 metres; the reaction of the right pupil to light was gone and in the left it was sluggish. Moderate nystagmus was present when the patient was looking to the right; it was more marked when she looked to the left. The left abducens was completely paralyzed, and the right internus was paretic. In the erect posture a distinct abducens paresis was demonstrable on the right side, which, however, was not always present. The uvula hung over to the right during phonation; the left side of the soft palate remained behind. The pulse was normal; when the patient tilted her head backward, it frequently ran up to 140 beats per minute. A moderate degree of rigidity of the neck was noticeable on moving the head. The right occipital region was sensitive to touch and percussion.

Distinct swaying was noticeable when the patient stood up; this became very marked when she closed her eyes. Her gait was decidedly cerebellar-ataxic; the finger-touch-nose-test brought out distinct intentional tremor of the right hand; in the left, there existed a combination of tremor and ataxia. Adiadochokinesis was present on both sides—stronger in the left. Tremor and ataxia of the lower extremities could not be

demonstrated with certainty. Getting up from a reclining position caused dizziness and vomiting. The reflexes were normal. There was a suggestion of the *Babinski* sign on the left side, and on the right it was marked.

The diagnosis of *Oppenheim* was: "Cerebellar tumor in the region of the vermis; meningitis serosa cannot be excluded with certainty, yet its presence appears improbable."

The first step of the operation was performed on the 2d of February, 1911, with the patient in chloroform narcosis. She was placed in a sitting position, and both posterior fossæ of the skull were exposed in a typical manner. After the two upper holes were drilled, and section of the bone had been partly accomplished, the respirations suddenly ceased, while the pulse-beat continued. The operation had to be suspended at once and a dressing applied hurriedly. We placed the patient in a horizontal position and, on account of the marked cyanosis, resorted to immediate artificial respiration and cardiac massage. After the lapse of a quarter of an hour, the cardiac activity was good again, the lips were red, and the patient reacted to calls, looked at the physician, and opened and closed her eyes at request. During all this, however, there was not a single spontaneous inspiration. Only after the continuation of artificial respiration and the administration of oxygen for thirty minutes, a few superficial respirations were noted, which, after ten minutes more of artificial respiration, improved to such an extent that the child could be returned to bed. Administration of oxygen however had to be continued for quite a while. We were unable to suture the wound and remove *Heidenhain's* deligations until the 4th of February. On the 13th of February, with the patient in the left lateral position, the second step of the operation was carried out. *Schleich's* anæsthesia mixture was used. The healed flap of skin was separated with closed scissors, and the occipital bone was divided with *Dahlgren* forceps. In this case an exception was made, and the greatest part of the bone was taken away with the rongeur forceps, until the confluens sinuum lay freely exposed; it was uncommonly wide and tensely filled. A tampon was placed against a bleeding spot in the sinus transversus. The dura presented on both sides under very high tension; this was strongest on the right side;

it pulsated only slightly. As soon as it was divided with the scissors, parallel to the sinus transversus and over the right cerebellar hemisphere, the latter bulged into the incision under great pressure. The brain substance pressed against the blunt scissors with such enormous force, that it was lacerated. A large, blue-walled, spherical cyst came to view, and bursted; about a wineglassful of amber colored liquid was forcefully ejected from it in a stream.

The fashioning of the flap of dura over the right cerebellar hemisphere was now completed; its base was directed downward. The cerebellar substance covering the cyst was divided transversely, and the cyst itself opened in the same direction. During this procedure two profusely bleeding veins and an artery had to be ligated. After this, the remaining contents of the cyst, which were of jellylike consistency, were evacuated. My index finger, introduced into the cavity, was deflected 7 cm. from the posterior wall of the cyst and slowly advanced forward and slightly upward to the region of the corpora quadrigemina and then downward, until the limits of the cyst were reached.

While the left index finger was in the cyst cavity the right cerebellar hemisphere and the region of the vermis were palpated with the right hand, but nowhere could there be discovered the slightest difference in consistency. The left cerebellar hemisphere, still covered by dura, was also explored in a similar manner; it was completely flaccid and showed no indurations. I therefore saw no indication to interfere with the dura covering the left hemisphere. This was especially contraindicated on account of the extremely weak and collapsed condition of the child. The interior of the cyst was velvety, grayish-red in color, and showed numerous small hemorrhagic areas. It became extremely problematic whether we were dealing with a tumor or not. On account of its great extent to the front, a total extirpation of the entire cyst-sac was not only impossible, but would undoubtedly invite immediate death of the patient; only the posterior portion of the cyst-wall, together with the adjacent cerebellum, were therefore cut away. It was also possible that we were dealing with a simple cyst, which may or may not have stood in communication with the fourth ventricle.

Tamponade and drainage of the cyst-wall would, on account of its close proximity to the rhomboid fossa, be a very dangerous procedure; and if resorted to would very likely cause softening of the surrounding brain-tissue, and death from paralysis of the respiratory and pulse centres. In order to avoid primary union of the wound surfaces of the cerebellum and the posterior section of the cyst-wall which would tend to give rise to a reaccumulation of cyst-fluid and blood (compare Observation VII, 1, p. 708), the cyst cavity was purposely kept wide open in its hind portion without the introduction of a foreign body. To accomplish this the cerebellar substance surrounding the opening of the cyst was everted by uniting it to the adjacent dura with catgut sutures. In order to prevent the slightest tension of the sutures on the very delicate and friable brain substance, the dura, together with the sinus sigmoideus, were bluntly pushed away from the posterior surface of the petrous portion of the temporal bone; this we were successful in doing without causing any hemorrhage. Two sutures were now introduced, one above, toward the sinus transversus, and one medianward, toward the falx cerebelli. Below, the entire flap of dura was intact; 1 cm. of it was projected into the cavity of the cyst and retained here in place with two catgut sutures. By this procedure we were able to keep the cyst cavity open to an extent of about the thickness of a thumb. A few blood-clots were finally gently removed from the cavity, and the skin-muscle-flap sutured into position without drainage.

The histologic examination of the cyst-wall (*Professor Dr. Oestreich*) disclosed nothing of the nature of a tumor. The specimen consisted of neuroglia, moderately rich in cellular elements and a great deal of yellowish brown pigment.

The severe operation was borne by the patient well. The healing of the wound progressed without any trouble, and during the first week only a slight quantity of clear liquor drained off. On the 24th of February the wound was healed. On the 22d of February, the patient complained of no more subjective sensations, her sensorium was free, the pulse 96, and the vomiting and vertigo had disappeared. *H. Oppenheim* found the movements of the eyes unrestricted and without nystagmus; the facialis, hypoglossus, and the motor trigeminus were normal;

the reaction was good on both sides, and the pupils were moderately dilated. The fundus oculi on the right side showed, as before, total atrophy of the optic nerves. On the left side, the papilla, especially on its temporal side, was pale and without neuritic changes. The power of vision of the left eye had improved; the patient could see the number of fingers shown to her at the other end of the room well; she could read *Snellen* at a distance of 1.5 m. Adiadochokinesis was still marked in both hands; the power was moderate. The movements of the hands of the patient were still accompanied by intentional tremors and they were ataxic—more so on the left than on the right side. The muscle-tonus of both lower extremities was strongly reduced. The disturbances, however, were already at that time much less marked than before the operation.

On the 25th of February the ataxia of both hands had completely disappeared, but intentional tremor still persisted. Adiadochokinesis was slighter than before, but still present on both sides—especially on the right. The knee-phenomena were somewhat weak on both sides; but both the heel-phenomena were lively. There existed no clonus or spastic reflexes; moderate weakness in the lower extremities, however, could be noticed, but no ataxia on motion. When the patient attempted to stand up for the first time, she was quite successful, but a tendency to fall backward was manifest. Soon, thereafter, she could stand up firmly. She was able to walk when supported by the nurse, but manifestations of synergia and cerebellar ataxia were still present. During this, no more nausea was complained of.

On the 8th of March, the patient was able to walk without support and without ataxia; she still was careful, however. The reflexes were normal. The field of operation was not bulging nor tense. The patient was discharged perfectly cured, and sojourned to her home.

A letter from the mother of the patient, dated April 30th (two and one-half months after the operation), informs us of the perfect well-being of the latter. Her visual power had still more improved, and the trembling of the hands had completely disappeared. Headaches occurred no more. Only her walk was somewhat uncertain. The girl resumed her studies at school. On the 18th of June, the family physician informed me of the

continued good health of the patient, and of the decided improvement in her eyesight. Her walk is now perfectly normal.

### Post-Operative Cyst-Formation

To traumatic cysts belong also those newformations that develop in connection with operative interventions that invade the cerebellar structure; they cause annoying disturbances to the patient, while they increase in size. In such cases a part or even a whole cerebellar hemisphere may be converted into a hollow sphere, surrounded by thin white layers of tissue, filled with a jellylike material divided by strands and thin partitions. After opening the cyst-wall the watery contents drain off, and there remain behind the white septa and strands referred to which traverse the brain-tissue that had undergone cystic transformation. We have made such observations a number of times in cases, where, as a result of previous operations for the removal of cerebellar tumors from the posterior fossa of the skull the cerebellar substance had been contused and injured, and also in cases where only a simple horizontal incision was made into its substance for diagnostic purposes.

For instance: In 1909, I removed a tumor of the cerebello-pontine-angle from a patient, twenty-nine years of age, in whom, after a year of perfect freedom from symptoms, there suddenly developed neuralgic pains in the frontal and parietal regions, as well as in the entire left side of the body. The field of operation over the left cerebellar half projected fully 1 cm. above the level of the rest of the surrounding cranium. Signs of pressure on the cerebellum or the adjacent portions of the brain did not exist.

Because of the persistence and increase of the pain in the left half of the head (despite all forms of treatment instituted for its relief) the scar of the original operation was circumcised again (November, 1910), and the flap reflected. The skin was firmly united to the underlying cerebellum, and the osseous valve was in a horizontal position. A great portion of the cerebellar hemisphere was replaced by a large fluctuating cyst of bluish-white color, through the thinnest portions of which its fluid contents were shimmering. An incision was made into the posterior wall of this cyst, and a clear waterlike fluid drained off. Its white

inner surface extended for a great distance to the front, so that the posterior surface of the petrous portion of the temporal bone could be inspected as far as the median line. This convinced us that no tumor-masses were present and that the subjective complaints of the patient could not be attributed to a recurrence of the original trouble. The very thin cyst-wall was removed as much as possible without undue trauma to the cerebellar structure and the bone-plate was ablated. The skin was replaced and sewn into its old position. The condition of the patient after the operation, however, did not improve much.

### Arachnitic Cysts

Arachnitic changes at the periphery of the cerebellum are also to be considered. These lead to the formation of spaces, which, when of sufficient size, give rise to manifestations simulating cerebellar tumor. The watery contents of these arachnoideal cysts are seen shimmering through their thin walls. In some places fine whitish and cicatricial connective tissue strands reinforce the transparent arachnoid. That inflammatory processes in the soft coverings of the brain may cause a fusion of the leaves of the arachnoid, and thereby encapsulate collections of fluid, is shown by the cicatricial changes and formation of strands in various places of the pia and the arachnoid. The first case of such nature has been described by *Placzek* and myself [1] and, on account of its importance, is herewith given.

## OBSERVATION VII, 3

*Arachnitis Chronica Adhæsiva Circumscripta. Manifestations of Tumor in the Posterior Fossa of the Skull. Large Arachnoid Cyst on the Internal Lower Surface of the Right Cerebellar Hemisphere (Toward the Vermis). Flat Adhesions Between the Upper Surface of the Cerebellum and the Lower Side of the Tentorium. Wide Opening of the Cyst. Separation of the Adhesions. Complete Cure for the Last Four and a Half Years.*

The patient, a woman twenty-five years of age, the oldest daughter of healthy parents, had never been seriously ill. Her

[1] *S. Placzek* and *F. Krause*, Zur Kenntnis der umschriebenen Arachnitis adhæsiva cerebralis. "Berliner klin. Wochenschr.," 1907, No. 29.

mental development was normal, and she was always considered lively, but nervous. In May, 1905, two years previous to the present trouble, while the patient was walking on the street, she suddenly perceived a strong sensation of weakness in both lower extremities which, when she arrived at home, terminated in complete paralysis. This was soon associated with disturbing noises in the ears. The left eyelid covered only half of the eyeball and could not be opened. Within six weeks all of these manifestations had completely disappeared, with the exception of a certain weakness of the entire body. After a severe attack of influenza the paralyses set in anew; however, this time, also accompanied by violent headaches and noises in the ears. While, following the attack of influenza, the paralysis totally disappeared, the patient did not regain her physical vigor for a whole year.

On the morning of January 1, 1907, the patient awoke with a complete paralysis of the right half of the face; while talking her mouth moved only at the left angle. When she was laughing or wrinkling her forehead only the folds on the left half of the face were visible. The right eye was again covered to half of its size, while the eyelid and the eyeball could not be moved in any direction. The patient saw therefore all objects double or blurred, and when she got up she was unable to walk with certainty. This attack was accompanied by violent headaches, vomiting, and noises in the ears.

At an examination, January 5, 1907, she was found in bed, the color of her skin was remarkably pale, and her state of nutrition very poor. The examination of the cerebral nerves showed a complete paralysis of the right facialis; the mouth was strongly drawn to the left; the right nasolabial fold was entirely effaced; the right half of the forehead could not be wrinkled into vertical or horizontal folds, and the right eye could not be closed actively. The tongue was protruded straight; the movements of the soft palate were equal on both sides; the uvula occupied a normal position. Electric tests showed no changes in the faradic or galvanic irritability of the nerves of the right side of the face. The contractions of the nerves and muscles were abrupt and lightninglike. Contacts with the brush were perceived equally distinct on both sides of

the face. The point of the needle was felt as very painful. On pressure, however, no painful points were found in the face.

The pupils were the same on both sides and reacted equally to light and convergence. The left eyelid was somewhat drooping. The eyeballs were very much hampered in their movements. The patient could move her right eyeball only slightly over the median line and in a vertical direction; its range of downward motion was somewhat greater. The right eye stood still in testing its mobility in any other direction. The mobility of the left eye was also severely damaged; it could be moved outward only slightly, and this, under nystagmuslike manifestations. Whether conjugate paralysis of the ocular muscles had previously existed could at that time not be ascertained, because tests for its detection were no longer applicable. The fundus oculi was normal. The optic nerve discs showed neither signs of neuritis nor choked disc. The hearing and the sense of taste were not pathologic. The pulse-beat was 86 per minute, and at times irregular. Noteworthy sensitiveness on percussing the head—especially the right occipital region—did not exist.

The arms and lower extremities were moved with full power; there was no incoordination. The reflexes of both lower limbs were very active. The walk of the patient was striking. She could not walk very well, unless strongly supported, and then only in a zigzag fashion; she caved in at the knees and constantly staggered to the left. She swayed strongly when standing, even with open eyes. Her psychic state showed nothing abnormal, and stupefaction was also absent.

We were unable to obtain a clear history with reference to the successive appearance of the morbid manifestations, and we could ascertain, only with a certain degree of probability, that it was the locomotion which was afflicted first, and that the ocular muscles then gradually became paralyzed; the right half of the face suffered last.

In the following two days the vomiting was repeated. The headaches were violent, especially in the forehead. The pulse-beat was, at times, only 58 per minute. There was difficulty in urination. While the sense of pain was, until that time, normal, pricks with the needle were perceived, in the right half of the face and in both lower extremities, only as dull contacts.

The corneal reflex was absent on the right. The uvula deviated to the right and turned inward during phonation, in glove-finger fashion. Examination of the ear showed slight retraction of the ear-drum which was of normal color. The hearing was normal and *Rinne's* test positive.

On the 11th of January the conditions persisted as before, but the ataxia became so marked that it was impossible for the patient to stand up unsupported. When attempting to walk or stand up, she invariably fell to the left.

On account of the extreme weakness of the patient, the operation had, unconditionally, to be divided into two stages. With the patient in chloroform narcosis, the entire right posterior fossa of the skull was laid open on the 11th of January, 1907, by the formation of a large osteoplastic flap that was reflected downward. The operation was well borne by the patient, so that ten days later (January 21), the final stage could be undertaken. The patient was in the sitting position. After the healed osteoplastic flap had been separated and the blood-clots removed, the dura mater of the entire right cerebellar hemisphere lay bare. It was not excessively tense and showed moderate pulsation. This state of affairs in itself spoke against the existence of a neoplasm.

A flap of dura with downward base was then fashioned; the upper border of the incision was united with two sutures to the skin above; by this means the tentorium cerebelli was pulled upward and the upper surface of the cerebellum rendered accessible. The dura was much thickened; a small section of it was removed for microscopic examination; this disclosed a firm fibrous structure. The exposed cerebellar hemisphere was not abnormally tense, but showed distinct pulsations. Careful palpation showed it to be entirely free from abnormal masses.

The cerebellum was then displaced medianward by means of flexible brain spatulæ; this brought to view the upper section of the posterior surface of the petrous portion of the temporal bone with the point of entrance of the acusticus and facialis in the porus acusticus internus; further displacement also exposed these nerves in their course backward toward the pons. Oblique displacement of the cerebellum inward and upward distinctly exposed the glossopharyngeus, vagus, and accessorius; the entire

base of the posterior fossa of the skull could be clearly inspected, and the accessorius rising from the vertebral canal was plainly seen. The lateral view of the medulla oblongata also presented. While the cerebellar hemisphere was in this position (pushed upward and delivered with a gauze-sponge), a tensely filled cyst presented below and medianward in the direction of the inferior vermis. (See Vol. I, Plate III, Fig. a.) Its thin transparent wall was bluish-violet and evidently made up of the detached leaf of the arachnoid. Its posterior wall was incised next, and its greater part cut away. Submerged in a drop of physiologic salt solution and placed under the microscope, it was shown to consist of a few compact connective-tissue strands, the outcome of a pathologic proliferation of the arachnoid. Besides this nothing abnormal was found.

On opening this cystlike space a large quantity of clear liquor issued forth, whilst up to this step of the operation barely a few drops had trickled away. The striking similarity of this condition with that found in cases of meningitis serosa spinalis did not only impress me, but my assistants were also commenting on the peculiar clinical picture they have learned to recognize from previous operations. After the posterior wall of the cyst-space had been exsected the exposed cerebellar half was found covered with pia; it was of a livid color and showed no pathologic changes discernible with the naked eye. *The cystic space was therefore the result of pathologic conditions in the arachnoid meshes that had become obliterated and consequently filled with a clear fluid.* The upper surface of the hemisphere had to be finally inspected. While it was pulled downward for that purpose, a number of wide and flattened adhesions were found (see Vol. I, Fig. 18, p. 54) in the depth between the two leaves of the arachnoid, to the front and inward of the sinus transversus (between the cerebellar surface and the dura, and on the under surface of the tentorium cerebelli). They were so firm that traction alone was not sufficient to cause them to yield, and they had to be detached with the blunt point of the scissors. During this, a fairly marked venous hemorrhage resulted from the posterior section of the sinus rectus, and in order to arrest the bleeding a gauze tampon had to be pressed against it with the brain spatula. Since, at attempts to remove

the tampon, the hemorrhage recurred, it was left *in situ* until the first change of dressings on the fourth day after the operation. Careful inspection of the upper surface of the cerebellum and the superior vermis showed nothing of an abnormal nature.

On account of the weak condition of the patient, I thought it best to desist from the usually practised anatomic incision into the cerebellar hemisphere; however, two deep punctures with aspiration of cerebral substance were made—one in the middle of the presenting cerebellar hemisphere, and the other in the region of the cyst, toward the lower section of the vermis. The cerebral cylinders thus aspirated, were found, upon microscopic examination, to be entirely normal.

When the operation was completed, the osteoplastic flap was reposited, and the wound, with the exception of a small space left for the exit of the tampon completely closed with sutures. Wound healing was uneventful. Thirteen days after the last operation (February 3d), it was completely healed.

The result of the operation was surprising. As early as on the first day after the first step of the operation, which consisted of simple opening of the skull, the right facial nerve was only paretic, the right eyelid could be closed, and the upper lid did not droop so much; this could not be noticed without a scrutinous inspection; the left eye followed the finger to the outer and inner canthus; the right eye was also movable in all directions, with the exception of outward. On the day following the second operation (Jan. 21, 1907), a careful examination of the right facial (as much as the dressings of the head permitted) showed only a trace of paresis. Both eyes followed downward and to the left, and their movement upward was much better than before. The left eye followed to the right, to the inner canthus, and the right moved only a little over the median line. The general condition of the patient was, despite the severe operation, excellent.

In view of this marvellous and rapid operative result, and furthermore, in the absence of any kind of general manifestation, no apprehension was entertained as to the outcome of the case. Soon, however, our enthusiasm was halted. On the third, fourth, and fifth days after the operation, not much attention was paid to the nocturnal rises of temperature to 38° and 38.2°, which between the sixth and tenth days post-operationem was

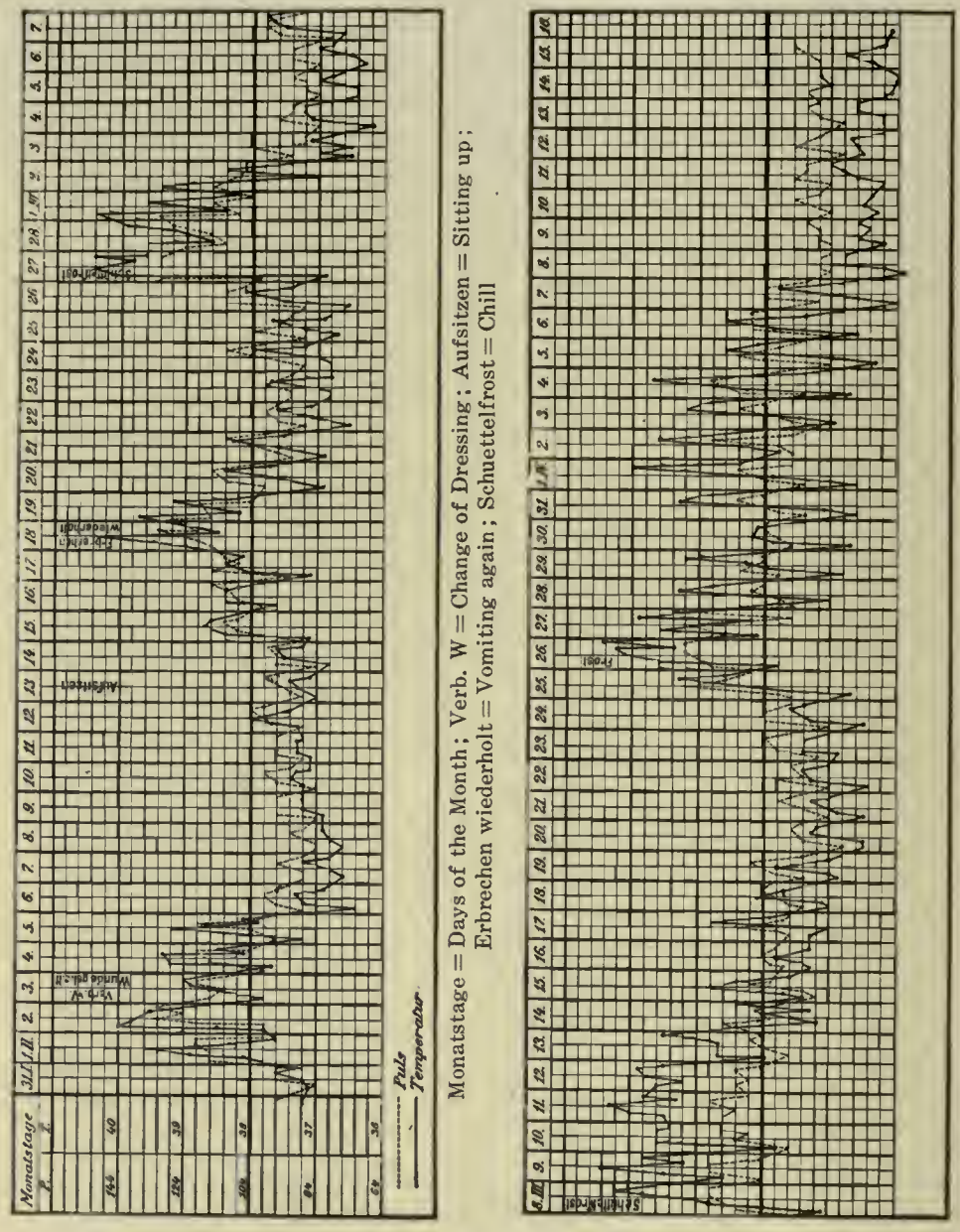
Monatstage
Puls
Temperatur
Monatstage = Days of the Month; Verb. W = Change of Dressing; Aufsitzen = Sitting up;
Erbrechen wiederholt = Vomiting again; Schuettelfrost = Chill
Schuettelfrost } = Chill
Frost

Fig. 125

normal again. On the tenth day after the operation, however, (February 1st) the temperature suddenly mounted to 39.5° and was accompanied by a chill and vomiting; this was followed by a critical period that lasted for a month and threatened to shatter our hopes for a cure of the patient. I shall desist from a minute description of the course of the trouble during that time. From the perusal of the accompanying temperature charts, a fair clinical picture may be gained. It shows that the temperature mounted to 40° for a number of days in succession, then declined, and again remained normal for nine days, to suddenly jump to 40° or over. Only after the 7th of April (two and a half months later) the temperature continued to be normal.

During the entire time (from January 21st to April 7th), the pulse-rate corresponded to the course of the temperature and accompanied it in all its fluctuations; it only rarely remained uninfluenced by it.

On two occasions the rise of temperature was accompanied by vomiting and chills; the latter were uncommonly frequent. This created a strong suspicion of neoplasm in some other portion of the brain, despite the fact that the general condition of the patient and the symptoms spoke decidedly against it. Not only was the young lady in a continually happy frame of mind, but frequently laughed and joked with her visitors, whistled her favorite melodies and did not show, upon examination, the slightest indication of an existing disease of the brain. She could move her head freely in all directions, and there existed no rigidity of the neck, no sensitiveness on percussion, no choked disc, and all other symptoms of paralysis had disappeared. There therefore existed a gross disproportion between the general condition of the patient and the alarming manifestations.

With this state of affairs, it is not to be wondered at, that to explain this peculiar clinical picture, we were searching for all possible etiologic factors. The possibility of an infection resulting from the operation could, in view of the perfect post-operative course of the healing of the wound, be excluded; for, if this were the case, it would not have commenced after ten days. The suspicion of tuberculosis had to be dropped, in view of all negative findings. All other infectious diseases could be

excluded. Even the cystitis, that was for some time held responsible for the symptoms, had finally also to be left out of consideration.

With the ruling out of all of these conditions, the assumption finally remained, that the manipulations during the operation, the palpation of the cerebellum, and the pressure exerted by the spatula on the cerebellum and on the medulla oblongata were responsible for the rise of temperature. For this assumption also spoke the experience that, after operations on the brain, periods of transient, quickly vanishing hyperthermia have not infrequently been known to follow, as already pointed out above. Regardless of the very long duration of the condition we must, for want of a better explanation, include this case also in the category of hyperthermic disturbances accompanied by acceleration of the pulse. However, the ultimate recovery of the patient was not in the least hampered by the last-described disturbances, for, on the 21st of March, 1907, she was discharged from the sanitarium. About the middle of April, she was able to walk a few steps when supported. On the 30th of May, her general condition was very much improved; she ate with good appetite and had gained remarkably in weight. Headaches, noises in the ears, vertigo and vomiting occurred no more. Her walk was still uncertain, but she did not stagger, nor did she fall or sway when quickly turning to the right or left. An examination showed her sensory organs to be perfect. All paralyses had completely disappeared. Movements of the eyes were perfect in all directions and without restriction; the extreme lateral position of the eyes was, however, still slightly hampered by a little horizontal nystagmus; this was especially true when the patient was looking to the left. The functions of the trigeminus and the facialis were performed uniformly on both sides and without any disturbance. The tongue was protruded normally. The uvula occupied a median position. All reflexes of the face and body were very active. The statement of the patient that she was frequently swallowing the wrong way could not be corroborated upon examination, nor could any cause be found for such being the case. About the middle of June she informed us that she was, at that time, in a summer resort, and that she felt perfectly well and undertook

daily walks, the distances of which were increased from day to day. The behavior of the temperature and the pulse showed no deviations from the normal. The patient was permanently cured.

I should like to mention that the exsected portion of bone had firmly united and did not yield on pressure, which goes to prove that the result, in this instance, cannot possibly be attributed to a valve-action, in the sense of *Kocher;* at any rate, this was not the intention.

Now, with reference to the peculiar accumulation of liquor cerebrospinalis, the whole process corresponds entirely to the formation and development of a retention cyst. While usually the liquor freely circulates in the meshes of the arachnoid, its retention and continued accumulation in a given circumscribed place may be explained as being due to cicatricial closure of its ports of drainage.

The autopsia in vivo has, in this case, enabled us to demonstrate the pathogenesis of the disease. I am not inclined to attach any importance to the thickness of the cranial bones (that undoubtedly was present), because I have seen too great a range of thicknesses during the many trepanations. The dura, on the other hand, was extraordinarily thickened and was shown, upon microscopic examination, to consist of a firm, fibrous structure, poor in cellular elements, very sparingly traversed by thin-walled blood spaces. None of the endothelial cells of the surface were preserved.

The broad adhesions between the upper surface of the cerebellum and the lower side of the tentorium were also undoubtedly the result of chronic inflammatory processes; and we make no mistake if we look upon the cystlike accumulation of fluid on the inner, lower surface of the cerebellum as being the result of an inflammatory fusion of the meshes of the arachnoid, and as a secondary stagnation of liquor within the thus resulting enclosed spaces. This leads to the natural conclusion that the liquor cerebrospinalis is not, as previously thought, the exclusive product of secretion from the chorioid plexus; but that the meshes of the arachnoid, lined with endothelium, do also, at least in part, secrete the fluid.

It appears very remarkable indeed, how such accumulations of liquor and liquor-tension will develop in a particularly circumscribed area. If we were to follow the teachings of *Bichat*, which are no longer entertained—that the arachnoid consists of a sac composed of an inner and outer wall—the occurrence of accumulations, as presently discussed, would be entirely unintelligible. The explanation of *Henle* on the other hand, that the arachnoid is to be looked upon as a connective tissue of extraordinarily loose makeup, which has a peculiar physiologic affinity for water, is, in my opinion, very satisfactory. Hence, according to this view, adhesions resulting from any cause (inflammations, mechanical irritations) may give rise to an abnormal exudation of liquid within a circumscribed area, which, under normal circumstances, would continue to drain away. Chronic diseases of the arachnoid do not only lead to simple adhesion formation; but the resorption capability of the arachnoid structure (in the diseased areas) suffers to a greater or lesser extent.

The term, arachnitis adhæsiva circumscripta, is, in my opinion, proper and descriptive of the condition under consideration. The probable pathogenesis of chronic serous spinal meningitis, described by *Oppenheim* and myself, can also be explained on the same basis. Of this more will be said in the chapter on Surgery of the Spinal Cord.

### Arachnoideal Cysterns

In the case just related, the morbid accumulation of fluid was restricted to the arachnoid of the basal portion of the right cerebellum. The uneven basal surface of the entire brain with its many recesses is transformed into a number of saccular spaces that result from the roofing of these pits by the arachnoid. These are the arachnoideal cysterns, of which we recognize a particularly extensive kind, the *cysterna magna cerebello-medullaris*, which extends from the basal surface of the cerebellar hemispheres to the dorsal aspect of the medulla oblongata. Other cysterns are located over the upper anterior angle of the petrous portion of the temporal bone, the chiasma, on the under surface of the cerebral peduncles and the pons. They have the make-up of sacs of greater or smaller size, filled with liquor. Fusion of two opposite leaves results in an encapsulation of the liquor. *Bor-*

*chardt* has called attention to the peculiarities of location of these enclosed spaces, and has pointed out that they are closely related to the large cysterns in the posterior fossa of the skull. He reports a case of *Oppenheim*, in which an arachnoideal cyst, at the exit of the acusticus, was cured by incision.[1]

On account of their communication with the ventricles, the subarachnoideal spaces, being part and parcel of these cysterns, frequently become filled with fluid, to an extraordinary degree, in cases of hydrocephalus especially. The cysterna magna cerebello-medullaris and the cysterna chiasmatis, have frequently the form of thin-walled sacs filled with liquid hanging down from the brain when the latter is exposed. The frequently observed symptoms in cases of hydrocephalus, which pointed to the cerebellum and the adjacent nerves so strongly that tumor in the posterior fossa of the skull was suspected, were later explained by the closure and increased fluid-tension in those cysterns. Compression of both hemispheres toward the foramen occipitale magnum, frequently seen as an impression on the cerebellar hemispheres, made by the border of the bone, is, in itself, hardly sufficient to explain the many manifestations emanating from the vermis and the posterior cerebral nerves at the base of the brain.

While symptoms of such cysts in the posterior fossa of the skull cannot clinically be distinguished from other space-restricting processes, *Oppenheim* has pointed out, in the above mentioned case, three factors that may, under certain conditions, enable one to make a differential diagnosis between cyst-formation and neoplasm. First, "the greater tendency to remissions and intermissions in the case of cysts as compared with tumors." *Oppenheim* adds, however, that the difference is not a decisive one, since cerebral neoplasmata will frequently behave similarly, especially after the patient has undergone a course of mercurial inunctions. In the second place, he emphasizes the excessive rigidity of the neck that "should be looked upon as a symptom of meningeal irritation." This symptom is, according to our experiences, of questionable value, because we have seen even opisthotonus develop in cases of solid tumors of the cere-

[1] *Oppenheim* and *Borchardt*, Meningitis Serosa. "Deutsche med. Wochenschrift," No. 2, 1910.

bellum. As a third important symptom, *Oppenheim* cites the pulsating murmur that was audible in the case operated upon by *Borchardt*, which was, in all probability, caused by the pressure exercised by the cyst on one of the basal cerebellar arteries; it disappeared as soon as the cyst was evacuated.

### Real Glia-Cysts of the Cerebellum

Real glia-cysts of the cerebellum have frequently been subjected to successful operative intervention. *Scholz*, *Borchardt*, and *Schmieden* have reported such observations. In all of these cases there existed within a cerebellar hemisphere, smooth spaces which were composed of a connective-tissue envelope with watery serous contents. These cysts are, in all probability, the result of displaced, embryonal connective-tissue matrices—hence, antenatal new-formations. The structure of their walls and the composition of their contents so closely resemble those of the cerebral ventricles, that a close connection in the development of the two is highly probable.

The following case illustrates a simple glia-cyst in the region of the cerebellum.

## OBSERVATION VII, 4

*Real Glia-Cyst in the Vermis. No Operation. Post-Mortem Findings.*

The trouble in this man began with headaches and recurrent attacks of vomiting. He was strong and twenty-six years of age. A month later he began to complain of vertigo and of having difficulty in getting about in the dark; this was accompanied by vomiting in the morning, and he was treated for stomach trouble. Four months later choked disc could be shown to exist in both eyes. At the same time attacks of very violent headaches tortured the patient, and drove the very energetic man nearly to distraction. Besides these symptoms, there was also anosmia on both sides, and the sensitiveness of the cornea and the reflex of the lid were reduced on the right side. Lateral movement of the eyebulbs showed a deficiency in the range of sideward movement; especially was this true when the

patient was looking to the right. The right eye also remained behind when the patient was looking upward; there existed, however, no diplopia, and nystagmus was also absent with the patient in the recumbent position, but when he got up and was looking to the left, nystagmus could be demonstrated. In this direction the movements of the eyes were also restricted, although only in a slight degree. When the patient assumed a left lateral position and attempted to look to the right, nystagmus with restriction of motion of the eyes appeared. The reaction of the pupils was prompt. The right facialis was somewhat paretic, and the left motor trigeminus (pterygoideus externus) was also weaker than the right. The speech of the patient remained entirely unaffected, and there existed no disturbances of a dyspraxic nature of any description.

Decided adiadochokinesis could be demonstrated in the right hand, but there was only slight ataxia at the finger-touch-nose-test. The patient held his head inclined toward the right shoulder. There was no sensitiveness on pressure in any part of the skull. When he attempted to walk, or when he closed his eyes, he was swaying; he fell to the right and was unable to keep his equilibrium.

The muscular reflexes of both arms were somewhat lively; the tendon reflexes were not exaggerated; the patellar reflex somewhat livelier on the right, and the Achilles reflex was very active but not clonic. There existed no *Babinski* on either side, and the abdominal-wall reflexes were positive on both sides. There was no decrease in the pulse-rate.

The diagnosis was tumor cerebelli cum hydrocephalo, with especial association of the vermis, situated more to the right. Before we had a chance to operate, however, the patient died from an attack of acute respiratory paralysis.

At the autopsy, while the cerebellum was being lifted off from the large brain, a soft area, as large as a medium sized plum, was discovered on the upper surface of the right cerebellum; it extended mainly from the median line into the right cerebellar hemisphere.

Sagittal section proved the cyst to belong to the substance of the vermis and to that of the right cerebellum; it extended more than 1 cm. over the median line toward the left.

Its contents were jellylike; its inner surface was retiform, and a special wall could not, on this section, be recognized. It was separated from the roof of the fourth ventricle by a stratum a few millimetres in thickness.

Complete sagittal section through the entire brain and the medulla oblongata showed that the cyst reached into the fourth

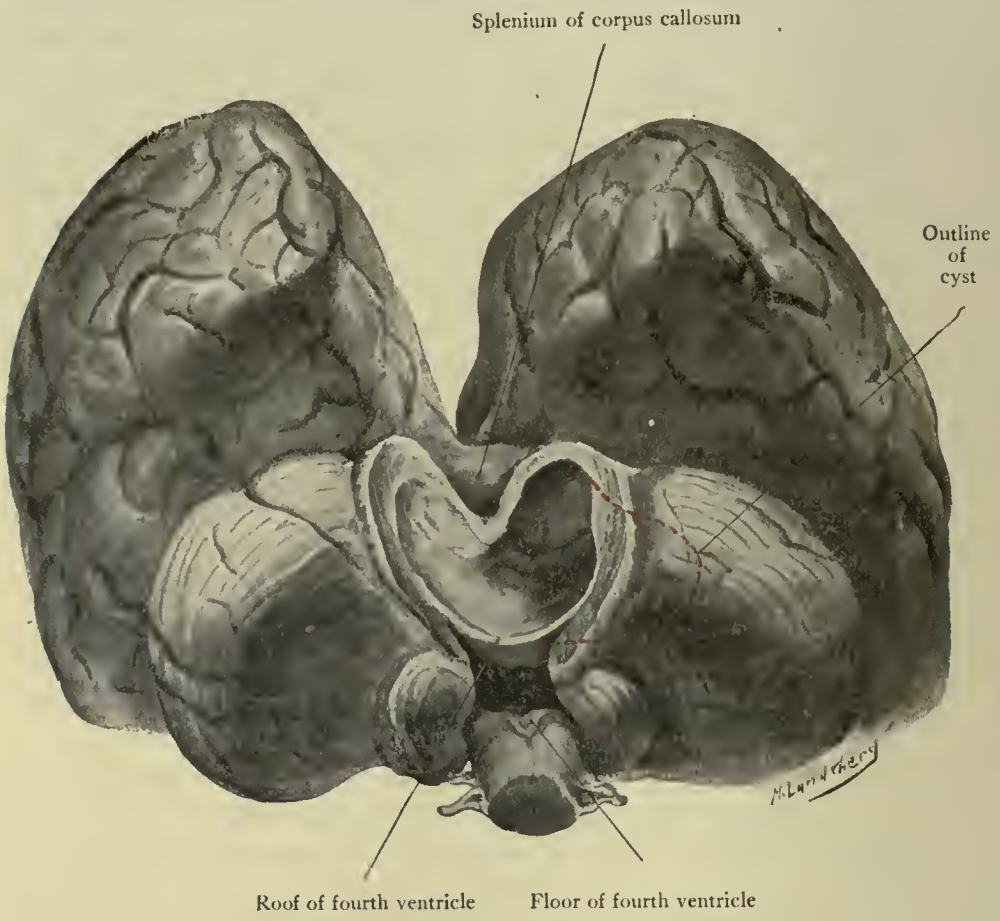


Fig. 126

Cyst in the Vermis, Extending into the Right Cerebellar Hemisphere. Sagittal section through the vermis. Posterior view; ¾ natural size.

ventricle above and to the front. The cyst-wall could be distinctly separated from the thin ependyma. The cavity of the specimen, hardened in formalin, measured, sagittally, 5 cm.; vertically, 3 cm.; and transversely, 2½ cm.

There existed a moderate hydrocephalus of the lateral ventricles and of the posterior horns; on the left this was only slight.

Microscopic section (*Professor Oestreich*), through the cyst-wall, showed the cortex of the cerebellum to be perfectly normal; it appeared thinned, however, and, in some areas it was rich in neuroglia-tissue and poor in cellular elements. The most careful examination failed to disclose the presence of tumor or other specific conditions.

### Cysts of the Cerebellum Accompanying Hydrocephalus Internus of all Ventricles

In two of the cases under my observation there existed, besides a severe general hydrocephalus of the ventricles, spaces within the cerebellar substance. In both instances focal symptoms overshadowed those of the manifestations of the hydrocephalus, and pointed to disease of one-half of the cerebellum. On exposure and horizontal incision of the corresponding side, a saclike space was found in the middle of the hemisphere; it was as thick as a finger and did not extend very deeply; it was smooth and filled with a clear liquor.

In the first volume of this work, I have already referred to similar cysts, which are caused by a saccular extroversion of the fourth ventricle. It may be that these two cases have originated in such a manner. Even though no visible communication could be demonstrated between the space in the cerebellar substance and the fourth ventricle, the assumption is justified that the heightened intraventricular pressure created an avenue in the cerebellar substance through which the liquor was forced. Mechanical factors may have been responsible for the reclosure of that avenue through the vermis, thereby preventing the return of the fluid. In a similar case, reported by *Virchow*, the communication between vermis, hemisphere-cyst, and the ventricle persisted.

### Tumor-Cysts

A tumor may be hidden behind every encapsulated chronic arachnitis and behind every cyst of the cerebellar substance. Therefore, if a cyst be found, careful inspection and palpation of the parts as well as puncture and, if deemed advisable, hori-

zontal incision of the cerebellum should be practised. Despite the greatest possible diligence and scrutiny in this respect a tumor located in the vermis or in the region of the aquæductus *Sylvii* may escape detection. In such cases a reaccumulation of the liquor in the field of operation will soon follow.

Cystic tumors of the cerebellar substance proper are not at all infrequent. The symptoms, of course, entirely correspond to those of neoplasmata to which, in most instances, they owe their origin in the beginning. The main three manifestations of cerebellar cysts, described by *Oppenheim*, were present in all cases operated on by me. In one instance, the excessive rigidity of the neck, that had existed for a long time prior to the onset of other cerebellar manifestations was very striking. Marked remissions and extreme differences between health and morbidity of the patient were also observed—especially in the first year of the disease.

The following observation illustrates a case of cerebellar tumor that had undergone cystic degeneration.

## OBSERVATION VII, 5

*Myxosarcoma of the Right Cerebellar Hemisphere with Large Cyst-Formation. Secondary Hydrocephalus of all Ventricles —Especially the Fourth. Death, in Collapse, After the First Stage of the Operation.*

The patient, a boy seven years of age, was sent to the Augusta Hospital by *Professor Oppenheim* in the beginning of May, 1906, for observation and eventual operation. Until the summer of 1905, the boy developed normally in every respect, and was very active mentally. In May, he met with an accident—he fell with his forehead against a stone—that was soon followed by headaches which became progressively worse. In October he began to vomit. In December this was an almost daily occurrence. In January, 1906, his walk became uncertain. When walking he tended to fall to the left. After a course of inunctions and after a lumbar puncture that yielded 15 $cm^3$. of apparently normal liquor, the condition of the patient became worse. At the same time the vision of his left eye began to suffer, and in April, 1906, his power of hearing commenced

to decline. In February, 1906, the mental faculties of the patient began to fail and he displayed a tendency to somnolence that would at times continue fourteen hours in succession. His urination became gradually more difficult, and there was a frequent tendency to obstipation. The most striking manifestation, however, was a rapid increase in the circumference of the boy's head; this was noted at the end of March and in April. Within two months there was an increase from 55 cm. to 57 cm., so that he could not hold his head straight, but tilted it strongly to the back and to the left side. During the attacks of cephalalgia the lateral inclination of the head became more marked.

The head of the boy was uncommonly large, and all over its back portion, cracked-pot resonance could be elicited. The sagittal suture was cracked and was perceived by the palpating finger as a distinct furrow. There was a marked choking of the discs with beginning atrophy in both eyes so that vision was almost completely extinguished. There was a hyporeflexia of the right cornea as compared with the left. The right facialis was decidedly paretic as compared with the left; this became more pronounced when the patient was taken from his bed and attempts were made to walk him about. Difficulty in hearing existed on both sides. The disturbances of the equilibrium were also considerable. When the patient attempted to walk or even to stand up, he at once fell to the left. The lack of control of the attitude of the patient was appalling. His trunk was arched to the left; the head to the back, and the lower limbs were kept spread apart with hyperextension of the knee-joints. All movements were ataxic and weak. The ataxia of the arms, however, was not as marked as that of the lower extremities. All tendon-periosteal reflexes could be elicited. The sense of position and the stereognostic sense were retained. On one occasion, *Oppenheim*'s toe-reflex could be distinctly elicited on the left side, while on the right it was never present. *Babinski's* sign was always absent on both sides. The examination of the boy was rendered difficult because even his father could not understand him. However, disturbances of sensibility, consisting of a hypæsthesia of the left extremities and left half of the trunk, could be demonstrated.

As a result of his examinations, *Professor Oppenheim* made the following diagnosis: "Probable tumor in the right posterior fossa of the skull in the region of the cerebellum or of the cerebello-pontine-angle; the former is more probable; there is also a marked hydrocephalus and comminution of the sutures of the skull. Pure hydrocephalus is not excluded, but improbable."

On the 8th of May, 1906, with the patient under chloroform-oxygen narcosis, and in the left lateral position, I fashioned an osteoplastic flap over the right cerebellum, that was 4 cm. high and 5 cm. wide. The dura appeared very tense, without the least pulsation. The operation had to be halted on account of

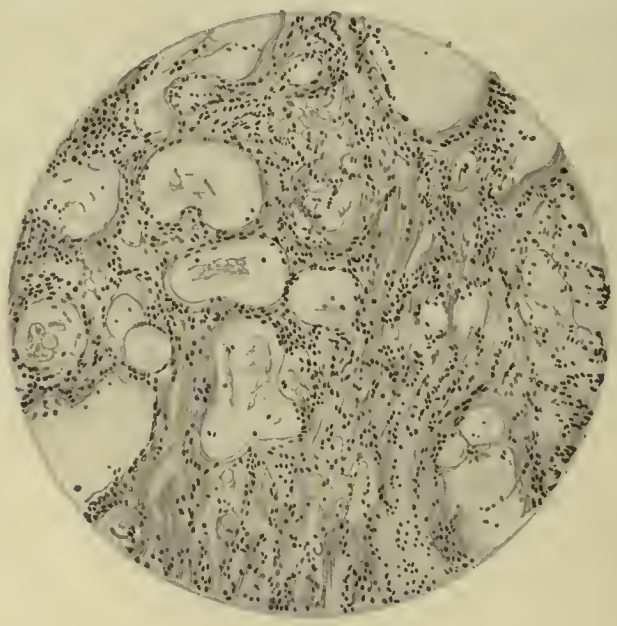

Fig. 127

Glioma Sarcomatodes Cerebelli with Cyst-Formation (Magnified 105 : 1)

the sudden increase of the pulse-rate and its bad volume. Despite the fact that, during the trephining, the child had only lost a very small quantity of blood, the pulse did not pick up again, and the boy died six hours after the completion of the operation.

The brain section (*Chief Physician Dr. E. Heymann*) showed the following: The brain was very large; its convolutions were

wide and flat, and its fissures fairly effaced. Frontal sections showed all ventricles to be considerably dilated. The right half of the cerebellum reached over the median line, to the left, over 1 cm.; the pons and medulla oblongata were also displaced and somewhat turned. Horizontal section through the right cerebellar hemisphere showed a cyst, the size of a hen's egg, and numerous smaller cysts, that were filled with a yellowish flocculent liquid (see Vol. I, Plate 4, Fig. a), and immediately adjacent to the median line there was tissue of whitish-gray color which was undoubtedly tumor. In this area there were softened places of jellylike consistency and also hemorrhagic sections that were firmer than the others. Only a small portion of the anterior and lateral part of the cerebellar hemisphere was retained. The evidently encapsulated tumor (myxosarcoma) that had undergone cystic degeneration, had pressed the hemisphere apart, so that the cortical substance of the cerebellum surrounded the tumor in parts like a paper envelope. In the centre, the neoplasm rested on the tentorium ventriculi quarti, which it had pressed inward and forward. The entire left cerebellar hemisphere was compressed and displaced by the enormously changed right hemisphere.

The microscopic examination (compare Fig. 127, p. 734) distinguishes two kinds of tissue. One part of the specimen was made up of connective-tissue fibres, between which there were a moderate number of spindle-shaped nuclei. The other parts consisted of spaces of larger and smaller size filled with jellylike masses, and intermingled with which there were isolated small roundish nuclei. Some of these spaces appeared, in places, to be lined with a sort of cuboidal cells. Between these cystic spaces, some places were made up of a very fine network of tissue; the nuclei of these parts were very small and spherical, and appeared to be bereft of any cell-body whatever.

We were, therefore, dealing with a *cystic glioma sarcomatodes.*

In Volume I, I have already called attention to *Williamson's* claim that only those cysts are to be looked upon as being of the simple serous variety, in which the closest possible examination of their walls fails to disclose the presence of any kind of tumor.

*Williamson* is of the opinion that all serous cysts, without exception, are only accompanying symptoms of a neoplasm. The observations of *Scholz* and *Baisch* speak for this assumption. In these cases, the size of the serous cysts were entirely out of proportion to the diminutive size of the tumor, from the surface of which the cyst developed. The tumor, in *Scholz's* case, was "somewhat larger than a pea," it had a round pedicle, and was "easily lifted out from the contiguous structures." In this instance, therefore, the serous cyst formed a part of the tumor or, still better, it was a secondary condition. However, this view of *Williamson* is by no means entirely correct. This may be incontrovertibly proven by the numerous cases of brain-cysts that have remained for years under my observation, and which were completely cured by extirpation; a neoplasm, therefore, could not have existed in these cases. In operating, the cyst-wall and its surroundings should be subjected to a most careful search for evidences of tumor. It is to be regretted that neither the size nor the contents of the cyst offer the slightest clue for the detection of their origin or of their character. The fluid contained within them is, as a rule, amber colored, at times it is somewhat lighter and serumlike, and again, it is of a somewhat darker tinge. In two of my own cases, the contents at once coagulated into a jellylike mass, and in another instance, they remained liquid. In a case of cyst of the temporal region that was cured by aspiration, the contents showed a great percentage of albumin which explained its prompt coagulation. The presence of albumin, however, has no diagnostic value with reference to the cyst being benign or malignant. It should be mentioned that after a cerebellar cyst had been opened and its contents evacuated, its walls may collapse to such an extent that it may be very difficult or even impossible to unfold the space again.

There are some cases in which a diagnosis as to the nature of the conditions present may be made from the structure of the cyst-wall or its vicinity. In such instances, suspicious-looking areas are found in contiguous cerebral parts, or palpation will show differences in their consistency. Firmness of structure speaks for neoplasm; delicacy and smoothness of the wall are more frequently simple cysts or extroversions of the

ventricles. In cases of tumor-cysts, the otherwise smooth but non-transparent wall of the cyst distinctly distinguishes itself from the color of the surrounding structure of the cerebellum by a peculiar ochre-yellow tinge.

## Solid Tumors in the Posterior Fossa of the Skull

According to my experience, tumors of solid nature develop most frequently in the angle formed between the cerebellum, medulla oblongata, and the pons. In times gone by they were known as acusticus neuromata, but since the appearance of the monograph of *Henneberg* and *Koch*[1] we speak of them as

### Neoplasmata of the Cerebello-Pontine-Angle

They are usually of a benign character, and, as a rule, either fibromata or fibrosarcomata. They are encapsulated and easily enucleable, and offer to the surgeon quite a problem when unilateral. Unfortunately they are sometimes bilateral. During their growth, they displace the cerebellum, medulla oblongata, and the pons, and produce corresponding symptoms. The symptoms produced by the involvement of the cerebral nerves, running in that section of the posterior fossa of the skull, the trigeminus, the abducens, the facialis and acusticus, the glossopharyngeus and the vagus are of great importance. Of the nerves of the ocular muscles, the abducens is foremost in importance. Fig. 128, on p. 738, depicts the area under consideration.

An enumeration of the clinical manifestations would necessarily lead to repetitions; they have been previously fully gone into and are briefly summarized in Observation VII, 7, p. 744.

The technic of the operation has been described in the first volume. With reference to its development, it may be stated that, in 1898, the writer was able to convince himself, in the following case, of the accessibility of the posterior surface of the petrous portion of the temporal bone, by going through the dura and the posterior fossa of the skull.

[1] *Henneberg* and *Max Koch*. Über "centrale" Neurofibromatose und die Geschwülste des Kleinhirnbrückenwinkels (Acusticus-neurome). "Arch. f. Psych.," XXXVI, H. 1.

## OBSERVATION VII, 6

### Intracranial Exposure and Resection of the Nervus Acusticus

The patient in this case was a spinster sixty-three years of age, who was totally deaf in the right ear; she was continually

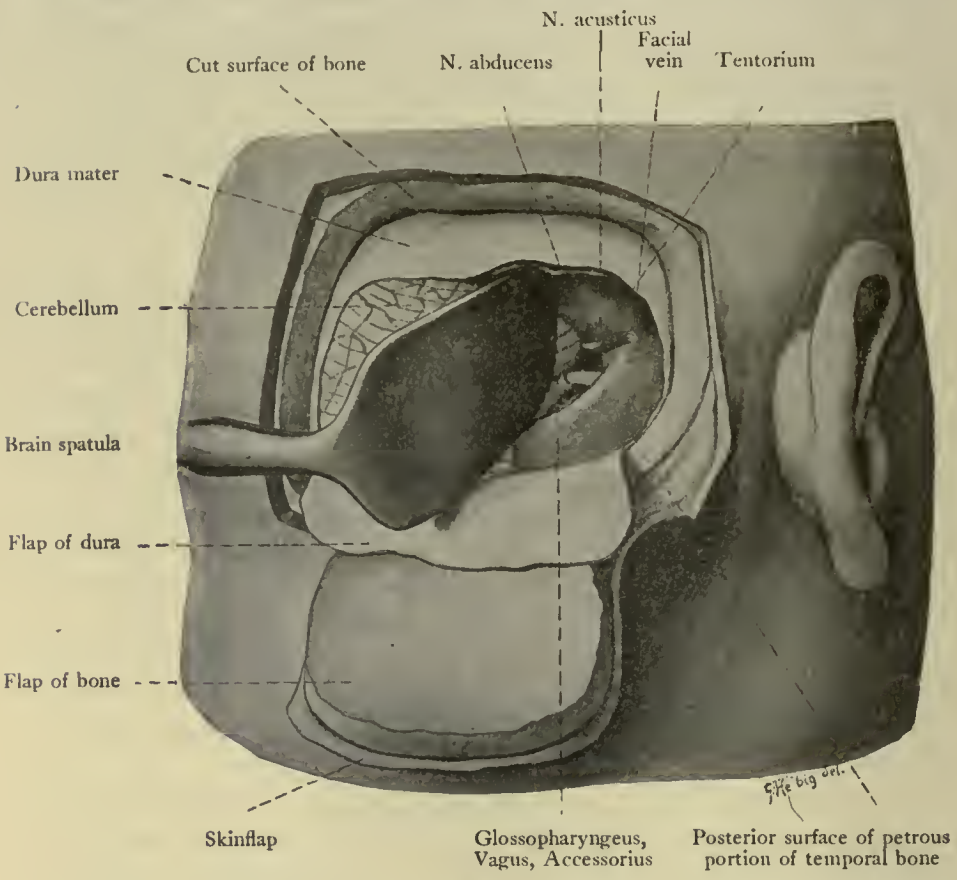


Fig. 128

Intradural Exposure of the Posterior Surface of the Petrous Portion of the Temporal Bone

tortured by subjective noises that were due to sclerotic processes in the internal ear, and that robbed her of her sleep and brought her to desperation. Since I am not a specialist in ear diseases I am giving the description of such cases by the renowned *A. v. Troeltsch:*[1] "Continued buzzing in the ears is a real torture that

[1] *A. v. Troeltsch*, Lehrbuch der Ohrenheilkunde, 7 Aufl. Leipzig, 1881. S. 599.

steadily annoys the patient, and that is entirely beyond his control. It is usually described by the patient as tormenting, or as in the highest degree agonizing. Many of the patients declare that the deafness is only very insignificant as compared with the noises in the ears, and they implore the physician to free them, at any price, from that torture which does not leave them even for a moment, and prevents them from working, thinking, or from even falling asleep; it frequently awakes them at night from their sleep and drives them to despair. There are a number of cases on record in which the aural noises have led to despondency and even to suicide."

The case under consideration was one of the most severe forms of the disease. The patient begged pitifully to be relieved from her torture. In June, 1898, I was asked by the attending otologist of the patient, *Dr. Engelmann*, of Hamburg, whether it would be possible to divide the acusticus in a manner analogous to the practice of resection of the root of the trigeminus. I studied the question carefully on the cadaver and came to the conclusion that it would be possible to resect the nerve of hearing at the posterior surface of the petrous portion of the temporal bone, but that such an operation could not be carried out without opening the dura—a procedure which offers so many advantages in the extradural removal of the *Gasserian* ganglion. To attempt to reach the acusticus by an extradural route, i.e., to bluntly detach the dura mater (which also represents the periosteum) from the posterior surface of the petrous portion of the temporal bone, to the porus acusticus internus, would mean to court the danger of injuring the sinus sigmoideus and the sinus petrosus superior and inferior, which would cause serious hemorrhage that would render the operation extremely difficult. Besides that, the tearing of the periosteum would undoubtedly injure or even completely tear the nervus facialis which enters the porus acusticus internus together with the nervus acusticus.

I selected for this reason the transdural route and chose to advance from the right posterior fossa of the skull directly to the posterior surface of the petrous portion of the temporal bone. I undertook to operate on the 14th of July, 1898. The patient was in a sitting position, her head supported by an assistant

from the front and somewhat flexed toward the chest. The technic may be seen in Fig. 128.

The acusticus had to be divided next. This may be successfully accomplished without injuring the facialis which runs in close connection with it. As is known, the acusticus is very soft, and had, therefore, been previously called the portio mollis, while the facialis the portio dura of the seventh pair of nerves. Furthermore, the intradural nerves are not surrounded by connective-tissue sheaths; their neurilemma is derived from the dura after their exit from that structure. Finally, the acusticus is located to the outer side of the facialis, and is, therefore, the first nerve reached when approached from the outside; it is grooved for the reception of the seventh cerebral nerve. With these anatomic facts in mind, I cut the acusticus from without inward with a pair of fine-pointed scissors (*A*). This was continued (*I*) until the facialis (*F*) was recognized. I next dissected the acusticus from the facialis with a delicate blunt hook. The separation was entirely successful, and no injury resulted to the facial. I had to operate very carefully on account of the softness of the nerves. No hemorrhages followed; the arteria auditiva interna had evidently escaped injury, or was very small.

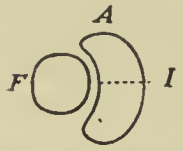


Fig. 129
Schematic Transverse Section

The divided acusticus was now placed backward, so that it came in contact with the cerebellum. Unipolar faradic irritation of the remaining nerve-trunk with the weakest possible current of the induction apparatus resulted in contractions of the right facial region, especially of the orbicularis oculi, as well as of the branches supplying the nose and the mouth. The irritation of the displaced acusticus (using also the very weakest possible current), caused the right shoulder to be elevated twice in succession. The accessorius situated below had undoubtedly been reached by the current, because it was, together with the stump of the acusticus, bathed in liquor that had trickled down.

After the completed operation, the osteoplastic flap was reposited into its old position and united with sutures. The loss of blood during the operation was insignificant; a slight quantity of blood was lost only at the time when the cerebellum

was pushed aside. It should especially be emphasized, that at no time during the entire operation were there any disturbances noted from the medulla oblongata.

After the patient awoke from the narcosis, the lower branch of the facialis was found paretic, and the angle of the mouth could not be moved as well as that of the other side. On the afternoon of the operation, the patient stated that the noises in her ear were just as bad as before. Besides that, she complained of a sense of dizziness, even when reclining. When not bothered with questions, she slept continually. She swallowed liquids poorly. Temperature, 36.5°, pulse, 120. On the following day (July 15th) the noises were still there, but the dizziness had disappeared, the temperature was 36.8°, pulse, 104, strong. On the same afternoon, the noises had considerably decreased; the patient lay quietly until evening, and then began to exercise active movements. She now took liquid nourishment, and her deglutition was very much improved. In no part of her body could there be demonstrated pareses or anæsthesia; the angle of her mouth was, at that time, only very slightly paretic. Temperature, 37.4°, pulse, 104.

During the night of July 16th, there was some restlessness which, toward the morning, disappeared. The patient moved actively. The buzzing in the ear was still less, and the sense of dizziness was completely gone. She took nourishment very well, and disturbances at swallowing existed no more. Morning temperature, 36.8°, pulse, 92; evening, 37°, pulse, 88.

July 17th. Chill in the morning, followed by a rise of temperature to 38.2°, pulse, 104; in the afternoon, pneumonic sputum. Despite all therapeutic measures directed to combat the pneumonia, it rapidly progressed and carried the patient off in the forenoon of the 19th of July. The post mortem was held in the evening of the same day. The wound healed per primam, the meninges were normal, and there were no extravasations of blood in the large brain, cerebellum, or in the medulla oblongata. The nervus facialis appeared uninjured, the acusticus resected. Cause of death: pneumonia.

The operation just described should be accorded a permanent place in surgery. I have since performed it twice with success. From consultations with eminent ear specialists, I learn that

there are many people who are rendered helpless, yea, even driven to suicide by the tormenting subjective noises in the ears. But my reason for reporting this case here was an entirely different one. It was first to demonstrate, that by careful displacement of the respective cerebellar hemisphere, we may reach the posterior surface of the petrous portion of the temporal bone,

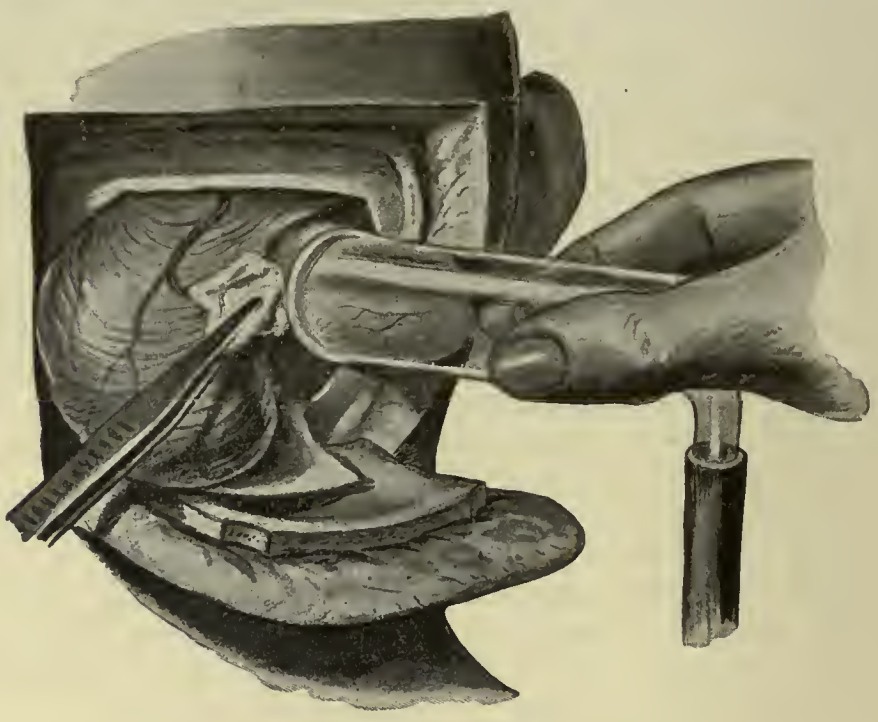

Fig. 130

Suction of a Tumor at the Cerebello-Pontine-Angle

until the porus acusticus internus lays freely exposed, without immediately endangering the life of the patient. We may even advance to the abducens, to a point where it perforates the hard membrane of the brain, when leaving the posterior fossa of the skull about the point of the pyramid of the temporal bone. In one of my previous works[1] I have pointed out that the exposure of the posterior surface of the petrous portion of the temporal bone is of especial importance on account of the relative fre-

[1] *F. Krause*, Zur Freilegung der hinteren Felsenbeinfläche und des Kleinhirns. "*v. Bruns*' Beiträge zur klinischen Chirurgie," Band XXXVII, S. 728.

quency with which neoplasms are met with in this situation. The same method has been described later on by other authors who reported cases of neoplasmata at the cerebello-pontine-angle (*Funkenstein, Garré, Becker* and others), and who credited my method with being the original mode of procedure.

### The Use of Suction

Since the appearance of the first volume of this work, I have added, in 1909, a new method of procedure, i.e., suction.[1]

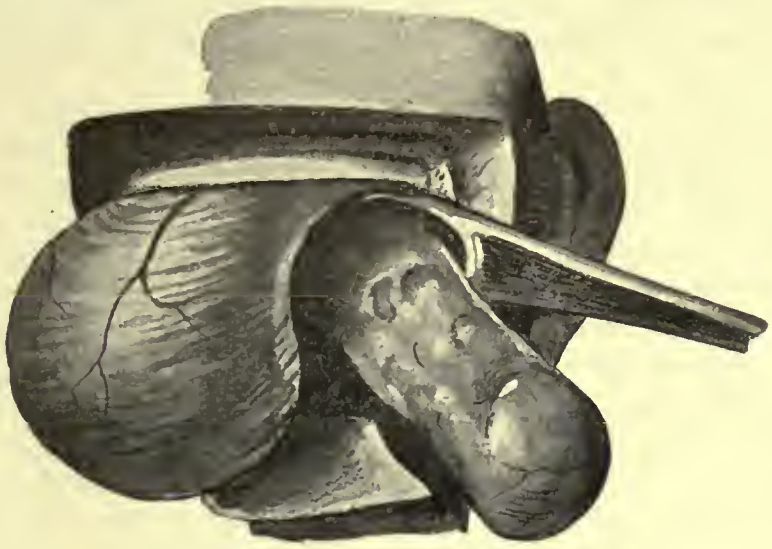

Fig. 131

The practical application of this method and its technic have already been described in another part of this work. It can also be advantageously used in cases of tumors at the cerebello-pontine-angle, especially when they are not too firmly attached. Median displacement of the respective cerebellar hemisphere brings the tumor to view (compare Vol. I, Fig. 32, p. 139, and Fig. 33, p. 141). After the thin capsule is torn through, suction is commenced at its exposed posterior surface; this gently pulls the tumor forward, while the contiguous brain substance is carefully pushed aside by the use of small gauze sponges. By this method, even extraordinarily large tumors may be brought

[1] Die Verwendung der Ansaugung in der operativen Chirurgie. "*v. Langenbeck's* Archiv für klinische Chirurgie," Band XC, H. 1.

to the surface without inflicting the slightest injury to the contiguous structures.

As an example of the symptomatology, I shall describe below the first case I operated on in 1905, and which *Geheimrat Ziehen* has reported in the *Medizinische Klinik*, 1905, Nos. 34 and 35.

## OBSERVATION VII, 7

*Fibrosarcoma in the Region of the Right Acusticus. Extirpation. Cure. Death, Ten Months Later, From Another Tumor Situated Between the Medulla Oblongata and the Pons.*

The patient, in this case, was a woman, forty-four years of age, who began to suffer in 1902 from attacks of dizziness that occurred at long intervals. Some time previous to the onset of these attacks, her husband had noticed that she did not hear well. As time went on, these attacks became more frequent and severe, so that the patient would sometimes fall, mainly to the right. The severest attacks were usually preceded by headaches; they were accompanied by loss of consciousness and by severe pains in the back of the neck and head. The patient would also vomit, and be continually eructating and complaining of a sense of chilliness. Later these attacks were accompanied by double vision. The patient came under the observation of *Geheimrat Ziehen* at the Royal Charité, where the following conditions were found.

In the beginning it was ascertained that choked disc was only marked on the right side, and that on the left it had barely commenced; on the 15th of June, it was present on both sides. The reaction of the pupils to light and convergence was retained. Looking to the right was always accompanied by nystagmus horizontalis; on the left, it was only of occasional occurrence. Diplopia was present only during the attacks. The right abducens, however, was slightly paretic (the right eye could not reach the extreme lateral position when looking outward). There was a complete absence of the right corneal reflex, while on the left it responded promptly. While in the beginning, there were no differences in the sense of touch in the region of

the trigeminus, contacts were perceived later in the right cheek, tongue, and forehead, but they could not be distinguished; on the left side they were precise. The patient also stated that the right half of her tongue felt as "if burnt." When she opened her mouth, her lower jaw distinctly deviated to the right.

In the beginning, the function of the facialis was perfectly equal. Later on there occurred very slight pareses in the right half of the face shown by the higher position of the angle of the mouth on the right, by a slighter folding of the skin of the forehead, and the right half of the face, and by the fact that the right angle of the mouth remained more or less behind when the patient was gnashing her teeth. There was almost complete deafness in the right ear, while on the left side, the patient could hear when spoken to in a whisper and the ticking of a watch at a normal distance. *Weber's* test was lateralized to the left; *Rinne's* test was positive on the left side only; on the right, it began to be positive from gii on (tests made at the Otologic Clinic of the Royal Charité). Upon protrusion the tongue deviated to the right. The motility and sensibility of the upper and lower extremities remained entirely undisturbed. The tendon-periosteal reflexes were somewhat livelier on the right than on the left side.

The severest of all symptoms were the *disturbances of equilibrium* that were noticed from the very beginning of the onset of the disease; they were present at times, and absent at others. During the *Romberg* test, the patient staggered to the right; especially was this the case when she was somewhat pushed, or when she was asked to lift an arm or a leg. While walking with open eyes, she always deviated to the right side. When she attempted to walk with her eyes closed, she invariably fell over to the right, after a few uncertain sways. In any attempt at walking, she kept her trunk fairly rigid and somewhat bent backward.

The attacks of vertigo were especially striking. *Geheimrat Ziehen* described them, in the *Medizinische Klinik*, No. 34, 1905, p. 849, as *vestibularis attacks* as follows: "Their frequency was from three to ten times in a day; they occurred at any hour of the day; at times, without any cause, at others in connection with a change of position. Walking, lying, standing, and sit-

ting had no influence. The course of an attack for instance (23d of April) was as follows: The patient suddenly staggered now in this direction and then in another, without closing her eyes. The difference in the pupils (constantly present) became worse for a moment. Immediately thereafter there occurred an active nystagmus of both eyes toward the right and upward. The patient who, during all this, was perfectly conscious and spoke normally, complained that she could not see with the right eye, and that everything looked double to her. The double visual pictures were parallel to each other and stood at an equal height. About a quarter of a minute later, the eyes showed a distinct tendency to deviate to the left. This deviation was continually corrected by an almost horizontal nystagmus, so that the eyes arrived, in jerky movements, at the median line again. The static disturbances described above were much aggravated during the attack. About four minutes after the onset of the attack, the double vision disappeared; nystagmus, however, persisted for quite a long period when the patient was looking upward, and the usual nystagmus, described above, finally remained. Immediately after the acme of the attack, a slight ataxia of the right arm was demonstrable when subjecting the patient to the finger-touch-nose-test. The sense of dizziness and turning gradually returned to normal again. This was frequently followed by eructations."

In another case observed by the writer, the nystagmus was purely rotatory (in the sense of an observed hand of a watch). On attempting to stand up, the patient fell to the right. Passive rotation of the head did not increase the vertigo. The clinical manifestations were, in this instance, as in the other case, the same, with the exception that there was no ataxia at the finger-touch-nose-test.

Based on the symptoms described, *Geheimrat Ziehen* made a diagnosis of tumor in the region of the right acusticus. On the 15th of June, 1905, the patient was referred to the Augusta Hospital for operation. Our observations entirely coincided with those of *Professor Ziehen.* On the 22d of June, 1905, I performed the operation in one stage with the patient in a sitting position. The bone was sacrificed, in this instance, and the cleft of the skull was enlarged with the rongeur forceps to

such an extent that the sinus transversus and mastoideus lay freely exposed. The prolapsed dura appeared very tense; pulsations could barely be recognized in it.

The dura was now incised parallel to the three sinuses, and the somewhat quadrangular flap of dura reflected downward. The uninjured right cerebellar hemisphere, covered with pia, was now carefully displaced medianward, with the brain spatula, the object being to render the posterior surface of the petrous portion of the temporal bone accessible. During this act of the operation, a stream of clear fluid gushed forth. No tumor was, as yet, visible. However, at the inspection of the lower and under surface of the cerebellum, while it was being lifted by the spatula from below and the right side, to above and the left, and also medianward, a knotty tumor came to view at a depth of 5½ cm. (measured from the surface of the bone), at the cerebello-pontine-angle. (See Vol. I, Plate XIX, Fig. b.) After tearing the thin connective-tissue layer that was covering it, the neoplasm could be lifted out with a delicate hook, to only half of its extent. To avoid tearing it, I used careful leverage, not unlike the removal of an impacted gallstone from the choledochus, and I was successful in delivering it from its bed, by means of a large blunt spoon. It bled only moderately. A strip of vioform gauze was next placed into the bed of the tumor, and thence brought to the surface through the lower lateral angle of the wound. The flap of dura was now reposited over the hemisphere and sewn into position with catgut sutures. The osteoplastic flap was finally exactly sutured into place, and a short drain was permitted to remain at the lower lateral angle of the wound. During the operation, which lasted an hour and ten minutes, there were no disturbances of pulse and respiration.

The position of the tumor is depicted in Fig. 31 of the first volume, p. 136. It was of an oblong and rounded shape, and measured 25:18:17 mm. It was of semisolid consistency and grayish-red color. The microscopic examination showed it to be a fibrosarcoma, rich in celiular elements, that appeared gliomatous in some places.

After the operation, the pulse was 88. On the following day it went up to 110 and fluctuated between 100 and 105.

From the 24th of July on, it continued below 100 beats per minute. Only on one occasion (on the second evening following the operation) the temperature rose to 38.1°; otherwise, it was always below 37.5°.

Immediately after the removal of the tumor, the vestibularis attacks completely disappeared. The patient frequently complained, however, of double vision, headaches, and some days she also vomited in the morning and in the evening. Her recovery was a comparatively rapid one. On the 4th of August

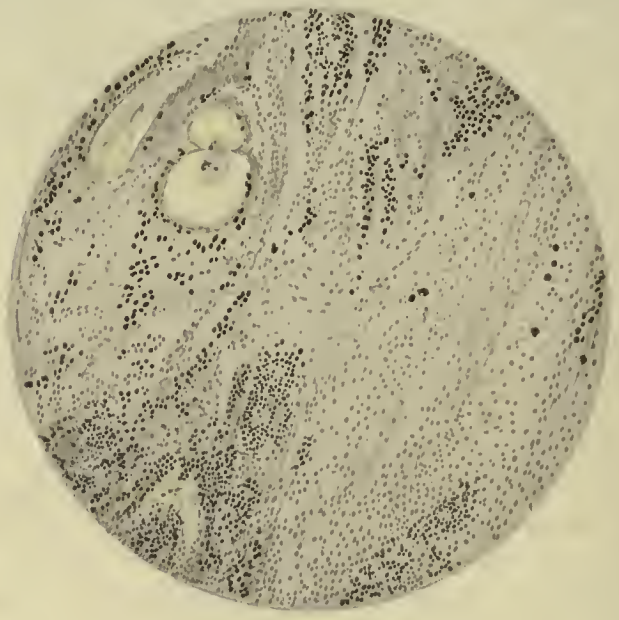

Fig. 132

Tumor at the Cerebello-Pontine-Angle

Fibrosarcoma, rich in cellular elements, with isolated gliomatous places (Magnified 80: 1)

she was able to leave the bed. On the 6th of November, 1905, she was shown to the Berlin Society for Psychiatry and Nervous Diseases by *Professor Dr. Seiffer.* All morbid manifestations had, at that time, completely disappeared.

On the 22d of February, 1906, an examination of the nervous system showed the following extraordinarily favorable conditions: The choked disc had vanished. There were no differences in the pupils. There was a slight nystagmus when

the patient was looking upward and to the right. The corneal reflex on the right side was active; on the left, it may perhaps have been a little livelier. The sensibility of the trigeminus was normal. Pains of any character did not exist. The facialis functionated equally good on both sides. *Especially remarkable was the improvement in the acusticus.* The patient who, prior to the operation, was totally deaf in the right ear, could now hear words spoken in a whisper. The vestibularis functions had also improved. When the patient was walking with her eyes open,

Fig. 133

there was not the slightest trace of staggering observable. With her eyes closed, it was only very slight. Even with closed eyes, she did not deviate from the direction she selected to take. The *Romberg* phenomenon was only occasionally slightly present. Subjective vertigo existed no more.

Despite the excellent general condition of the patient, a cerebral prolapsus gradually developed, from which liquor was dribbling. For some time it gradually receded, only to return soon again. It was about the size of a fist (see Fig. 133).

The dribbling of liquor was constant. We attempted twice to reduce the size of the prolapsus by puncture and firm

bandaging. In this we were unsuccessful, for, a few days later, it was filled again and exceeded the rotundity of the head, posteriorly, to a height of 6½, a width of 4½, and a thickness of 2½ cm. In the beginning of April, 1906, a picture of it was made by our artist, *Landsberg*, which is reproduced in Vol. I (Plate XXIV). Puncture was soon followed by violent headaches, motor unrest, increased frequency of the pulse-rate, and a rise of temperature to 39.3°; the patient also complained of pain in the præcordium, and she vomited once. No other cause outside of the puncture could be found for these symptoms, and they disappeared within the next twenty-four hours.

The patient remained under treatment until April, 1906, because the dressings frequently became saturated by the flow of liquor and had to be changed twice weekly; she was, however, able to live at her home without much inconvenience. Whenever the bandages remained dry for a few days, headaches, weakness, and an inclination to vomit were sure to follow, but disappeared again after a perforation took place in some part of the thinned prolapsus, which permitted the pent-up liquor to drain off. On the 18th of April, 1906, she was dressed and departed for home without the slightest complaint. A few days later, however, she was brought back to the hospital by her husband, on account of the onset of severe headaches which lasted continually for a few hours, and that were accompanied by confusion, continued vomiting, and noises in the ears. After removing the dressings, a small stream of liquor was seen issuing from a minute opening; the microscopic examination showed it to contain a few mononuclear leucocytes and no polymorphonuclears. Toward noon her face had become white and a few hours later it was cyanotic, with the pulse-beat about 130 per minute. The temperature was (at noon) 40°. To this was added a strong motor unrest. On the following evening there was somnolence, *Cheyne-Stokes* respiration, and two hours later the patient died.

The post-mortem examination (*Professor Dr. Oestreich*) showed a basal tumor in the region between the pons and the medulla oblongata. There was no meningitis.

After removing the vault of the cranium, the cerebral membranes appeared entirely free from evidences of suppuration. A

tumor, the size of a walnut, was found at the base at the point of union of the pons and the medulla oblongata. It was hard in consistency and somewhat nodular. After the pia was ablated the neoplasm was seen to rest in a trough in the brain substance. Pons and medulla were dislocated to the left. A portion of the right half of the cerebellum was missing. It stood in direct connection with the sac that led to the exterior. No other details could be recognized. The walls of the arteries at the base of the brain were delicate.

The examination of the internal organs showed nothing abnormal outside of hyperæmia and œdema of the lungs.

The symptoms of this typical case of acusticus tumor were of two kinds—(a) manifestations of general cerebral compression, and (b) focal symptoms. The gradual development of the first type (in the course of three years) speaks for a certain benignity of the tumor; as a matter of fact, it was a fibrosarcoma rich in cellular elements. The first symptoms consisted of attacks of vertigo that gradually became more noticeable until they led to fainting-spells, disturbances of hearing, and staggering to the right side, intense headaches, vomiting and double vision that were sometimes accompanied by loss of consciousness and convulsive seizures. This brought the patient to the Charité, from whence she was referred to the Augusta Hospital for operation on account of tumor of the acusticus.

The cerebral nerves that participated were: the olfactorius slightly, and both optic nerves to a marked degree. This was shown by the decided bilateral choked disc that, in the beginning of the observation was more marked on the right than on the left side. The nerves of the ocular muscles, the oculomotorius, trochlearis, and abducens were also sympathetically affected. This was shown by the diplopia and the nystagmus observed when the patient was looking to the right side. The left pupil was wider that the right. With reference to the trigeminus, the woman had a total anæsthesia of the cornea on the side corresponding to the tumor. The corneal reflex on the right side was extinguished. The patient complained occasionally of pains in the right side of the face; these were not distinctly located. Later the sensibility of the patient became aggravated.

The fact that a certain paresis of the musculus pterygoideus externus existed proves that the motor portion of the trigeminus was slightly affected (sympathetically).

The facialis was only slightly involved, while the acusticus of the afflicted side was suffering in the extreme. The otoscopic findings were normal. This nerve divides into two parts, which in this connection is of the greatest importance. Its first part is known as the cochlearis which has to do with the sense of hearing. During all the otologic examinations of the right ear, the patient was found completely deaf. The other part is the vestibularis that governs the equilibrium of the individual. The patient was barely able to stand erect with her eyes open. During the examinations she was very apprehensive, and when attempting to walk she invariably deviated to the right side. With her eyes closed, she always fell. Swaying occurred, by preference, always to the right. She had from three to ten attacks of vertigo in a day and was awakened by them from sleep. The vagus and accessorius did not participate. A difference in the sense of taste on both halves of the tongue could nevertheless be demonstrated.

It is important to note that high tension pulse was never observed in this patient during the entire time she was under observation; on the contrary, the pulse-rate was somewhat accelerated. The mastoid process was not sensitive on pressure.

The splendid results of the first operation were destroyed by a second tumor that developed between the pons and the medulla oblongata and caused the death of the patient exactly ten months after the operation. It is a well-known fact that acusticus-fibromata are not infrequently multiple, occurring on both sides. In our case, the second tumor was situated in the median line, at the point of junction of the pons and the medulla oblongata. This second tumor was evidently very small at the time of the operation, so that an opportunity was given to the clinical manifestations to recede. It then grew and caused the large prolapsus, and, finally, the death of the patient.

In this connection, I shall describe a case in which the operation was followed by complete cure of the patient.

## OBSERVATION VII, 8

*Fibroma at the Left Cerebello-Pontine-Angle, Rich in Cellular Elements. Extirpation in Two Sittings. With the Exception of Slight Symptoms, Complete Cure in the Last Two Years.*

The patient in this case, was a man thirty-four years old, who was of weak constitution and had suffered for quite a long time from asthma. In the spring of 1905 there occurred two attacks of vertigo, the cause of which was attributed by the patient to the indulgence in alcoholic excesses. In the summer of the same year there suddenly set in difficulty in hearing in the left ear that within a few weeks progressed to complete deafness. Headaches, which became more intense during the year 1908 and in the beginning of 1909 accompanied these attacks, which became annoying and more frequent, and were attended by a sense of giddiness with uncertainty at walking. During these attacks of vertigo, the patient complained of a sensation as though a veil were placed in front of his left eye. In the last two years he also complained of difficulty in deglutition.

The patient was referred to *Professor Oppenheim* who made an examination on the 9th of October, 1909, and his findings were as follows: The psychic condition of the patient was striking; he displayed maniac tendencies; there existed "Witzelsucht" and great talkativeness. There also existed a very slight paresis in the left facialis; the protruded tongue deviated somewhat to the left.

The examination of the eyes: The fundus oculi showed marked choked disc on both sides (about 1.5 mm. prominence); the acuteness of vision was r. $=\frac{5}{10}$, l. $=\frac{5}{7}$. On the left side there existed an areflexia of the cornea. Generally speaking, the movements of the eyes were free, but we were nevertheless able to demonstrate a weakness of the abducens, especially of the left eye. When the patient was looking to the left, a coarse, irregular nystagmus became apparent. This was more marked, finer, and more rapid when he was looking to the right.

The examination of the ears: The right ear-drum showed no marked changes. The left was retracted, and outside of an

indistinct small cicatrix it showed no other pathologic findings that could be looked upon as a peripheral etiologic factor for the existing disturbances of hearing.

The tests of hearing showed that the patient could hear on the right side words spoken in a whisper at a distance of 5.5 metres; while with the left ear, he could hear speech above a whisper only immediately in front of the ear (ear open or closed). Tuning-fork tests showed *Weber* distinctly lateralized to the right. Aerial conduction of tuning-fork (A) was not heard with the left ear at all; bone conduction, on the other hand, was heard as long as on the right side. Both aerial and bone conduction on the right were normal. $a_1$ and f $sharp_4$ were heard well on the right side, but were strongly reduced on the left. The examination with *Galton's* whistle was not of much value, because it was apparently not heard with the left ear but with the right ear closed.

Caloric reaction was negative in the left ear, while in the right it was obtained promptly. The patient complained of vertigo, even before $\frac{1}{4}$ litre of water was injected, and the nystagmus became more marked when he was looking to the left side while it did not disappear on looking to the right. After the syringing, the ataxic disturbances of gait were much exaggerated. Subjectively, the patient complained of a hissing in the left ear.

The ataxia-test showed distinct ataxic disturbances. When the patient closed his eyes he began to stagger heavily; his gait was cerebellar-ataxic. There was motor ataxia of the left lower extremity. It did not exist in the left hand. There was, however, marked adiadochokinesis.

Reflexes: The knee-phenomenon was lively on the left side and weak on the right. *Oppenheim's* test was positive on the left side. *Babinski's* phenomenon was uncertain on the left.

Taking into special consideration the pronounced cochlearis and vestibularis symptoms, *H. Oppenheim*, on the 11th of October, 1909, made the diagnosis of tumor of the cerebello-pontine-angle on the left side. The left posterior fossa of the skull was entered into in the usual manner and the bone was preserved. The dura did not pulsate, but it felt as hard as a billiard-ball. The second step of the operation was undertaken

on the 20th of October. A flap of dura was formed with its base directed downward. The cerebellar hemisphere now prolapsed and was pulsating. As soon as it was displaced medianward with the spatula, a tumor was brought to view, about 2 cm. under the surface of the dura. The neoplasm was of grayish-red color and coarsely granular on the surface. Here and there, yellowish spots were found interspersed. We were successful in delivering it by suction, because its soft consistency did not differ from that of the cerebellum, and furthermore, because it was not encapsulated. The tumor was next detached from the tentorium cerebelli and the posterior surface of the petrous portion of the temporal bone, by means of a large, flat, blunt-edged spoon. Working in this manner, we were successful to reach the anterior pole of the neoplasm. Its detachment from the petrous portion of the temporal bone was accomplished by pressure, after which it was luxated backward, and removed. The cavity created by the removal of the tumor measured, from the surface of the dura, 48 mm. in depth. The measurements of the neoplasm were 50:44:20 mm. Since the floor of the cavity showed everywhere normal cerebral substance and since there existed no hemorrhage to speak of, the cerebellum, that had until now been displaced medianward, was replaced over the cavity occupied previously by the tumor, and the wound was entirely closed by suturing the osteoplastic flap into position.

The patient withstood the operation well and healing of the wound was usual in every respect. On the 26th of October, the wound had entirely cicatrized with the exception of a very small open space about its middle, from which liquor oozed in greater or less quantities. When the dressings were found dry, i.e., if there was a stagnation of liquor, the patient showed a reaction with a rise of temperature as follows: October 27th, 39.7°; November 4th, 38°; November 8th, 38.3°; November 13th, 38.4°; and November 16th, which was the last temperature taken, 38°. These rises of temperature were accompanied by excruciating frontal and temporal headaches and especially by annoying sticking pains in the left ear. No more liquor was discharged after the 22d of November and the wound was completely healed. The patient did not have any temperature rises

after the 17th, and complained of no more headaches after November 22d.

After healing, the psychic state of the patient showed nothing abnormal. The previously observed euphoria and "Witzelsucht" were referred to by him as "reckless merriment."

The examination of the nervous system, made by *H. Oppenheim* three days after the operation, did not disclose any marked changes. The adiadochokinesis of the left hand was more marked and there also existed a distinct motor ataxia that disappeared completely on the 28th of October, while the adiadochokinesis, as well as an uncertainty in the use of the left hand, persisted throughout the entire time the patient remained at the sanitarium. On the 23d of October, the fundus oculi showed a commencing regression of the choked disc, and on the 13th of November it had vanished. All that remained now was a moderate redness and cloudiness of the papilla. On the 27th of November, even these manifestations had completely disappeared. Disturbances in the innervation of the facialis and hypoglossus could no longer be demonstrated. The abducens paresis had also disappeared; except when the patient was looking to the left, the extreme lateral position of the eye could not be obtained. The nystagmus accompanying the movements was very slight, and on looking to the right could not be seen at all. The areflexia of the left cornea was only slightly improved, and the corneal reflex on the right side was still greatly reduced. According to the statement of the patient, his visual power had markedly improved. The left-sided deafness, however, remained unchanged. Of the ataxic disturbances there still remained a slight motor ataxia of the left lower extremity. The gait of the patient still showed a slight cerebellar-ataxic character. Otherwise, he walked with certainty and without swaying. With open eyes, he stood entirely firm; with eyes closed, he swayed only occasionally (slightly to the left). His reflexes were normal.

The patient was out of bed since the 17th of November, and felt subjectively very well, so that on the 7th of December, 1909, he was discharged from the hospital.

At a subsequent examination, five months after the operation, it was shown that the patient had recuperated remarkably

well. His only complaints were of a slight sense of vertigo, and an uncertainty in the use of the left hand. Objectively, nothing abnormal was discovered on examination of the nervous system. The osteoplastic valve was as yet slightly fluctuating on palpation and still somewhat prominent.

On the 20th of March, 1911 (about a year and a half after the operation), the patient paid us a visit. He was in blooming health and did not complain of any subjective manifestations. In 1910, he still enjoyed good health, with the exception of a slight sense of dizziness and some uncertainty in the left hand. In 1911, he was so much improved that there was a complete absence of any form of swaying or giddiness when he closed his eyes as well as when he turned around. His walk showed nothing abnormal and was entirely satisfactory.

The papillæ were normal on both sides. When the patient was looking to the left, however, in the extreme end position of the eye-bulbs, a slight, somewhat coarse nystagmus could still be observed, and looking to the right, a fine nystagmus persisted. Usually, the bulbs were entirely quiescent. When the patient was suddenly changing the direction he was looking in, he occasionally would see double pictures at a great distance. To explain this phenomenon, however, nothing objective could be found. The power of both hands and feet was normal, and no ataxia was present at any movements. However, the deafness on the left side, the areflexia of the left cornea, and the adiadochokinesis of the left arm and hand persisted unchanged. The sensation of the left half of the tongue was not as good as that of the right; the sense of taste on that side having completely gone. Outside of these residual manifestations, no other disturbances existed—consequently, the patient was cured. His pulse was 76, full and strong. The mode of life of the patient was entirely that of a healthy person. He volunteered the information that the tendency to crack jokes and look upon everything in a humorous light, while in the serious condition before the operation, was very much exaggerated during his illness. He is a "Rhineländer" and consequently naturally of a jovial disposition. The field of operation was only slightly bulging and fluctuated a little. The patient did not use any protective apparatus over his cicatrix.

### Impossibility of Radical Extirpation

In operating on tumors at the cerebello-pontine-angle, I have a few times found the neoplasm to be firmly attached to the posterior surface of the petrous portion of the temporal bone, in the vicinity of the porus acusticus internus. Twice I have seen it penetrate into the substance of the bone, so that after it had been removed there remained an irregularly split or eaten away surface in the bone about the size of a half dollar, resembling closely osseous caries. Generally speaking, such cases are, as a rule, inoperable.

The extirpation, in such instances may be difficult or frequently even impossible. This is especially the case when the tumor is very extensive and when, on account of its friability, it falls to pieces during the necessary manipulations. The task at enucleation is a great deal more difficult when the neoplasm has invaded the pons and when it projects anteriorly toward or into the middle fossa of the skull. Such tumors are always inextirpable. It is regrettable that the diagnosis of such extensive invasion by the neoplasm cannot be made beforehand. The following observation illustrates such a case.

## OBSERVATION VII, 9

*Tumor of the Acusticus Between the Point of the Petrous Portion of the Temporal Bone and the Anterior Pole of the Left Cerebellar Hemisphere. Removal of a Considerable Quantity of Friable Tumor-Masses; a Large Portion of It, However, Remained Behind. Death Three Weeks After the Operation.*

The patient, a woman, fifty-five years old, was admitted to the hospital on the 20th of November, 1907, having enjoyed good health up to that time. Her trouble began with an annoying buzzing in the left ear. This became associated with attacks of headaches and vertigo, accompanied by diplopia. She could not describe her vertigo more fully. The attacks of dizziness became more frequent as time went on; later they would be as frequent as twice in an hour, lasting about half a minute. The double vision behaved likewise. The visual power became lessened. At times, the vision was only blurred; again, every-

thing appeared dark in front of the patient's eyes. Noises in the ears, difficult hearing, and a slight lymphadenitis behind the left ear caused her to consult a physician, who incised an abscess and then sent her to *Professor Oppenheim.* The latter referred her to the Augusta Hospital, and on the 26th of November he made a diagnosis of tumor of the left nervus acusticus.

The examination by *Oppenheim* showed that the sensorium of the patient was perfectly free. She appeared very healthy, despite the fact that she had lost considerably in weight. Marked choked disc of both papillæ with beginning atrophy of the left papilla were observed. There existed a slight paralysis of the abducens on the left side and coarse tremor of the eyelids on lateral movement of the eyes to the left as well as to the right. The left cornea was entirely insensitive to contacts with the head of the needle, while on the right side the reflex was entirely normal. The patient complained of a constant sense of tension in the left cheek and in the left half of the forehead. The corrugation of the skin of the face remained behind on the left side as compared with the right. The power of hearing was much reduced in the left ear, and speaking in a whisper could not be heard at all on that side; she heard ordinary conversation only when spoken immediately in front of the ear. *Rinne's* test was positive on the right side only. In *Weber's* test also, lateralization of the tone was confined to the right. The free border of the left palatine arch was flattened, as compared with the right. The uvula favored the right side and the arch of the palate was on phonation less elevated on the left than on the right side. Slight tympany was obtained from percussion of the head over the left occiput. This procedure was more painful on the left than on the right side. The spontaneous headaches were always said by the patient to be located in the right half of the forehead. The tendon-phenomena of the extremities were, on the whole, very active, and patellar clonus could be elicited on both sides. Ataxia, on the other hand, could not be demonstrated either when walking or standing. Outside of a fine tremor of the fingers of both hands, no motor disturbances existed. The temperature never rose above 37°, and the pulse varied between 65 and 80 beats per minute.

On the 26th of November, 1907, an osteoplastic flap was fashioned over the left occipital protuberance; it was broken off at the foramen occipitale magnum and displaced downward. The resulting cleft in the skull was then enlarged over the confluens sinuum and extended to the knee of the sinus mastoideus.

The exposed dura of the left cerebellar hemisphere was only slightly pulsating; this was also the case with the dura overlying the exposed occipital brain. The flap was now reposited and sutured into place. In the days following the trephining, the patient was free from headaches. Eight days after the first operation—December 4, 1907—the osteoplastic flap was detached without hemorrhage and displaced downward. The dura now pulsated visibly. A dural flap with downward base was fashioned. A considerable quantity of liquor drained away from the subdural space. The cerebellum could be easily displaced medianward by means of the brain spatula and the posterior surface of the petrous portion of the temporal bone came to view. Quite deeply, there appeared a mass of grayish-red color that resembled the cerebellum in appearance. It was firmly wedged in between the point of the petrous portion of the temporal bone and the anterior pole of the left hemisphere. Since the consistency of the tumor was firmer than that of the brain substance its bulk could gradually and without considerable loss of blood be detached from the pyramid of the petrous portion of the temporal bone and from the cerebellum by means of small sponges held in the grasp of thumb-forceps. The semisharp spoon completed the removal of a piece of the tumor-mass which measured 21 mm. in length, 22 mm. in width, and 11 mm. in thickness. Inspection of the tumor-bed, however, showed that other knotty tumor-masses were present in the depth. They were delivered with the spoon until neither the finger nor the eye could discover any other remnants. The length of the tumor-masses removed subsequently was 21 mm., the width, 22 mm., and the thickness, 15 mm. The depth of the wound was, measured from the dura, $5\frac{1}{2}$ cm. There was a remarkably slight quantity of blood lost during the entire operation. This enabled us to entirely close the wound at once. During the operation, the pulse was always full and strong; it

gradually mounted to 96 beats per minute. At the conclusion of the operation, the orofacialis was found paralyzed.

A few days later, the patient had greatly recuperated, and felt very well indeed. On the 6th of December, 1907, *Professor Oppenheim* found that while her speech was strikingly nasal and dysarthric, it was nevertheless distinctly intelligible. The left facialis was completely paretic to such an extent that the patient was unable to close her eyelid completely. The left-sided abducens-paresis, the eye-tremor on looking to the left, and the paresis of the palate, became aggravated. The left motor trigeminus was also paralyzed. The left half of the tongue was folded, and the patient occasionally swallowed the wrong way when drinking. There was a distinct ataxia of the left hand and left lower extremity. There was also adiadochokinesis in the left hand, while the extremities of the right side showed no deviations from the normal. The coarse power of both extremities remained the same.

In the following weeks, the patient recuperated very slowly. She slept fairly well and gradually became apathetic and had to be nourished principally by liquids. The pareses of the cerebral nerves on the left side became gradually more noticeable while her general disposition became at the same time improved and she stated that she felt well. She complained no longer of vertigo, headaches, and attacks of diplopia. The choked disc also vanished gradually and only the left papilla appeared somewhat reddened and cloudy. A slight trigeminus-keratitis had developed in the left eye that soon cleared up under atropin.

On the 21st of December, 1907, the patient created a decided apathetic impression. She spoke little and answered only a few questions. She uttered single words however with distinctness. She frequently swallowed the wrong way while drinking. For twenty-four hours there issued a considerable quantity of liquor from the puncture canals of the otherwise firmly united and slightly prominent wound in the skin, so that the dressings had to be changed frequently. The objective findings had not changed at all. The temperature had dropped to 36°, and the pulse-rate rose to 130 beats per minute.

Since there existed a possibility that a part of the cerebellum had been injured during the operation, that may have been fol-

lowed by softening, and also that masses of neoplasm had been left behind, that exercised pressure on the pons, and, in order to establish decompression, the firmly united osteoplastic flap was liberated again and slightly lifted up from the underlying cerebellum. The surface of the cerebellar substance was found to be united to the bone, and appeared neither softened nor changed in any way. The wound was loosely packed with vioform gauze, and a large dressing placed over it.

Soon after this procedure, which was undertaken without an anæsthetic, the patient became livelier. She asked for a drink from time to time, and recognized those about her. The pulse-rate sank from 130 to 100 beats per minute. Two days later, however, swallowing the wrong way, sopor and total apathy set in again. On the 25th of December, 1907, the patient died. In the last two days there was a profuse drainage of liquor cerebrospinalis, that required frequent change of dressings.

Cerebral section (*Chief Physician Dr. E. Heymann*) showed that there existed another tumor which was situated in a cavity in the left half of the pons, in the anterior pole of the somewhat softened and backward dislocated left cerebellar hemisphere. It measured from the front to the back, 46 mm., and from right to left, 20 mm., and from above, downward, 36 mm. This tumor-mass had a knotty nodular surface. It exceeded the pons anteriorly by half a centimetre. The neoplasm could be luxated from its bed, between the pedunculus and the elongated crus cerebelli ad pontem, after severing the pia covering it. It now appeared that a plug of the tumor had grown onto the tentorium cerebelli. Of the cerebral nerves, the left trigeminus and abducens were displaced to the front and medianward. Both of these nerves appeared, compared with those of the right side, thin, flatly compressed and gray. The acustico-facialis bundle stretched in a deep furrow over the rest of the neoplasm. This and both nerves could not be separated from one another. Laterally on the tumor a flat surface was found on which the acusticus-facialis was severed. This broad, whitish surface was covered with a few spots of yellowish pigment and corresponded to the place from which the main tumor had been extirpated.

Transverse sections of the pons and medulla oblongata

showed displacements of their structure from left to right, but nowhere could there be found any form of degeneration or softening.

### Sarcoma of the Arachnoid

We sometimes observe neoplasmata in the posterior fossa of the skull as well as of the cerebrum, that originate from the arachnoid. This form of tumor is rarer than the forms of neoplasm hitherto described. They are either sarcomata or fibrosarcomata. When located on the lateral surface of the cerebellum they are subjected to the same kind of surgical treatment as are tumors at the cerebello-pontine-angle. The modus operandi in one of these cases, the clinical history of which follows, has been described in Volume I.

## OBSERVATION VII, 10

*Large Sarcoma in the Left Posterior Fossa of the Skull, Rich in Cellular Elements. Laterally, Partly Extracerebellar, Partly Situated in the Left Half of the Cerebellum, Pons, and the Medulla Oblongata. Extirpation. Death, Four Hours Later, from Respiratory Paralysis.*

The patient, in this case, was a boy, sixteen years of age, who prior to the present illness was perfectly sound, and remarkably well developed mentally. At the age of thirteen, at a period when he was growing rapidly, he began to complain of buzzing in the left ear and of difficulty in hearing. At the same time his gait became swaying. Following a vacation on a farm, a transient improvement was noted. Soon, however, the swaying became more marked, and after slight physical exertion the patient had to halt for a moment and could not continue to walk. A course of inunctions and potassium iodide did not improve his condition. About a year after the onset of the noises in the ear, following a cold bath, there occurred a convulsive seizure, which was accompanied by loss of consciousness. Both hands and feet became spasmodically contracted and his head was turned to the right side. These attacks continued for about three months, occurring on the average of about ten times in a month, mainly setting in at night. The

seizures now became less frequent and the intelligence of the patient began to decline. He also broke down physically. Despite this, after a period of suffering of two and a half years, he was able, accompanied by his father, to sojourn from Chile to Berlin. He could walk up and down stairs without special difficulty and could frequent the offices of physicians without much fatigue.

At the examination it was found that the boy was well developed for his age, and that he was still powerful. The examination of the skull disclosed nothing abnormal. The middle of the left occipital protuberance was sensitive to touch and percussion. The percussion-sound was distinctly duller and of a lower pitch in this situation, and toward the atlanto-occipital articulation. The X-ray examination of the skull showed that the sutures in the left posterior fossa were distinctly separated for a number of millimetres (compare Vol. I, Plate XXV, Fig. c). There was choked disc in both eyes, but no reduction in the visual power. When the patient was looking to the left, the movements of the eyes were tremulous and the extreme lateral position was not reached. Looking to the right was freer and the nystagmus accompanying it much less. The reflex of the conjunctiva was extinguished; the corneal reflex was sluggish, being more intense on the right than on the left side. The accommodation reflex of the pupil was retained. In the trigeminus there were no motor nor sensory deviations from the normal. The folds of the skin of the left half of the face were obliterated on moving as well as at rest. The electric irritability of the facial nerve on the left side was reduced. There was difficulty of hearing on the left side of a nervous kind. On account of paralysis of the left half of the soft palate, there existed dysarthria and dysphagia. The point of the tongue distinctly deviated to the left on protrusion.

The sensibility of the entire body remained undisturbed and the coarse power of the left extremities, as compared with that of the right was remarkably weak. Almost all joints of the extremities of the left side were in a condition of tonic tension. There consequently existed ankle-clonus and clonus of the patella. These phenomena could not be demonstrated on the right side. The reflexes however were more marked than usual.

The reflexes of *Babinski* and *Oppenheim* were present on both sides. The gait of the patient was therefore decidedly spastic-paretic. When the patient closed his eyes, *Romberg's* test was positive. The stereognostic sense was somewhat reduced on the left. During my absence, my former *Chief Physician, Dr. Bail,* made a diagnosis of tumor of the left cerebellum and referred the boy to *Professor Oppenheim.* The latter advised an attempt at radical operation. The diagnosis of *Oppenheim,* was "Neoplasm in the left posterior fossa of the skull, maybe originating from the acusticus, and certainly extending downward and posteriorly."

On the 2d of May, 1906, with the patient in the right lateral position, I fashioned an osteoplastic flap over the left cerebellar hemisphere. Below the sinus transversus, the dura showed strands of thickenings. It was very tense and pulsations were nowhere visible. I performed the second stage of the operation on the 4th of May, 1906. While fashioning a rectangular dural flap with downward base, an injury was inflicted, with the scissors, to the sinus transversus that was running in an abnormal, oblique, median direction. This was at once repaired with a continuous suture of the finest silk. (For further description of the operation, see Volume I, pp. 142–145.)

Despite the prompt administration of camphor and coffee by the hypodermic method, and infusions of salt solution, the pulse began to rise immediately after the suture had been completed. Immediately after the large tumor had been delivered the patient ceased to breathe, and while the respirations soon returned, they lasted for a short period, and then failed again, so that we had to resort to artificial respiration. The patient refused to breathe as soon as rhythmic tractions of the tongue were suspended, and when manual compression of the thorax was left alone for one or two minutes. At such times, the face of the patient would become blue and the pupils were dilated *ad maximum.* The pulse continued to beat strongly, although its rate was somewhere between 120 and 160 per minute. Four hours after the operation, the patient died from respiratory failure. The autopsy findings are described in Vol. I, p. 144.

Of the significance of this observation, *Oppenheim* has already

reported in a previous communication.[1] Besides the distinct lowering of the percussion-sound that was undoubtedly occasioned by the large tumor-masses between the bone and the brain, the paralysis of the cerebral nerves, causing spastic hemiplegia of the same side, is noteworthy. *Oppenheim* concluded that we were dealing with a "neoplasm that corresponded to the pons, medulla oblongata, and the cerebellum; and that it compressed at its proximal pole the corresponding cerebral nerves, and that it interfered with its distal end with the pyramidal tract, after its decussation." This conclusion was found to be correct, by the findings at the operating table and at the autopsy.

### Tumors in the Region of the Vermis, and in the Cerebellar Substance

Neoplasms are sometimes encountered in the substance of the cerebellum, as well as in the region of the vermis. The corresponding cerebellar hemisphere may be completely consumed by the tumor. At other times again we find, in the masses of tumor-tissue, dispersed here and there, remnants of normal brain substance, hemorrhagic areas and small cysts which are occasionally very large, and represent the principal mass of the tumor. In neoplasmata of the cerebellum, we have mainly to deal with sarcoma, angiosarcoma, gliasarcoma, and fibrosarcoma. In operating on tumors, we have frequently observed them originating from the superior vermis, extending to one or even into both cerebellar hemispheres. From the latter, large portions or even an entire hemisphere may be removed. In great extension of the neoplasm in the region of the vermis, we must frequently satisfy ourselves with the extirpation of portions of the tumor commensurate with the condition of the patient at the time of the operation. That even in these apparently hopeless cases, we occasionally get results close to complete cures is taught in the following case.

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[1] *H. Oppenheim*, Beiträge zur Diagnostik und Therapie der Geschwülste im Bereich des centralen Nervensystems. Berlin, 1907.

## OBSERVATION VII, 11

*Tumor of the Vermis Extending to Both Cerebellar Hemispheres. Doubtful if Radical Extirpation was Successful. Operative Cure. Complete Disappearance of All Symptoms.*

A boy, ten years of age, became ill, when eight years old, with pains in the back of the head. These were occasionally attended with vomiting and fever, becoming more and more frequent. Later on bilateral choked disc set in. A short time prior to his admission to the hospital, swaying at walking as well as an uncertainty in the right hand, especially when he was eating, were noted. When admitted (January, 1911), the patient kept his head bent rigidly to the front, and he had to support it when lying down. He resisted all passive motions, especially when attempts were made to move his head backward. The circumference of his head was 54½ cm. The right mastoid process was sensitive to pressure. His pulse was irregular—60 to 64 beats per minute. His respirations were moderately accelerated. There was bilateral choked disc, more marked on the right than on the left side. There was also a slight paresis of the right oro-facialis. The corneal reflex was weaker on the left side than on the right. In the right lateral position, there occurred hyporeflexia of both corneæ.

In the dorsal decubitus marked nystagmus was noted, only when the patient was looking to the right. There was no restriction of the ocular movements. In the left lateral position the nystagmus became more marked, and in the right lateral position diminished. When in the latter position, there was nystagmus when the patient was looking to the left. Convergence-nystagmus was only occasionally observed. The other cerebral nerves showed no deviations.

The power of the right hand was reduced. This was accompanied by slight motor ataxia. The boy was left-handed. Marked unrest was observed when he held his hands extended, showing static ataxia. There was adiadochokinesis of both hands which was more marked on the right side than on the left. The knee-phenomenon was lively on the right side and weak on the left. There existed no other pathologic reflexes. The

power of both lower extremities was normal. A slight to and fro swaying was observed in the right limb.

While the boy stood with his legs somewhat separated, he kept his attitude firmly, even when his eyes were closed. When both feet were brought together, he began to sway, and displayed a tendency to fall to the right. This became more marked when he attempted to stand on one foot or when bending forward.

Based on these findings, *H. Oppenheim* made a diagnosis of "probable tumor of the cerebellum near the median line, more to the right. Concomitant hydrocephalus. Pure hydrocephalus cannot be excluded, but is improbable."

The first stage of the operation was performed on the 29th of January, and the second, on the 4th of February, 1911. After reflecting the osteoplastic flap in a typical manner, both cerebellar hemispheres were found very tense and without pulsations. A dural flap was now fashioned, after the reflection of which the right hemisphere was exposed. It at once bulged forcibly into the cleft, and a superficially situated cyst bursted; its clear contents were evacuated in a stream. Following this evacuation of the cyst (decompression), the cerebellum began to pulsate. Inspection showed that the entire interior of the cyst was represented by a grayish-yellow mass of neoplasm, the consistency of which was somewhat harder than that of the normal cerebellar substance. Complete enucleation was entirely out of the question, on account of the extent of the tumor and the absence of a capsule. As much as possible was extirpated with the scissors. This was commenced on the right side in the sound substance of the cerebellar hemisphere.

While thus advancing forward toward the median line—into the region of the vermis, it was found that the tumor had also invaded this portion of the brain.

In order to reach the left limit of the neoplasm, it was necessary to subject the sinus occipitalis, together with the falx cerebelli, to typical double ligation and division, and the left cerebellar hemisphere had also to be exposed. This showed that the tumor had overreached the vermis and projected into the left hemisphere. The entire visible region of the vermis was studded with tumor-masses. The following characteristics

showed them to be new-formations: Their grayish-yellow color, their firmer consistency, and the fact that they were everywhere beset with cysts of greater or smaller size. As much as possible was taken away of these tumor-masses with the scissors. This was successful as far as both cerebellar hemispheres were concerned. In the region of the vermis, on the other hand, a number of remnants, that could not be enucleated on account of the close proximity of the fourth ventricle, had, in all probability, remained behind.

The loss of blood was slight, and only three vessels of the cerebral substance had to be ligated. The extirpated tumor-masses, put together, represented the size of one cerebellar hemisphere of this patient. In order to insure absolute decompression, the bone-plate was removed. The dural flap was now reposited, and regardless of the very large cavity that remained in the right cerebellar region, the flap, composed of soft parts, was sutured into place without drainage.

Healing of the wound progressed without disturbances, with the exception that until the 13th of March, a profuse discharge of liquor necessitated a change of dressings twice daily. From the 12th of February on, the dressings were changed once a day. Only on the 13th and 16th of February, the wound remained dry, and, in the evening of both of these days, the temperature rose to 39.2° and 39°, respectively. The pulse mounted, in one day, to 130, and in another, to 110 beats per minute. A soon as drainage of liquor set in again, the pulse and temperature became normal. It was peculiar that from the 16th of February on, the liquor did not trickle away in its usual clear appearance, but it was very cloudy and contained small, necrotic, and yellowish shreds, that were rich in coagula and fibrin. We were able to express such masses until the beginning of March. This was evidently due to portions of cerebral substance that had sloughed away. They may also have been tumor-rests, and it is not unlikely that the portions of neoplasm that remained behind, had in this manner been eliminated. After the 13th of March, no more discharge was present, and the dressings remained dry thereafter. The boy was discharged on the 21st of March.

Now with reference to the other findings, on the 11th of

February, the choked disc was present in the right eye only. The psychic condition of the patient was perfectly normal. Coarse nystagmus, without restriction of the ocular movements, existed only when he was looking to the right. Slight ataxia was still present in the right hand. Adiadochokinesis was present in both hands but weaker in the left. The power of both hands was normal. The patellar reflex could be elicited on both sides, but on the left, somewhat irregular. Besides these, no other pathologic findings could be demonstrated.

On the 8th of March, the findings in the eyes were normal. At that time the patient was able to sit without experiencing any dizziness, and he could also stand up with some effort. With closed eyes, however, he fell backward. His gait still had a cerebellar ataxic character, but he was able to walk short distances without falling. His pulse-beat was now 112 per minute.

I examined the boy, for the last time, on the 29th of June, 1911. His condition was excellent and he looked the picture of health. He complained of neither headaches nor attacks of vertigo and not the slightest cerebellar ataxia was present. He could walk and turn around with his eyes closed and without swaying in the least. He was able to ride his bicycle with perfect confidence. The ophthalmoscopic findings were normal on both sides. The field of operation was slightly (barely $\frac{1}{2}$ cm.) more prominent than the surrounding parts of the skull. It was soft and showed slight pulsations. When the patient was bending his head backward, this place would become a little more prominent and tense. While so doing, the pulsations were somewhat distinct. All the movements of the upper and lower extremities were free from ataxia. Adiadochokinesis was barely demonstrable in the right hand. The movements of the eyes were normal and the extreme left lateral position could be reached by the patient, but he could not retain it for a long time. When so doing, there were isolated movements of nystagmus. When the eyes were moved to the extreme lateral position on the right side, the nystagmus was slight but more marked than on the left.

### Wide Opening of the Fourth Ventricle

In another instance of neoplasm of the vermis, I was compelled to remove the roof of the fourth ventricle (velum medullare posterior), on account of the complete destruction of this membrane by the tumor. At the conclusion of the operation, the rhomboid fossa lay freely exposed in its characteristic form. To our surprise, the results in this case were thus far excellent. The history follows.

## OBSERVATION VII, 12

*Endothelioma in the Posterior Section of the Superior Vermis. Total Extirpation with Wide Opening of the Fourth Ventricle. The Cerebellar Hemispheres were Placed Over the Rhomboid Fossa for Protection. Operative Cure for the Last Seven Weeks. Observation not as yet Concluded.*

The patient, in this instance, was a young unmarried woman, thirty years of age, who came from healthy stock, and, outside of the usual diseases of childhood, had always enjoyed good health. Lues did not exist. Three years prior to the onset of the present trouble, she disarranged her stomach with cold drinks. This was followed by great abdominal pains, headaches, and vomiting that continued for fourteen days. The headaches, which were mainly localized in the frontal region, have since recurred quite frequently. This was also true of the vomiting. The patient observed that she occasionally saw double—the visual pictures overlapping one another. She gradually lost in weight. Ten weeks of dietetic treatment at a sanitarium improved her to such an extent that she was able to resume her daily occupation. She was a seamstress. However, she never remained entirely free from disturbances since then. In March, 1911, severe headaches recurred again, but they were mainly perceived by the patient in the back of the head, in the left ear, and in the left half of the face. They were accompanied by vomiting, vertigo, and noises in the ears, to such an extent that she was compelled to remain in bed. Later on her memory suffered to a marked degree.

On the 2d of May, 1911, *H. Oppenheim* found the following

conditions: Bilateral choked disc. Slight exophthalmus. Hypalgesia in the left half of the face. Adiadochokinesis in the left arm and in the left lower extremity. Sensitiveness to pressure in the left occipital region. When the patient was reclining in the right lateral position, an areflexia of the left cornea could be demonstrated. When she closed her eyes, she staggered. This staggering was of a hysterical character, as shown by the fact that when her attention was diverted, she did not sway. The symptoms pointed with great probability to the existence of a tumor in the region of the left cerebellar hemisphere. A meningitis serosa chronica could not be excluded with certainty. *Oppenheim*, therefore, recommended to give mercury a trial. He added that if no improvement be noticed within a period of from three to four weeks, and above all, should the visual power begin to fail, to at once subject the patient to an operation.

On the 6th of May, *Oppenheim* found the following conditions: Pain in the region behind the left ear and in the occiput. At rest, or during the usual movements of the eyes, no nystagmus was present; extreme left lateral position of the eyes, however, was carried out by the patient with difficulty, and was accompanied by a slight rotation-nystagmus. There existed hyporeflexia of the left cornea that was now entirely uninfluenced when the patient assumed the right or left lateral position. Her statements with reference to the sensations of pain in the region of the face were very uncertain. The left half of the face, however, appeared somewhat hypalgesic, and the hands were free from ataxia. Adiadochokinesis in the left hand was distinct. The tendon phenomena were equal on both sides and were not very active. The lower extremities showed no pathologic reflexes. When the patient opened her mouth, the lower jaw was seen to slightly deviate to the left side. Behind each ear, a swollen gland was found which was larger on the right side than on the left. A number of other enlarged cervical glands were found, but they were smaller than those behind the ears.

Since the inunction cure was entirely unsuccessful, the patient requested us to discharge her. Her request was complied with, and she left the hospital on the 9th of June. *H. Oppenheim* examined her on the 16th of June, and reported that the findings were somewhat changed. "The slight local manifesta-

tions are limited to an areflexia of the left cornea, when the patient is in the lateral position, and to adiadochokinesis of the left hand. A diagnosis of tumor in the left posterior fossa of the skull may be made from this symptomatology with a certain degree of probability, yet we must bear in mind that a simple meningitis serosa chronica may also give rise to a similar clinical picture. Since the power of vision is constantly getting worse, and since the general condition of the patient is gradually, but surely, on the decline, the only thing that remains to be done is operative intervention. I recommend exploratory trephining over the left cerebellar hemisphere. If this be found negative, puncture of the ventricle should be performed."

The patient was trephined in the region of the left posterior fossa of the skull, including the crista occipitalis, on the 23d of June, 1911. The second step of the operation was undertaken on the 30th of June. Osteoplastic resection showed the left cerebellar hemisphere to be so tense, that while the dura was being incised in the usual manner, the cerebellum bulged into the opening with such terrific force that the arachnoid and pia were torn. Approximately about 150 $cm^3$. of a clear liquor was projected in a strong stream from the arachnoid meshes, on making the usual median incision of the dura with the scissors. The formation of the dural flap was quickly completed and was then reflected downward. This brought to view a yellowish-red tumor, the granular surface of which resembled a blackberry. It was situated posteriorly and below in the region of the superior vermis. In order to expose the tumor on all sides, the upper incision had to be enlarged, and after detaching the soft structures, a margin of about 2 cm. of bone had to be taken away from the right border of the wound. The dura overlying the right cerebellar hemisphere was now incised below the sinus transversus, and the falx cerebelli, together with the sinus occipitalis, were ligated and divided in the usual manner. The tension had now completely disappeared, and the brain receded from the dura. Typical division of the sinus occipitalis and the falx cerebelli between two ligatures rendered the entire region of the vermis freely accessible.

The tumor was situated exactly in the median line below, toward the medulla oblongata. It was covered by the arach-

noid, which was of a grayish-white color. *In situ,* the neoplasm represented an exposed surface, 2 cm. wide. Its height could not be exactly ascertained on account of its deep position toward the medulla oblongata. It is estimated, however, that it was at least 3 cm. high. After the arachnoid had been removed, and in order to obviate the troublesome hemorrhage that might otherwise obscure the field of operation, we attempted to enucleate the tumor from below. This was done with small gauze sponges held in the grasp of blunt-pointed dissecting forceps. A very large tortuous vessel, about 2 mm. in diameter, was seen coming from the left side; it was, in

Fig. 134
$\frac{3}{4}$ natural size

all probability, an artery. (See Fig. 134.) This vessel was treated by double ligation with a *Deschamps* needle and then divided between the two ligatures. At this step of the operation, a slight quantity of liquor was still seen to drain away from the arachnoid meshes. The tumor was now carefully enucleated in the manner described above. This could be done with facility, on account of it being encapsulated, and because its consistency was considerably firmer than that of the contiguous brain substance. The measurements of the extirpated

tumor were as follows: Its length, from above downward, was over 40 mm.; its thickness, from the front backward 25 mm.; its transverse diameter was 30 mm. The neoplasm was situated

Fig. 135
¾ natural size

between the inferior vermis and the left hemisphere, and was of the size of a walnut. The slight hemorrhage from the bed of the tumor was arrested by light gauze compression. After the sponges had been removed, *the fourth ventricle lay widely exposed,*

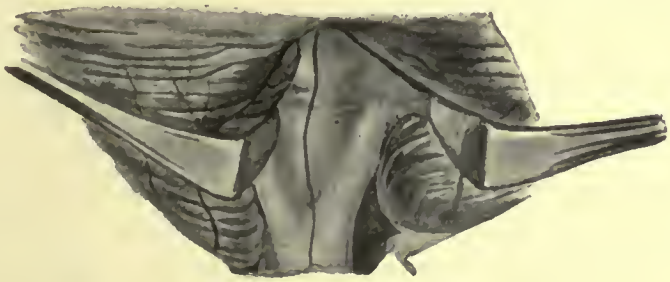


Fig. 136
¾ natural size

*and the rhomboid fossa was recognized by its characteristic form, and it could be very clearly examined.* The tumor was, therefore, situated in the roof of the fourth ventricle, and the velum

medullare posterius had been removed together with it during the enucleation.

The rhomboid fossa was next carefully examined for tumor remnants. This was facilitated by gentle separation of the crura cerebelli ad medullam oblongatam with two brain spatulæ (see Fig. 136). This showed that the tumor had been completely extirpated.

For the protection and covering of the rhomboid fossa, both cerebellar hemispheres that remained uninjured, together with the pedunculi cerebelli ad medullam oblongatam, were placed

Fig. 137
Semidiagrammatic—$\frac{3}{4}$

over it from both sides, so that only a narrow slit remained visible of the fourth ventricle. The small plate of bone that belonged to the left posterior fossa of the skull was removed, and the dura reposited in the following manner. The divided falx cerebelli was first deflected upward in such a manner that the small open place of the rhomboid fossa was completely covered by it. It was temporarily retained in that position with vulsella. Both lateral flaps of dura were kept upward in the same manner, and while the head of the patient was in a hyperextended position, the musculo-cutaneous flap was sutured into place. Drainage was dispensed with.

The microscopic examination (*Chief Physician Dr. E. Heymann*) showed the following conditions: (*a*) The structure of the tumor was made up of a stroma that showed numerous branch-

ing lymph-spaces; (*b*) the walls of these places were lined with a single layer of cells of various heights. The architecture of the tumor, as a whole, closely resembled that of alveolar carcinoma. However, on account of the great number of lymph-spaces present, it had to be looked upon as a lymphangioma plexiforme. Brain-tissue was nowhere to be found. Between the various parts composing the tumor, colloid masses were found in places. Diagnosis: *Lymphangioma plexiforme* (*endothelioma*). The microscopic pictures closely resembled those described in Observation XI, 3.

Despite the exposure of the rhomboid fossa, there occurred on the day of the second operation or in the further post-operative course of the case—no disturbances of respiration or cardiac interferences. On the sixth day after the operation, the evening temperature rose to 38.2°. On one occasion after the first operation, it also mounted to 37.6°. The average range of temperature, however, during the first ten days, was between 36.5° and 37.9°, then returning again to normal. Slight fluctuations in the pulse-rate were also observed, but its frequency was never above 100 beats per minute; it ranged on the average between 80 and 90 beats per minute. After the second operation the wound healed smoothly. In the first few days following the operation only a moderate quantity of liquor drained away, and the dressings had to be changed daily. On the eighth day, only the layers of gauze nearest the wound were saturated so that the dressings could remain undisturbed for three days after most of the sutures had been removed. The remaining sutures were removed on the twelfth day.

Our attention was called to the fact that on the fifth day the patient did not recognize her relatives, and she occasionally interchanged the identity of persons, and displayed hallucinatory manifestations. This condition lasted until the eleventh day post-operationem, and during all that time it was of changing magnitude. During the ninth night after the operation, while unobserved, she removed the dressings from her head, because, she said "the upholsterer wanted me to do it." Since, however, the wound was healing per primam, no harm resulted from disturbing the bandages. Later on, the psychic disturbances disappeared.

On the 3d of July, the patient complained of a sense of deafness and of weakness in the left arm and in the left lower extremity, as well as of weakness in her whole body, and of a sensation of dizziness. No objective findings were present to account for these disturbances. She also stated that she had an inclination to nausea and vomiting—this, however, did not correspond with her appetite which was very good. On the 8th of July, the choked disc of both sides was already receding, and the nystagmus on looking laterally could no longer be elicited. Adiadochokinesis and decided ataxia were present in the left upper extremity. On the 12th of July, the findings of *Oppenheim* were as follows: The somewhat restless patient had all sorts of complaints that were mainly of an illusionary character. Objectively, the choked disc of the right eye was very much better, and on the left it had partly disappeared. When she was looking to the right, nystagmus was still distinctly present, and there was also a restriction of ocular motion. The corneal reflex could be promptly elicited on the left side. A slight degree of ataxia could still be demonstrated in the left arm.

On the 15th of July, 1911, all subjective complaints of the patient had become much less. The dressings remained dry. She was of better mood, and her complaints were only of slight nature.

From the 15th of July to the 9th of August, the general condition of the patient improved in so far that her appetite was better, the headaches and sensations of weakness were not as intense as before, and she could sleep nights without resorting to soporifics. On the 20th of July, a cerebral prolapsus, the size of a pea, was noted, in the left upper angle of the wound, that gradually became larger, and that, on the 9th of August, was the size of a hazelnut. At the summit of this protrusion, a distinct punctum was observed, from which liquor was dropping. When moderate pressure was applied to the healed skin-flap, the liquid was ejected in a stream. On account of the profuse drainage, the dressings had to be changed twice a day. When it occasionally remained dry for a couple of days, the headaches became more intense, and the patient vomited morning and night. She would then complain of alternating sensations of heat and cold all over her body, and of weakness in the left arm

and in the left lower extremity, and the admission of light into her eyes, she said, was painful. A few days later, the patient was able to leave her bed and remain in a reclining chair, for half an hour. She was too weak as yet to sit up for a longer time.

From the 22d of July on, the temperature-curve still showed fluctuations and remissions somewhere between 36.5° and 39°. From the 6th of August on, the temperature was again normal (never over 37.2° in the evening). The patient was able to sit up in bed by herself without experiencing the slightest sense of vertigo. An examination by *Oppenheim*, on the 9th of August, showed that a trace of ataxia and tremor was still present in the left hand, and that there was also distinct adiachokinesis, which was of slighter degree. The prominence of the papillæ could no longer be demonstrated by the ophthalmoscopic examination. The sensitiveness to light still persisted. When she stood up, she complained of dizziness, became pale, and said that she felt very weak. Her respirations were regular and the pulse became more frequent but of smaller volume, rising from 80 to 112 beats per minute.

There was a marked improvement in the general condition of the patient after the 10th of August. Her disposition and appetite were good, the headaches and sensation of dizziness had disappeared, and she complained no more of the dazzling effect of light. The pulse-rate was 76 per minute, and the temperature, 36.8°. This remarkable improvement progressed hand in hand with the disappearance of the flow of liquor and marked diminution of the size of the prolapsus, and at the time of the conclusion of this work (20th of August) the condition of the patient was good.

The fact that the fourth ventricle may be widely opened without inviting immediate danger to the life of the patient is much the more remarkable when we think of the vital nervous elements that are situated in the floor of the rhomboid fossa. The good result obtained in the case just detailed is, in my opinion, due to the fact that immediately after the neoplasm had been extirpated, the rhomboid fossa was at once closed by placing over it both cerebellar hemispheres and the dura. This

mode of procedure had forestalled a secondary post-operative softening that, if present even in the mildest form, would undoubtedly have led to the death of the patient. In a previous case, where I was obliged to open the aquæductus *Sylvii* on account of a similar neoplasm, I permitted a small gauze tampon to remain, on account of considerable hemorrhage that followed the operation, and while the post-operative course was excellent for the first five days, the boy suddenly died of general spasms seven days after the operation; the gauze had been removed two days before. In this case, the deathly spasms were undoubtedly brought about by the softening that followed the pressure and irritation exercised by the tampon on the pyramid and the medulla oblongata. In view of my experiences, I must state very emphatically once more that the operative wounds of the brain and spinal cord should at once be closed by primary suture. This, of course, must be done under the strictest possible asepsis. Only in this manner can the dangers following such operations be avoided. The case of the boy just referred to follows in detail.

## OBSERVATION VII, 13

*Cystic Sarcoma in the Left Cerebellar Hemisphere and the Vermis. During the Extirpation, the Widely Dilated Aquæductus Sylvii was Opened Into. Post-Operative Course for Seven Days Excellent. Sudden Death from General Spasms.*

The boy, in this case, was eleven years old at the time of the operation. Three months after sustaining an injury by falling on the back of his head, he began to suffer with vomiting, headaches, and diplopia, as well as weakness in the left lower extremity. When admitted to the hospital, the same morbid manifestations so often described (choked disc, tremor, and ataxia of the extremities) pointed to a neoplasm in the posterior fossa of the skull with especial participation of the left side. Soon after the exposure of both posterior fossæ in typical fashion, the reflection of the dural flap at once disclosed numerous hollow places of various sizes which were surrounded by thin layers of cerebellar substance, and after they were opened, were seen to communicate with one another. These cavities

were filled with dense masses of a brownish-red color, which were at once pronounced as neoplasms. Toward the upper, lower, and the median surface, the nodular new-formation gradually faded into the pale waxy-yellow cerebellar substance. The latter had evidently undergone cystic degeneration in the vicinity of the tumor. The latter was located in the median section of the left cerebellar hemisphere and in the region of the vermis. Its hard consistency permitted the index finger to outline it in all directions from the surrounding softened cerebral mass. It extended very deeply, and after it had been detached from the parts surrounding it, and brought to the surface, a funnel-shaped space, measuring 9 cm. in depth, remained behind. The point of this funnel was directed to the front and above, and its end corresponded to the median line. It terminated in a canal, the thickness of a goose-quill, which from its position was recognized as the aquæductus *Sylvii*. A continual stream of waterlike liquor issued from it. The deeper walls of the entire cavity were also composed of narrow lamellæ of cerebellar substance that were beset with numerous cystic spaces and clefts. The length of the extirpated tumor measured 6 cm., and was 4 cm. thick.

On account of the profuse venous hemorrhage that followed the extirpation of the tumor, which could not be controiled, despite the ligation of a few stout veins, I was obliged to compress the bleeding areas with strips of gauze. This was done in order to avoid the prolongation of the operation that would necessarily be required in ligating all bleeding points—a procedure which the critical condition of the patient did not permit at that time. The cerebellar tissue, that had undergone cystic degeneration and was now hanging on the flap of dura which had been reflected downward, was removed without difficulty. Outside of the small space that permitted the egress of the tampon, the rest of the wound was closed with sutures.

The post-operative course for the first five days was excellent. For the first twenty-four hours, the patient complained of slight general headaches, and he vomited only a few times. The dressings were continually saturated, so that the upper layers had to be frequently renewed. On the fifth day following the operation, the boy felt so well that he wanted to get out of bed,

and he asked for some fruit. The wound was at that time healing perfectly well without any signs of irritation, and the temperature was normal. His pulse, however, was still ranging between 116 and 120 beats per minute. I now removed the gauze packing. This was followed by the evacuation of a large quantity of clear liquor. On the day following this dressing, the general condition of the patient was as good as heretofore. About noon of the following day, however, general convulsions suddenly set in that were repeated an hour later in milder form. The patient appeared to withstand these attacks very well. Toward evening, another very severe attack, that lasted a number of minutes and involved the entire musculature of the body set in and soon caused the death of the patient with symptoms of suffocation. This was on the seventh day after the operation.

The post-mortem examination (*Professor Dr. Oestreich*) showed no meningitis and no remnants of tumor-tissue. Careful measurements showed that more than half of the left cerebellar hemisphere was gone. A large defect was also discovered in the region of the vermis, that extended to the front, and that led into the much-dilated aquæductus *Sylvii*. The surface of both of these defects was irregular and segmented, and their interior was filled with clotted blood. The cross-section of the right cerebral peduncle showed it to be softened. All ventricles were much dilated but empty.

### Solitary Tubercle of the Cerebellum

New-formations that offered the most unfavorable prognosis in my series of cases were those of solitary tubercle of the cerebellum; they were not infrequently observed in children. The symptoms produced by these conditions do not essentially differ from those occasioned by other solid neoplasmata. All that we may obtain from the closest possible study of these cases is, at best, a suspicion that we are dealing with a case of tuberculosis. If other tuberculous foci are found in some part of the body, or if we find considerable enlargement of the cervical lymph-glands, especially if limited to one upper lateral region of the neck, our suspicions of the existing trouble are well founded. One of the most unfavorable peculiarities of solitary tubercle is

its frequent multiplicity, e.g., in one or both cerebellar hemispheres, together with foci in the pons or in the cerebrum. After successful extirpation, the danger of tuberculous meningitis faces us. For example, *H. Oppenheim* made the diagnosis of tuberculosis of the brain, in the case of a cuirassier, twenty years of age, in whom I removed a solitary tubercle from the left cerebellar hemisphere, the size of a walnut. It was found to be grown to the dura, and extended close to the sinus transversus, necessitating an upward placing of the base of the dural flap. (See Fig. 138.) The neoplasm was removed together with the dura. After the extirpation, no pulsations were

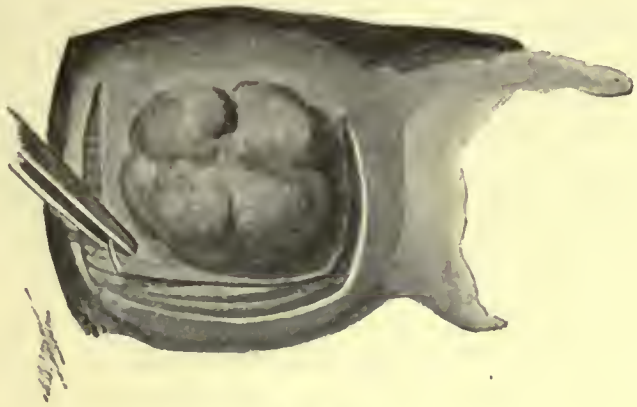


Fig. 138
Tubercle of the Cerebellum United with the Dura. (½)

found in the dura covering the right cerebellum. For that reason, a flap of the latter was fashioned, the base of which was directed downward. After it had been lifted off, a much larger conglomeration of tubercle of the right cerebellar hemisphere was discovered and removed. Soon after this, normal pulsations, synchronous with the respirations and the pulse, were observed in both hemispheres.

On account of the tuberculous nature of the trouble, the cavities remaining from the extirpation of the tuberculous masses were packed with iodoform gauze. The wounds were now sutured and the packings removed on the sixth day. Healing was uneventful. On the ninth day following the operation, the examination by *Oppenheim* disclosed no pathologic findings

outside of a motor weakness of the left lower extremity. The patient was now able to sit up in bed without swaying. Three weeks after the operation, he left his bed and felt well. Although his temperature never exceeded 37.1°, and his pulse was never over 86 beats per minute, there occurred, three and a half weeks after the operation, rises of temperature that would mount to 39.4°, while his pulse-beat became accelerated to 112. Symptoms of basilar meningitis soon became very pronounced, and six weeks later the patient died. The post-mortem examination showed tuberculous meningitis of the entire base of the brain; this was especially marked in the region of the pons, the hypophysis, and the *Sylvian* fossa, and also on the median surface of both lobes. The soft membrane of the convexity of the brain remained unchanged. After the brain was hardened, a series of frontal sections of the cerebrum and cerebellum showed no other tuberculous foci. Both posterior horns, especially the right, were somewhat dilated.

In other cases again, successful extirpation of solitary tubercles caused subsequently the death of the patient from progressive tuberculosis of the lungs or general miliary tuberculosis.

Plate XXXVII, Fig. a, shows the unfavorable findings in a child five years old. In this case, the clinical manifestations were those of an acquired chronic hydrocephalus. On account of the complete absence of focal symptoms, no operation was undertaken. The post-mortem examination showed, outside of a very marked degree of hydrocephalus of all ventricles, the greatest part of the right cerebellar hemisphere to be studded with solitary tubercles, and a tubercle, the size of a plum, was found in the region of the hypophysis.

Similar to solitary tubercles, **gummata** may also give rise to all clinical manifestations of real tumors. Since the diagnosis of this kind of tumor cannot be made with certainty, and since old gummatous processes do not always yield to the influences of mercury and the iodids, operative intervention is to be taken into consideration in these cases also.

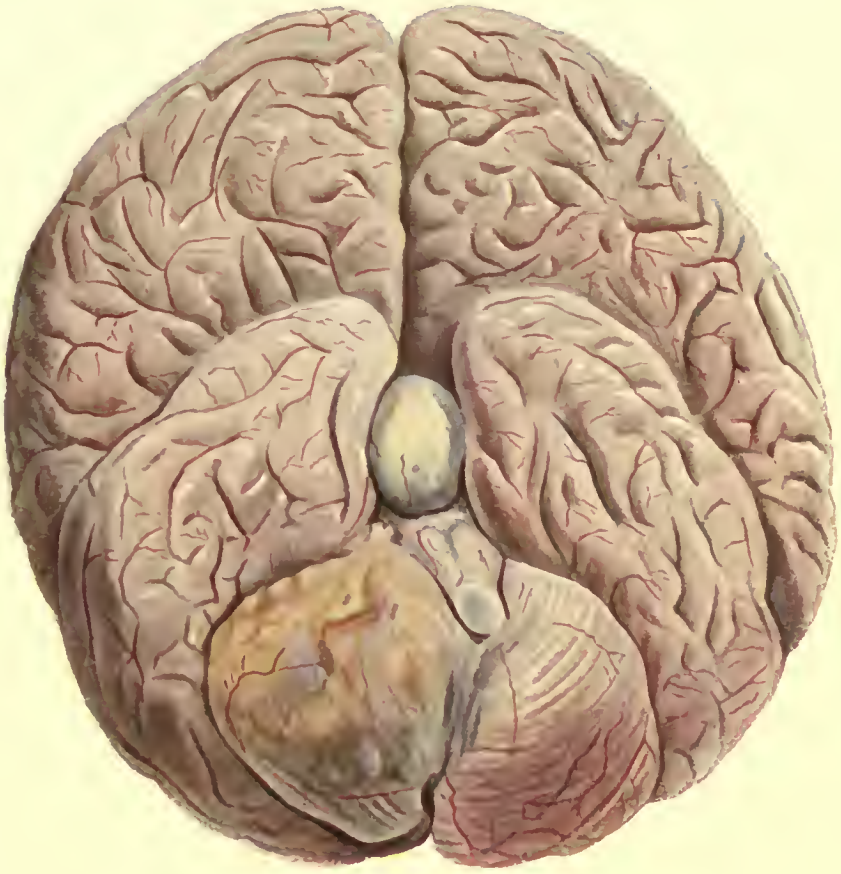


Fig. a.

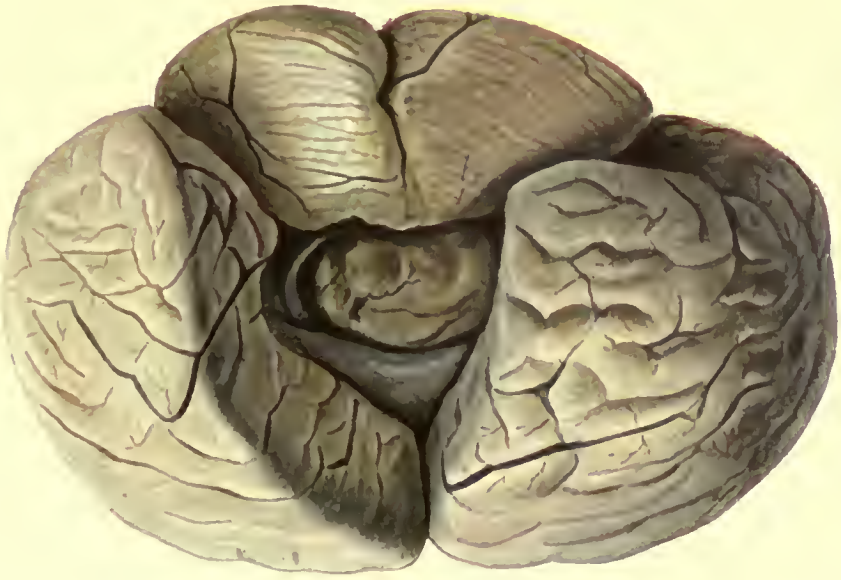


Fig. b.

# Neoplasmata at the Base of the Brain and in the Neighboring Regions

Strictly speaking, neoplasmata of the cerebello-pontine-angle belong to this chapter, because that portion of the brain forms a part of the basis cerebri. However, the clinical and operative peculiarities of that class of cases call for a division of their own. Tumors of large size may develop at the base of the brain, and extending over the edge of the petrous portion of the temporal bone, involve the entire extent of the clivus *Blumenbachii*, and even invade the middle fossa of the skull and give rise to similar manifestations. Guided by the clinical symptomatology, they are usually operated upon via the posterior fossa of the skull. It is to be regretted that only too frequently we find ourselves face to face with inoperable conditions. The following observation illustrates such an instance.

## OBSERVATION VIII, 1

*Trouble Began with Manifestations of Tumor of the Acusticus. Neoplasm at the Base of the Brain the Size of a Hen's Egg in a Cavity in the Pons and the Medulla Oblongata. Operation not Completed. Death After Five Days.*

The patient was a Russian woman, twenty-nine years of age. The symptoms developed in the brief period of six months. They consisted of headaches that were now perceived in the forehead and then again in the occipital region, and of nausea and vomiting. About the end of September, 1905, the gait of the patient became uncertain. She frequently staggered to the right. Since October, her hearing on the left side became affected, and she complained of subjective noises. Since August, attacks of vertigo frequently set in. Convulsions were never observed. On one occasion, the patient became unconscious for two minutes. She frequently swallowed the wrong

way. This she noted since October. She had difficulty to urinate, so that she had to be frequently catheterized. The rapid aggravation of the cephalalgia and the great restlessness caused the patient to come to Berlin and consult *Geheimrat Ziehen*, who referred her to me for operation on the 13th of January, 1906, with the following diagnosis: "Neoplasm in the region of the posterior fossa of the skull. The clinical picture does not correspond entirely to that of tumor of the acusticus pure and simple."

The symptoms pointed to the left side. Before the operation, they were as follows: The examination of the patient at the Charité could still demonstrate choked disc that was more marked on the left side than on the right; this symptom was receding when the patient came under our observation (stage of atrophy). The left pupil was wider than the right, and when the patient was looking to the right, nystagmus was noted. The pupillary reflexes to light were distinct; the convergence-reflex of the left pupil was absent. The motility of the trigeminus was equal on both sides. The sensibility was disturbed as follows: The left half of the tongue and the left hard palate were less sensitive than their opposite fellows. Point was not distinguished from blunt in these situations. The reflexes of the eyelid and of the cornea were present on the right side, while on the left they were totally absent. Participation of the facialis was doubtful or changeable. On the 13th of January, the left naso-labial fold remained behind on motion. The glossopharyngeus was also sympathetically affected to a moderate extent. The sense of taste was blunted on the left side; and on the right it was distinct. The protruded tongue deviated to the right. The examination of the acusticus showed considerable digressions from the normal. The otoscope showed normal conditions in the left ear, but there was nervous deafness. Disturbances of the vestibularis were shown by strong deviation to the right side when the patient was walking with closed eyes. During the *Romberg* test, she invariably fell to the right. The patellar reflexes were more marked on the right than on the left side. *Babinski's* phenomenon was positive on the right. The abdominal-wall reflexes could not be elicited on account of a marked degree of pendulous abdomen.

The first operation, performed on the 25th of January, 1906, consisted of an osteoplastic trephining over the left cerebellar hemisphere. The patient withstood the operation well, but on the day following its performance, a right-sided hemiparesis resulted, that mainly affected the lower extremity. The left facialis was also strongly paretic. However, two days later, the paresis of the extremities was less pronounced. On the 30th of the same month, a neuroparalytic keratitis of the lower section of the left cornea was noted that, under the influence of atropin and protective eyeglasses, soon improved, and on the 5th of February it was as good as cured. On the 8th of February, the wound had healed, and the general condition of the patient was good. An examination of the nervous system was made, the principal result of which was as follows: Right corneal reflex present; left absent. Sensibility of the face unimpaired. Left facialis strongly paretic, almost paralytic. Slight paresis in the right arm and lower extremity. The left abducens did not follow as far as the right.

The second operation was performed on the 10th of February. While fashioning the dural flap, a voluminous stream of liquor cerebrospinalis was forcibly projected from the subdural spaces, and when the flap was reflected, the left cerebellar hemisphere strongly bulged into the cleft created with the trephine. After the liquor had drained off, it pulsated visibly. While the cerebellum was being gently lifted upward with the spatula in order to examine the medulla oblongata as much as possible, the respirations and cardiac action of the patient suddenly stood still, despite the fact that no difficulty was encountered in displacing the cerebellum. With the aid of mechanical manipulations, we were able to restore the heart action and respiratory function again, so that after the lapse of a quarter of an hour, the operation could be resumed without the use of an anæsthetic. and with the patient in the exaggerated *Trendelenburg* position. While elevating the cerebellum with the spatula, from outward and below, toward the inner side and above, a tumor was discovered at a depth of about 68 mm. in the situation of the posterior surface of the petrous portion of the temporal bone at the cerebello-pontine-angle. It had the form of a raspberry, and was of bluish-violet color. At this stage of the operation,

another cardiac collapse set in, the pulse became barely perceptible, small, and extremely rapid. The operation had to be abandoned.

I attempted to extirpate the tumor, but was only successful in removing a piece the size of a phalanx. It at once became evident that the portion removed could not have been the entire neoplasm. Despite all efforts, I found it impossible to accomplish a satisfactory extirpation. On account of the deep position of the tumor, I could not bring it sufficiently to view. The operation was, therefore, interrupted and the wound sutured.

Fig. 139

The condition of the patient following this intervention, was variable. She was always perfectly rational, but displayed symptoms of extreme restlessness. Her pulse fluctuated between 100 and 120 beats per minute, and finally mounted to 130 and 140. It was generally full and of good tension, with the exception of the day of the death of the patient. She expired on the 15th of February with all manifestations of respiratory and cardiac paralysis.

Plate XXXVIII, Fig. b, shows the brain removed at the post-mortem examination. There is a tumor at the base that was entirely inextirpable. Even if we were able to make a

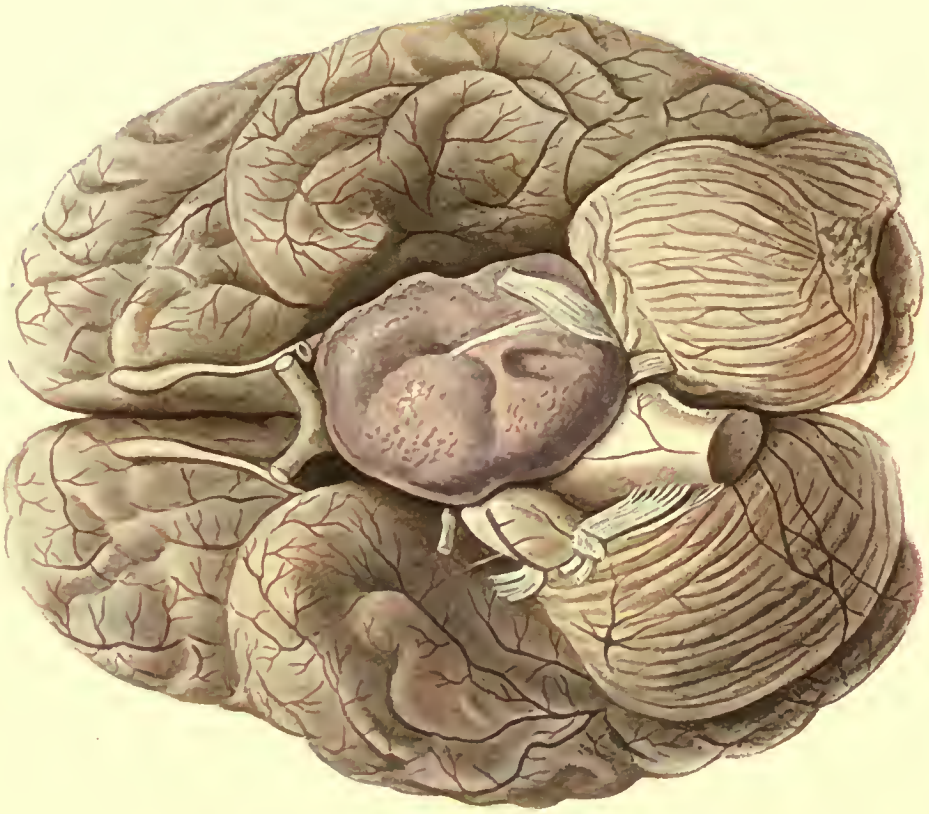


Fig. b.

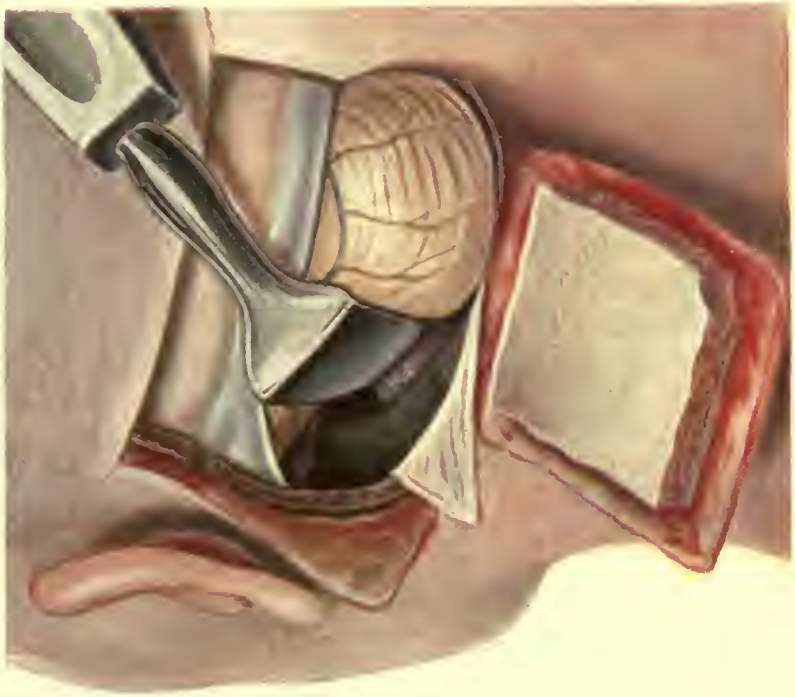


Fig. a.

diagnosis of the great extent of the tumor beforehand an operation via the posterior fossa of the skull would naturally be contraindicated. The size of the tumor was larger than that of a hen's egg (small-celled sarcoma with glia-tissue, very rich in nuclear elements). It had displaced the medulla oblongata sideward and extended to the opposite side and to the front as far as the chiasma opticum. Of the left side of the pons and the pedunculus cerebri, nothing could be seen. The upper section of the medulla was displaced downward and to the right, and it was distinctly flattened. The most remarkable fact, however, was that while the left *Gasserian* ganglion was entirely transformed forming a part of the tumor-mass (see Fig. 139), the woman had, at no time complained of neuralgia of the trigeminus. Anatomically, we were not able to separate the sensory from the motor root. Despite the very large size of the tumor, it could easily be enucleated from its bed without resorting to force, after tearing through its thin cover of arachnoid. Only its position was unfavorable for extirpation, for if its site were different (for instance in the cerebellum itself) it could have been enucleated with ease.

The tumor was separated from the contiguous brain by a delicate membrane that contained vessels (pia). In order to better show the points of exit of the cranial nerves this membrane was removed. After the tumor was taken away, a deep cavity remained (see Fig. 140), the measurements of which were as follows: Width, 43 mm.; sagittal diameter, 58 mm.; depth, 22 mm. All cerebral nerves of the right side could be easily dissected. The oculomotorius was entirely displaced to the side in its middle portion, and the abducens was flatly compressed posteriorly.

The position and form of the cerebral nerves of the left side were more affected by the tumor than those of the right. Their condition was as follows: The olfactorius was somewhat narrower in its posterior portion than the nerve of the right side. The opticus was slightly displaced to the front. The oculomotorius lay at the base of the cavity, flatly compressed—hence vertically displaced. The trochlearis, abducens, and the trigeminus were also flattened by the tumor and displaced downward. These three nerves were displaced in a lateral direction.

The facialis was somewhat flatly compressed, but to a less degree than the acusticus. The accessorius was absent in the specimen, and only the first portion of the hypoglossus was present.

The left half of the pons did not present its usual convexity,

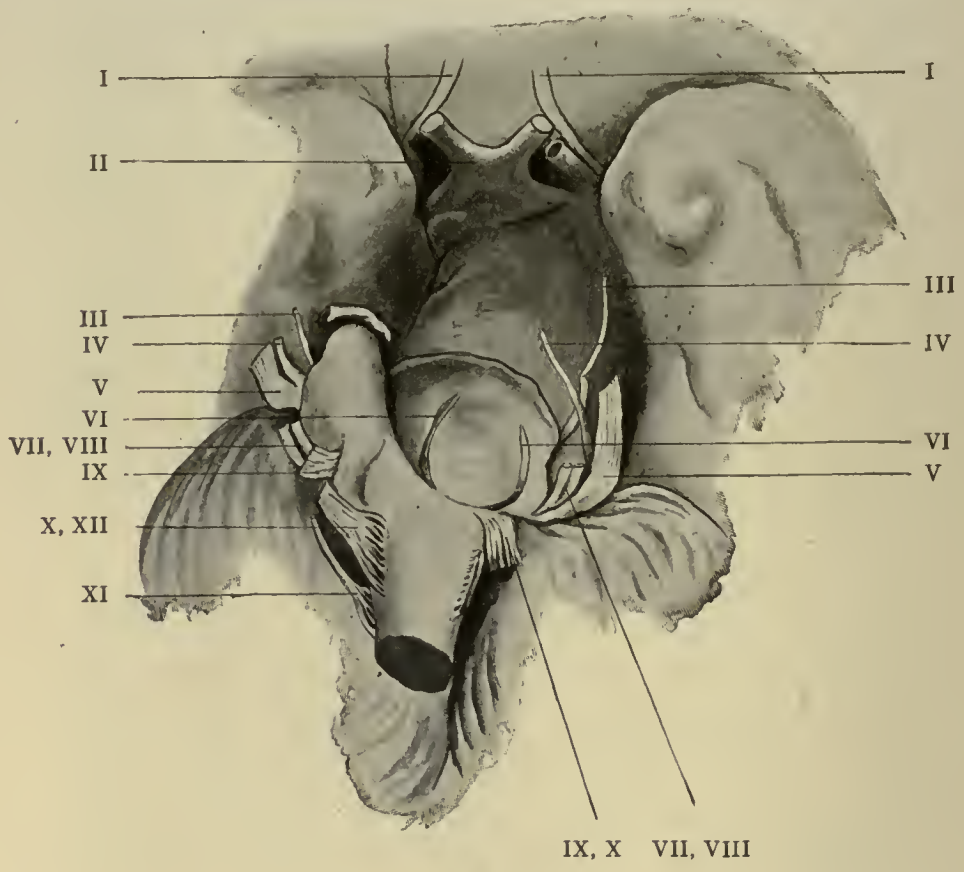



Fig. 140

but in its stead, a deep cavity was found. Its original form, however, although considerably widened (about twice the normal size), was recognizable. The left pedunculus cerebri was similarly caved out, depressed in depth, and widened to about twice its size. The brachium pontis was also caved out and widened. The latter cavity extended a little to the anterior border of the cerebellum. The median portion of the temporal lobe was transformed into a flat cavity.

The anterior portion of the right half of the pons projected 1 cm. above the median line to the right. The pedunculus was also changed like its opposite fellow.

Of neoplasmata met with at the base of the brain, *cholesteatomata* deserve special mention. They are characterized by a very insidious, slow growth that extends over many years, and also by their comparative benignity. An example of this form of new-formation has been detailed above.

### Neoplasmata of the Hypophysis

All tumors springing from the hypophysis also belong in this chapter. Besides symptoms of general cerebral compression that do not always occur, certain neighborhood-symptoms, such as participation of the olfactorius, of the nerves of the ocular muscles, of the trigeminus, and the excavation of the sella turcica seen in the *Roentgen* plate, and the clinical picture of acromegaly described in the *Revue de médecine*, in 1886, by Pierre Marie, as well as manifestations resulting from the interference with the chiasma of the optic nerve are frequently met with in these cases. Pressure exerted by a neoplasm on the latter may totally or in part destroy the conduction of the visual fibres situated at its anterior or posterior angle, as well as those located medially and those that cross. This results in a more or less complete *bitemporal hemianopsia*, e.g., a destruction of the temporal half of the visual field or a part of it. However, this important symptom is, outside of instances of tumors of the hypophysis, occasionally met with in case of very marked hydrocephalus internus, where the floor of the 3d ventricle is bulging downward toward the base of the skull, thus exercising pressure on the chiasma. Just as the sella turcica may be injured from pressure exerted upon it from above, empyema of the sphenoid cavity may also attack the base of the skull and cause an upward displacement in the region of the Turkish saddle, thereby giving rise to an interference with the chiasma that may be followed by hemianopsia.

When, in these cases, the uncrossed lateral bundles are also affected, blindness of the temporal retina and the nasal half of the visual field will result. Incomplete destruction of the lateral fibres of one side will result in total blindness in the eye of the

corresponding side, while in the other the temporal hemianopsia will continue.

Methods for operating on tumors of the hypophysis will be found described in Volume I (see pp. 115–130). Since the conclusion of the first volume of this work, I have removed a large neoplasm springing from the hypophysis in the manner there described.

## OBSERVATION VIII, 2

*Large Sarcoma of the Hypophysis. Removal by the Frontotemporal Route. Regression of the Symptoms of Acromegaly.*

This patient, a saleslady, twenty-nine years of age, had not menstruated for the last eleven years. She attributed her loss of menses to a chloroform narcosis. Five years prior to this time, she noticed a sudden duskiness of her face that lasted about fifteen minutes. From that time on, her visual power began to suffer, and for about three years she was unable to read the newspapers. Her visual disturbance was at that time characterized by the fact that she did not perceive objects that approached her from the side and was therefore frightened by passersby. Her vision was somewhat better on the right than on the left side. During the last three years, her sense of smell had considerably diminished. With the beginning of the visual disturbance, she was frequently suffering from headaches that were mainly located in the temporal region. Dizziness would set in when she turned her head backward. She was never nauseated, neither was there any tendency to vomit. Polydipsia and polyuria were absent. Since the beginning of the disease, the patient had increased in weight, and of late she noticed that her "gloves got too small." Outside of the hands, she also noticed a distinct enlargement of her nose, her tongue, and her feet. Occasionally there also existed macropsia. She frequently complained of formications in the lower extremities. A high degree of mental weakness was noted and she displayed a tendency to somnolence.

The examination made at the end of February, 1909, showed the following conditions: The sense of smell was considerably disturbed. Camphor, oil of cloves, and turpentine were not

recognized at all, peppermint was indistinct, and ammonia, she named correctly (irritation of the trigeminus). There existed a bilateral atrophy of the optic nerve, and bitemporal hemianopsia. The visual power was at that time much worse on the left side than on the right. When the patient was looking to the side a slight nystagmus was occasionally noted. The ocular movements were otherwise free. The pupils reacted promptly to light and convergence. On the left side, only a slight exophthalmus was demonstrable, which on the right side was barely noticeable. The corneal reflex was lively on both sides. Occasionally the macropsia was marked to such an extent that children were mistaken by the patient for grown-up people. The region of the left trigeminus was especially sensitive to pricks with the needle. The other cerebral nerves disclosed no abnormalities. The patient complained from time to time of extremely severe headaches, that ceased when she lay down. She was obliged to keep her head bent forward when suffering from these headaches. Her skull was somewhat sensitive to pressure and percussion. The disproportionate size of her nose, the tongue, the lips, the feet, and especially of her hands, was very striking. Her mental condition showed distinct euphoria. Her nervous system showed otherwise no deviations from the normal. The X-ray picture disclosed considerable widening of the sella turcica.

*H. Oppenheim* made a diagnosis of tumor of the hypophysis. Taking into consideration the findings of the Roentgengram, in connection with the existing bitemporal hemianopsia, the disturbances in the sense of smell, the symptoms of acromegaly, the adiposity, amenorrhœa, and the headaches, his diagnosis seemed probable. The urine was free from albumin and sugar.

On the 2d of March, 1909, I trephined the skull in the right fronto-parietal region. The base of the osteoplastic flap was situated toward the back. The measurements of the cleft were: In the front 96 mm., in the back 85, above 95, and below 92 mm. I was able to undertake the second step of the operation on the 8th of March. After reflecting the osteoplastic flap a large dural flap with downward base was fashioned.

The careful lifting of the frontal brain with the spatula, in the absence of any bleeding whatever, the anterior fossa of the

skull and the posterior border of the lesser wing of the sphenoid, together with the here coursing sinus and the processus clinoideus anterior, were distinctly visible. However, operative manipulations were mainly limited to the anterior fossa. Below the right olfactorius a grayish-red mass was discovered that was the size of a pea and undoubtedly represented a neoplasm. Since

Fig. 141
$\frac{3}{4}$ Natural size

the olfactorius interfered with all forward advance, it was torn through with a pair of dissecting forceps, and displaced to the back. Further elevation of the frontal brain now gradually permitted the appearance of the tumor. This was shown to be a soft, œdematous, infiltrated sarcoma of grayish-red color, that was by no means firm; on the contrary, its consistency was softer than that of the contiguous brain substance. After the

surrounding brain-tissue had been pushed aside by means of sponges held in the grasp of forceps, the tumor was exposed. It was about the size of a half dollar. An attempt was made to pull it forward by means of weak suction applied to it through a glass tube of 20 mm. clearance. While suction brought the neoplasm into the glass, it soon tore, on account of its soft consistency. This compelled us to abstain from the use of suction in this case. The neoplasm was now carefully examined with the index finger. It projected considerably over the median line, and the examining finger felt its lower limit only after it had been introduced to a depth of 8 cm. The finger, aided by the large spoon, was successful in enucleating the tumor, piece-meal. The frontal brain was now carefully lifted up, and the sella turcica, the processus clinoideus anterior of the left side, as well as the eminentiæ capitatæ of the left roof of the orbit, were distinctly visible. The crista galli and the ethmoid bone on both sides were also brought to view.

While the tumor-masses were taken away as much as possible with the aid of the spoon, their soft consistency left room for apprehension that the extirpation had not been radical. Gauze compression was sufficient to arrest the hemorrhage. The dural flap was now reposited, and the osteoplastic flap sutured into its old position. No drainage.

The entire tumor consisted of a somewhat flattened mass, the size of a small kidney, which it considerably exceeded in size, and two nodes of the same consistency, each the size of a walnut, were found attached to its anterior portion. After putting all the pieces together, the total length of the tumor, that had at that time considerably shrunk from the action of the air in the operating-room, was 10 cm., the width of the principal node was 7 cm., and its thickness 4 cm. The surface of the neoplasm was smooth and was surrounded by a delicate capsule. Shreds of cerebral substance were attached in places to its surface. After drying, its consistency appeared somewhat harder than that of the normal brain.

An almost insatiable thirst developed immediately after the operation. On the day following the operation, the urine contained sugar that, on the following day, could no longer be found. The quantity of urine passed *pro diem* was from six to

seven litres. Only after ten days, its quantity diminished, but was still as much as two or three litres a day for a number of weeks subsequently. In the first few days after the operation the patient was extremely restless, but her sensorium was generally clear. On the third day following the operation, a paresis of the left facialis and arm developed, that within the course of a week gradually culminated in a complete paralysis that extended to the left lower extremity. The paretic limbs were hyperæsthetic. The reflexes of the paralyzed side were exaggerated. *Babinski*, *Oppenheim*, and ankle-clonus were present. On the 24th of March, the lower part of the nose of the patient appeared somewhat thinner and softer than before the operation, and on the 28th of March it was not as prominent and thick. The hands, especially the right, became thinner. The lips, which up to this time were thick, showed no signs of becoming normal, as far as motility is concerned. On the 10th of April, the examination of the nose showed absolutely no deviations from its normal form.

In the further course of the disease, states of hyperexcitability would occasionally occur. The patient, who previously was of sedate nature, now became very irritable. Within a period of seven weeks, the facial paresis receded, and the paralysis of the left arm and lower extremity also moderately improved. In April, the patient was found mentally normal, she spoke a great deal, and frequently complained of being very thirsty. This condition remained unchanged for several months. She was discharged from the Augusta Hospital on the 12th of February, 1910. According to the last report, dated the end of December, 1910, her condition is said to have greatly improved. She remained in bed for six months, and would then sit up for hours at a time in a reclining chair, and was able to walk when supported. Her appetite was voracious. Her general psychic condition was very good. She menstruated twice since the operation. On the day of her dismissal from the hospital, the plate of bone in the field of operation was somewhat more prominent than the rest of the skull surrounding it, and was elastic to the touch. I received no information as to the further course of the disease.

Despite the terrific surgical attack that the method just

described incurs, it nevertheless appears to be the only procedure that offers a possibility to successfully extirpate neoplasmata of the hypophysis of considerable dimensions. The observation just detailed proves that the hypophysis and the sella turcica may be rendered easily accessible by my incision. Generally speaking, the surgical attack, in these instances, where the patient is a right-handed individual, should proceed from the right side. The only reason why the tumor in the above case could not be removed in one piece was its consistency (soft sarcoma). A fibroma or a fibrosarcoma of the consistency of a neoplasm of the acusticus could have been easily removed in one piece with the aid of suction. According to the findings in the above instance, coupled with our experiences in the post-mortem room, there is no doubt that the radical extirpation of solid tumors from below after trepanation of the floor of the sella turcica, is obviously impossible. Personal communications with *Geheimrat Ziehen* and *Professor Benda* inform me that neoplasmata of the hypophysis are most frequently of solid nature. Cystic tumors, in this situation, are only rarely met with. It is remarkable, however, that *v. Eiselsberg* and *Hochenegg* have seen the manifestations of acromegaly disappear after curetting masses found in the sella turcica. *Hochenegg* was fortunate to see such results within three weeks after the operation.

My views in the matter are well emphasized by the findings in the case cited below.

## OBSERVATION VIII, 3

*Manifestations of Neoplasm of the Hypophysis. Schloffer's Operation Discloses Marked Thinning of the Bone of the Sella Turcica and Evidences of Tumor-Masses. Death from Respiratory Paralysis. Large Sarcoma in the Right Temporal Region.*

The patient, thirty-five years old, was suffering since January, 1911, with pains in the back of the head that, after continuing for some time, disappeared only to recur two months later with greater intensity and in the whole head. These seiz-

ures became more and more frequent and were occasionally accompanied by persistent vomiting. The attending physician had at the same time found a distinct reduction in the number of pulse-beats per minute (36). The patient, having gone through syphilis three years before the present trouble began, was subjected to an inunction cure that was supplemented by the use of potassium iodide. This, however, did not improve him in the least.

In the last years, the patient had frequently noticed that his nose became swollen; these swellings would continue for weeks at a time and finally resulted in a considerable enlargement of that organ. His relatives corroborated his statements. A few weeks before, there developed a great thirst that was not accompanied by abnormalities of the appetite and no disturbances were observed in the state of nutrition of the patient. His potency was unaffected. The *Roentgen* picture showed a considerable enlargement and flattening of the sella turcica.

The findings of *Oppenheim* were the following: The sense of smell was undisturbed. The nose of the patient was uncommonly thick and long, and the entire region of the arcus supraorbitalis was very prominent; the lids were slightly puffy, the eyebulbs were somewhat prominent (the right more so than the left), and the movements of the eyes were free. The tongue did not appear thickened, and pressure applied to the supraorbital nerves at their points of exit was slightly painful, while pressure applied to the skull did not cause the patient any suffering. There existed a swelling and redness of the papillæ on both sides (papillitis) that was somewhat more marked on the right than on the left side. Visus: l. $\frac{5}{8}$, r. $\frac{5}{10}$. The visual field was normal. The patient did not sway when he closed his eyes. No symptoms of acromegaly were found on the extremities, and neither were there thickenings of the sternum or the clavicles. There existed no ataxia, but a somewhat fine tremor of the left hand could be demonstrated. There was no other nervous manifestations. There also existed a general weakness that was more of an adynamia than a paresis.

*Oppenheim* made a diagnosis of probable tumor of the hypophysis although positive symptoms were wanting. An opera-

tion was advised and the recommendation cheerfully accepted by the patient on account of the torturing headaches.

The operation was performed strictly with the principles laid down by *Schloffer* (see Vol. I, p. 127). The only difference being that I had only to remove the cartilaginous septum of the nose, the superior turbinate bodies, and the ethmoid. The sphenoid fossa was then entered into. After removing the mucous membrane, a flat convexity, measuring at least 1 cm. square, was found at the base of the skull corresponding to the position of the upper wall of the sphenoidal fossa. Pressure with the thumb forceps found this entire area to be elastic. The sensation imparted was that of the *Dupuytren*'s parchment-paper symptom—the characteristic sign of myelogenous sarcoma of bone.

A small sagittal incision through the mucous membrane in the median line, made with a scalpel, 56 mm. behind the root of the bony nose, brought forth a clear liquor that continued to drain away. The thin wall, now made accessible through the incision, could be easily removed on both sides with a pair of dissecting forceps. It consisted of bone the thickness of paper. A mass of grayish-red color presenting the appearance of tumor was now exposed. A moderate venous hemorrhage obscured the field at this stage of the operation. A sponge, soaked in a solution of adrenalin, was pressed against it. After keeping the sponge in this position for a few minutes, a part of the tumor, the size of half a hazelnut, presented into the incision immediately after its removal. As much as possible was now cut away from the presenting tumor with the scissors and dissecting forceps. The removed portion was about the size of the last phalanx of the little finger. Despite the fact that the opening in the sella turcica was as large as the end of a finger, the tumor could not be radically removed through this opening. This caused us to abandon the operation. The basal opening in the dura was packed with a tampon of iodoform gauze (10 per cent.). The tampon was brought out through the nostril, and the incision of the soft parts sutured.

The chiasma was not rendered visible at all. The exposed surface at the base of the skull was in this case uncommonly large. This was evidently due to the action of the tumor on the sella turcica and on the adjacent sections of the base of the

cranium—causing pressure atrophy and downward displacement.

Despite the slight loss of blood the pulse became irregular during the nasal operation, and analeptica were, therefore, continually administered. It then picked up again, but a number of pauses in the respiration were noted even before the dura was opened. The pulse then became stronger and of full volume. The respiratory disturbance made us think of our experiences with neoplasmata in the posterior fossa of the skull, and we thought of the possibility of a large basal tumor in this instance. In view of these disturbances, I expressed my suspicion in that respect even before the dura had been opened. The further course proved my assumption to be true. Two hours after the operation, the patient died with all manifestations of respiratory failure, while the pulse kept up beating quietly and with force until the end.

The autopsy (*Professor Dr. Oestreich*) showed the dura to be moderately tense and transparent and the gyri were flat. Air-bubbles were found in an ascending branch of a large vein in the region of the left fossa *Sylvii*. The anterior pole of the right temporal lobe was intimately blended with the inner surface of the dura in the middle fossa of the skull and very hard. Cross section of this locality disclosed the presence of a neoplasm, the size of an apple which was very hard in consistency, grayish-red in color, and discolored in stripes. The hypophysis was absent, and in the region of the olfactory nerve, small parts of cerebral tissue were missing. The arachnoid was everywhere delicate.

The opening in the base of the skull corresponded exactly to the position of the sella turcica and was the size of a quarter of a dollar. The chiasma as well as the basal nerves were uninjured. The cleft extended on both sides to nearly a few millimetres of the median side of the opticus at the point of its entrance into the canalis opticus.

The carotis and sinus cavernosus were uninjured. The tumorlike protrusion in the field of operation was shown by the microscopic examination to consist of hypophysis and prolapsed brain substance.

After a few days of hardening in formalin, the section of the

brain was completed. The tumor was then seen to have commenced immediately on the surface of the brain. It was situated entirely to the front at the most anterior portion of the pole of the temporal lobe very close behind the frontal brain. Had the operation been performed via the right side of the skull, the surface of the dura, with which the neoplasm was intimately connected, would naturally present itself at once. The formation of a flap of dura and traction upon it caused the tumor to be pulled out from the surrounding softened brain-tissue. Its size was that of an apple, and its surface facing the brain was nodular. It was completely encapsulated and could be enucleated with facility. Its radical removal could have been accomplished with ease. The posterior half of a trephine opening described above (see Fig. 141, p. 794), would have undoubtedly exposed almost the entire basal portion of the tumor.

The microscopic examination showed that we were dealing with a spindle-celled sarcoma. The hypophysis was the size of a bean, grayish-red in color, and showed microscopically no deviations from the normal. The changes in the region of the sella turcica, as well as the symptoms of acromegaly, have in this instance been occasioned by hydrocephalus of the third ventricle. No local manifestations occurred because the neoplasm developed in a decidedly silent territory of the brain.

This observation teaches more than any amount of theoretic discussion, that had I operated on this man in my original way, i.e., going through the right frontal and temporal region, I would have been face to face with the dura that was covering the encapsulated sarcoma, and, as proven by the post-mortem examination, the neoplasm could have been completely enucleated with ease.

Besides *Schloffer's* operation, described in Vol. I, a new method has been devised by *Oscar Hirsch*,[1] by which it is attempted to reach the hypophysis through the endonasal route. He used this method in three patients, and describes it as follows:

"The mucous membrane of the septum of both sides is anæsthetized with a 20 per cent. solution of cocain, and infiltrated

[1] Endonasale Operationen bei Hypophysistumoren. "Archiv für Laryngologie," XXIV. Band, Heft. 1.

in its entire extent with *Schleich's* solution. The mucous membrane of the septum on one side is now incised down to the cartilage, along the anterior border of the cartilago quadrangularis, and is then detached backward together with the perichondrium from the cartilage and bone with a raspatory. The cartilage itself is now removed about half a centimetre away from its anterior border, by making a parallel incision, care being taken not to injure the mucous membrane of the opposite side, and a raspatory is insinuated between the mucous membrane and cartilage, and the former is detached from the cartilage and bone. The separated branches of a nasal speculum spread both leaves of the mucous membrane and show that a median nasal space has been created, that permits the inspection of the dissected cartilage on both sides. This is now removed with a cartilage knife and the greatest part of the vomer and the lamina perpendicularis of the ethmoid are resected with bone forceps. Thus far, the steps of the operation are identical with *Killian's* submucous resection. In order to expose the anterior wall of the sphenoid bone it is necessary to detach the mucous membrane covering the articulation of the vomer with the sphenoid on both sides. This is easily accomplished. After the detachment is completed, we arrive at the anterior surface of the sphenoid bone, from which the mucous membrane is also lifted off of both sides, and the raspatory will now find its way into the sphenoid cavity. The mucous membrane of the posterior portion of the vomer and the rostrum sphenoidale are next removed with bone forceps, the anterior wall of the sphenoid is broken through by a few strokes of the chisel, the opening in the bones dilated, and the removal of the wall dividing both sphenoid cavities exposes the neoplasm of the hypophysis in its entirety. The chiselling open of the sella turcica and the incision of the dura freely exposes the hypophysis or the hypophysis tumor."

### Neoplasmata Originating from the Inner Surface of the Dura

In previous chapters we have frequently referred to tumors that have originated from the inner surface of the dura covering the cerebral convexity extending into the brain, and have consequently given rise to all clinical manifestations of cere-

bral tumor. Tumors springing from the inner surface of the dura at the base of the brain belong properly to neoplasmata of the base of the brain, and not to those of the base of the skull. For all intents and purposes, a clinical division of neoplasmata that corresponds with the morbid manifestations occasioned by the respective tumors will suffice, and I must add that tumors of the base are most frequent in the middle fossa of the skull and cannot be distinguished, clinically at least, from neoplasmata of the brain proper. An example follows.

## OBSERVATION VIII, 4

*Sarcoma of the Left Middle Fossa of the Skull Originating from the Inner Surface of the Dura. All Symptoms of Tumor in the Area of Speech. Partial Extirpation. Death in Collapse.*

The patient, in this instance, was a man, forty years of age, who had always enjoyed good health. Six months ago he began to suffer from headaches, visual disturbances, and difficulty in speaking. An examination made about the end of May, 1911, showed the presence of choked disc on both sides, aphasia, principally of sensory and amnesic character, paraphasia, alexia, agraphia, and slight paretic conditions in the right side of his body. The latter consisted of a slight paresis in the right lower facialis and of the right extremities with an exaggeration of the right knee-phenomenon and an absence of the abdominal reflex on the right side. There was also sensitiveness on pressure of the skull mainly in the left temporal region, and a change in the percussion-sound of the same side. Symptoms pointing to an involvement of other cerebral nerves, especially the trigeminus and abducens, were absent. There was no enlargement of the glands, but a decrease in the weight of the patient has been noted. *H. Oppenheim* made a diagnosis of tumor located, in all probability, in the region of the left temporal lobe. He concluded his report by saying: "Since the affection of the right side of the body is only slight, and in the absence of hemianopsia, we must conclude that the tumor is relatively superficial in situation. The prognosis, by subjecting the patient to operative treatment, is fairly favorable."

A large opening was trephined in the left temporal region, and a flap of dura fashioned. When this was reflected, a grayish-yellow area, the size of a half dollar, was found in the cortical region in the anterior lower portion of the wound. It was softer than the rest of the normal looking cerebral substance surrounding it. Palpation of the surface offered nowhere any particular resistance. Active rotation of the head of the patient took place while pressing upon this area, and a stream of blood, the thickness of a goose-quill, was projected from the softened region. This was undoubtedly a venous hemorrhage, for no pulsations were noted. Compression with gauze sponges for a few minutes was successful in arresting the bleeding. This also proved the venous character of the hemorrhage. A stout vessel of the pia was now severed between two ligatures, and the cerebral convolutions surrounding the discolored and softened area of the brain were gently pushed aside. During this manipulation, a tumor which was nodular and fairly hard to the touch was discovered with the index finger under the softened area. This region corresponded to *Broca's* centre. Careful exploration of the surface of the tumor with the index finger proved that the neoplasm occupied the entire middle fossa of the skull, and that it extended to the location of the sella turcica.

Aided by the index finger which was introduced in its entire length into the wound, I was successful in detaching the brain from the tumor, but it was so firmly attached to the base of the skull that its separation from it could only be accomplished with much force. At an opportune moment, I was successful in grasping the neoplasm between my index fingers held in forceps fashion, and in removing it. Its size was $7:6\frac{1}{2}:4$ cm. Considerable venous hemorrhage was now arrested by compression with gauze applied exclusively to the base of the skull. The largest part of the gauze was removed at the conclusion of the operation, and only a small strip of it remained *in situ.*

The flap of dura was now reposited over the tampon, and the osteoplastic flap was fastened with fixation sutures. The patient was in a state of profound collapse. While the secondary hemorrhage was only extremely slight, analeptica gradually lost their efficiency, and the patient died, thirty hours after the operation, from collapse. The post-mortem examination, made

by *Professor Oestreich*, showed, after removing the left temporal lobe, that there were many other tumor-masses in the middle fossa of the skull which were inseparably blended with the dura. The neoplasmata also extended into the pole of the left temporal lobe to the extent of the size of a plum. The middle portion of the left temporal lobe was absent. The operation field extended nearly to the left pedunculus cerebri. Both arteries of the *Sylvian* fossæ were thin and showed yellow spots in isolated places. As far as could be determined, on the fresh brain, the island of *Reil* on the left side was entirely unaffected. The pons was asymmetrical and its left side was smaller than the right. The cerebral gyri were everywhere smooth, the sulci effaced, and the dura under great tension. The neoplasm showed on section to be of yellowish-gray-red color, uneven, moist, and firm.

After removing the brain from its osseous case, the base of the left middle fossa of the skull, especially in its median part, was found filled with similar masses of tumor which could not be separated from the dura. Careful inspection of the dura disclosed on its outer surface no tumor-masses of any description. The bones were also free from neoplasm.

Diagnosis: Sarcoma of the dura mater, originating from the left middle fossa of the skull and extending into the left temporal lobe. The microscopic picture was that of a neoplasm, very rich in cellular elements, which were elliptic or spindle shaped, and frequently arranged in strands. Spindle-celled sarcoma.

Cysticerci are also occasionally met with at the base of the brain, which, in the form of a

### Cysticercus Racemosus

may lead to basal cysticercus meningitis. An example of this condition is depicted on Plate XXXIX, on which a two-thirds size of the specimen is shown and also in

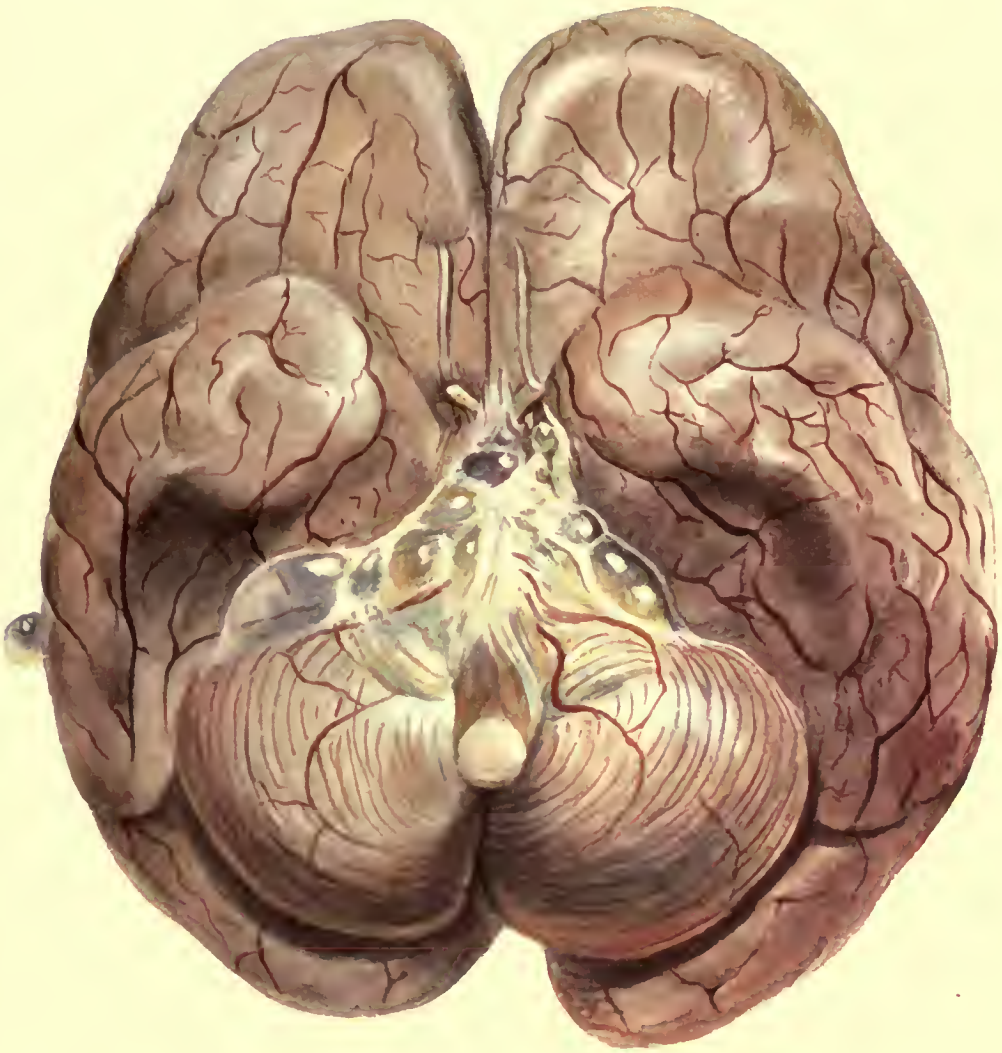
## OBSERVATION VIII, 5

*Manifestations Pointing with a Certain Degree of Probability to the Left Posterior Fossa of the Skull. Trephining (First Stage), Followed by Death from Respiratory Failure. Cysticercosis of the Base of the Brain.*

A farmer, twenty-eight years of age, was attacked by headaches and vertigo while at work in the field, in the summer of 1909. These symptoms became gradually more marked. At that time there were intervals between the attacks, during which the patient felt well. As a result of his staggering gait, and the declining visual power, he was compelled to give up his occupation. He was admitted to the Augusta Hospital about the middle of January, 1910.

His condition was as follows: The sense of smell was decidedly reduced on both sides, more so on the right side than on the left. There was marked choked disc on both sides, with atrophy of the optic nerve on the right. The reaction of the pupils to light and convergence was fairly prompt. Lateral nystagmus, said to have existed prior to his admission, especially when the patient was looking to the left, could not be demonstrated. There were disturbances of the nervus vestibularis; these lasted for a few minutes, during which the patient believed he was falling out of the left side of the bed. The left half of the velum palati was found on phonation to be restricted in its movements as compared with its opposite fellow. The tongue showed slight fibrillary twitchings, and deviated somewhat to the left. The other cerebral nerves showed no disturbances whatever. At this time percussion of the skull was not sensitive, but it was asserted that the left occipital region had, prior to his admission to the hospital, been found sensitive to pressure. *Oppenheim's* reflex was slightly present in the left lower extremity. A slight degree of ataxia could be demonstrated in the left arm and in the left lower limb.

The patient could stand up with difficulty whether he had his eyes open or closed. He displayed a great tendency to fall backward and to the left side. Especially was this noticeable



Rebman Company, New York

when he was requested to turn around. His psychic condition was that of euphoria, and he frequently smiled. No apathy or weakness of the intelligence were noted during this examination, but the psychic state of the patient changed from day to day. At times, the apathy would become very marked, closely bordering on stupefaction. The patient would, at such times, pass his urine involuntarily. At times, in the morning following such states, he would again be found happier, and he took interest in his surroundings.

In explaining the diagnosis of the case, *H. Oppenheim* spoke as follows: "The patient shows manifestations of an affection of the brain that points either to a neoplasm or to a chronic serous meningitis. Taking it as a whole, the assumption of neoplasm is the more probable. The location of the tumor is also uncertain; yet, many factors speak for the posterior fossa of the skull (the occurrence of vertigo and disturbances of equilibrium, the marked degree of choked disc, lateral nystagmus, especially when the patient was looking to the left, falling to the side when the eyes were closed, and sensitiveness to pressure, especially in the left occipital region). On the other hand, there are a few circumstances that speak for an affection of the right lobus frontalis. These are: Marked apathy, somnolence, and weakness of the intellectual power, the early onset of atrophy of the right optic nerve, and an evident anosmia of the right side of the nose. Taking the whole symptomatology collectively, and in view of the threatening blindness, I would recommend decompressive trephining over the left cerebellum, and exploration of this area."

The first stage of the operation was performed on Jan. 25th. Two days later the patient died from respiratory paralysis.

The post-mortem examination (*Professor Dr. Oestreich*) showed the vault of the cranium to be very thin and rough on its inner surface. The arachnoid was free from suppuration. A cysticercus cyst, the size of a pea, was found about the right temporal lobe. In the region of the chiasma and the pons, the arachnoid showed a yellowish-gray infiltration with oblong and branching cysts. The more detailed findings of the brain (see Plate XXXIX) were reported to me by *H. Oppenheim* to be as follows: "The gyri and sulci of the convexity of the

brain show nothing abnormal. The meninges at the base of the brain from the medulla oblongata to the chiasma are very cloudy and thickened, and, in part, transformed into a yellowish, greasy membrane which is permeated with cysts of various sizes.

Two of the largest cysts (larger than a bean) were found symmetrically situated in the region of the cerebello-pontine-angle, between it and the mediobasal region of the temporal lobe. The right cyst (the largest of the two) is entirely transparent and hangs on a few very delicate threads of arachnoid. The stoutest thickenings and deposits are mainly found on the basal surface of the pons. The olfactorii are also affected. Some coagulated blood is to be found on the basal surface of the cerebellum. A cyst, the size of a cherry, is attached to the meninges of the lateral surface of the right lobus temporalis. Frontal section, anterior to the chiasma, shows the ventricles to be much dilated, and a large quantity of liquor together with a number of fair-sized cysts are evacuated."

An examination of the internal organs disclosed nowhere the presence of cysticerci. The cause of death was, in all probability, due to respiratory paralysis shown by the pulmonary conditions found (multiple atelectases of the lower lobes, hemorrhages into the pleura). There was also a mild degree of fatty degeneration of the myocardium and slight dilation of the right ventricle. Otherwise, the findings were negative.

## Operations on the Brain-Stem and in Its Neighborhood

Under the term brain-stem are included the medulla oblongata, the pons, the cerebral peduncles, and the corpora quadrigemina. Since these structures have thus far not been subject to surgical treatment, I shall not enter into a discussion of the symptomatology produced by their involvement in morbid processes. However, it may suffice to point out here that the principal manifestations caused by disease of the brain-stem are those of involvement of the cranial nerves in the most varied forms of combination; the only exception to this may be found in the olfactorius or perhaps in the opticus.

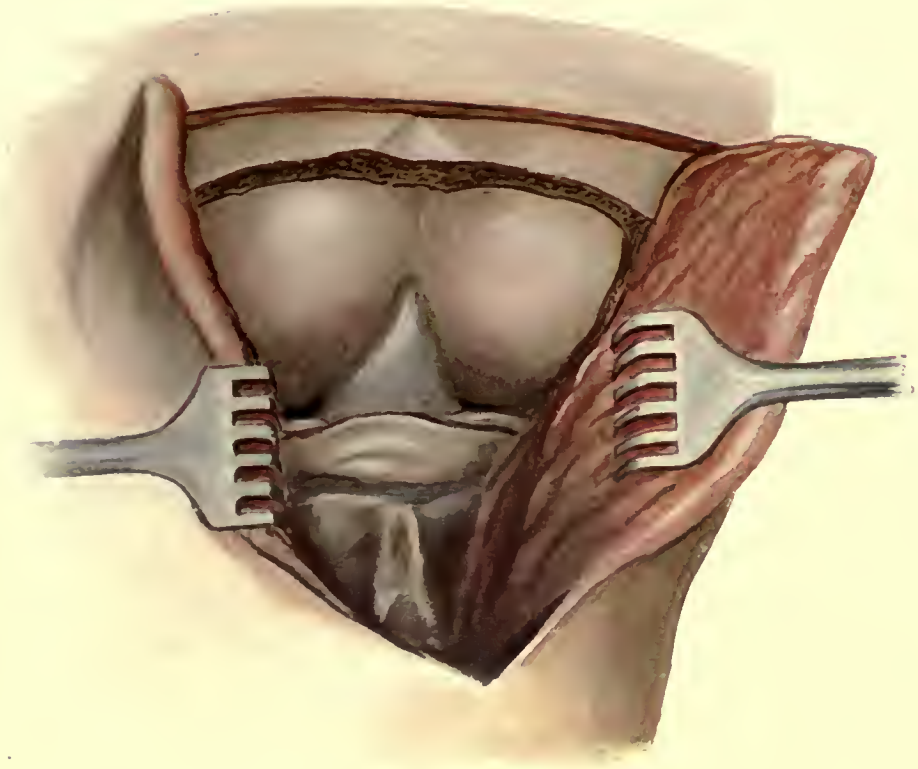


Fig. a.

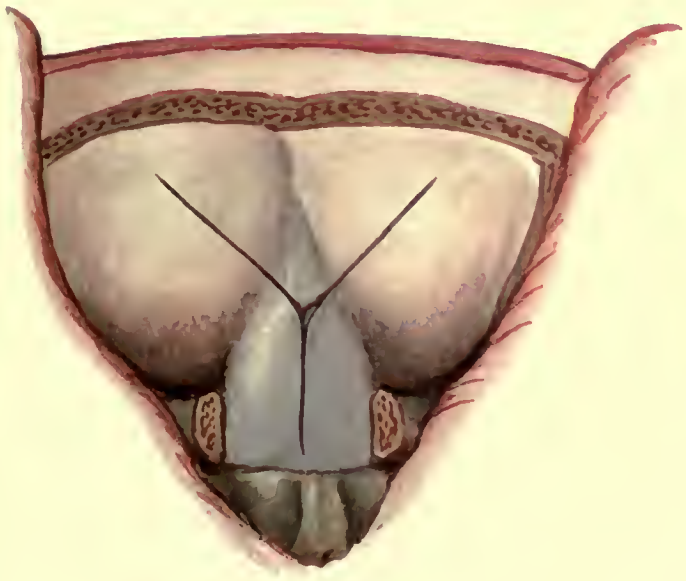


Fig. b.

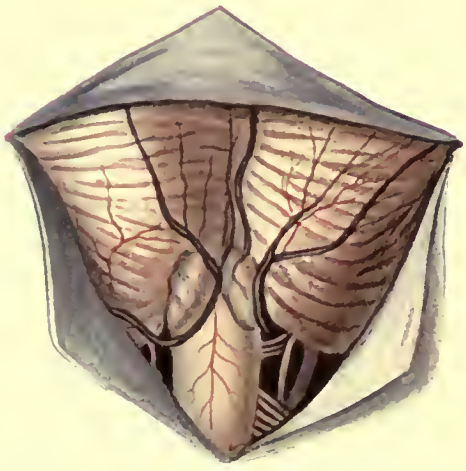


Fig. c.

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### Exposure of the Medulla Oblongata

If we contemplate beforehand exposing the medulla oblongata and opening the fourth ventricle, as would be the case, for instance, in an isolated focus of cysticercus, we will have to proceed differently from the procedure described in Observation VII, 12, on p. 771. An incision in the median line, commencing at the protuberantia occipitalis externa, continued to the third cervical vertebra, divides all tissues down to the bone. Care should be exercised with the ligamentum atlanto-occipitale. The upper end of the first incision is joined at right angles on both sides with another one (about 8 cm. long) (see Plate XL). After dissecting the muscles to the side, enough of the lower portion of the external occipital protuberance is removed to expose the median half of the cerebellar hemispheres. The dura is now bluntly detached from the posterior arch of the atlas which is next divided mesially to the arteria vertebralis, with my laminectome (see *Surgery of the Cord*). A piece of bone about 3 cm. in length gained by this division, together with the membrana atlanto-occipitalis posterior still attached to it, are next taken away.

We now have before us the medulla oblongata and the cerebellum surrounded by the dura. As much of the latter as covers the medulla is now divided in the median line. At the uppermost point, the incision is continued over the convexity of each cerebellar hemisphere at about an angle of 130°. The length of each of these branches is about 3 cm. The placing of the incisions must be calculated in such a manner as not to touch the sinus occipitalis. When the dura flaps, thus created, are reflected, the upper part of the cervical cord, together with the lower portion of the cerebellum, are brought to view. The anatomic landmarks thus rendered visible are the posterior median fissure, the clava, the funiculus cuneatus, and the roots of the nervus vagus and the accessorius of the cervical cord, the hemispheres and convolutions of the cerebellum, the vermis and flocculus. Section of the vermis in the median line and lateral retraction of its halves opens the fourth ventricle. (Compare Fig. 136.)

### Exposure of the Pons Varoli

The pons Varoli rests on the upper surface of the pars basilaris of the occipital bone. Its lower surface may, therefore, be reached by trephining through the basilar portion of the occiput. Transverse detachment of the soft palate from the posterior border of its hard fellow (if deemed advisable, the removal of a portion of the border of the latter) with strong retraction backward, while the patient is under the influence of an anæsthetic administered by *Kuhn's* intubation method, would afford ample room to carry out the other steps of the operation. We must keep in mind, however, that the large arteria basilaris with its many rectangular branches and accompanying veins are coursing on the under surface of the pons. The narrow space is thereby still more restricted and will barely permit a puncture, with perhaps drainage of a cyst by operating through the base of the skull, to say the least of asepsis that would be difficult or well nigh impossible in this particular region.

Yet, this method is worth mentioning for another reason. It appears plausible that suppurative processes at the base of the brain may be attacked in the manner described, and while no clear-cut indication for such procedure has as yet been definitely established, it is not at all improbable that with the rapid advances made in brain surgery in recent years, this method may be elaborated upon and establish for it a legitimate place in this particular field of surgery.

Up to the present time, tumors of the pons are not amenable to surgical treatment. I have attempted to get to the pons by operating from the side and behind in a case in which I suspected the existence of a cyst. Although no cyst was found, the extensive operation did not harm the patient; on the contrary, it perhaps benefited her by the decompression following the trephining. A brief report of the case follows:

The patient, a girl of seventeen, began to suffer from general weakness and an aural disturbance that terminated, within the brief period of two months, in total deafness. This was associated with a sense of dulness and hypæsthesia, which was followed by a gradually increasing paresis in the extremities of the right side, diplopia and visual paralysis to the left, paresis of the left

facialis and hypoglossus, vertigo that kept the patient in bed, and difficulty in urination. There was no choked disc. This is frequently the case in intrapontine neoplasmata. On the right side, adiadochokinesis, the *Babinski* phenomenon, and exaggerated patellar reflex were present. Repeated examinations of the patient were made by *Oppenheim*, who diagnosed tumor of the left side of the pons. The possibility of finding a cyst in the region of the pons, and encouraged by the requests of the parents of the patient, I decided to operate. The first stage of the operation (trepanation in the region of both posterior fossæ of the skull) was performed on the 21st of February, 1911, and the second step, which consisted of exposing the entire cerebellum and double ligation and division of the falx cerebelli and of the sinus occipitalis, was completed on the 3d of March.

While the large dural flap was being formed, a considerable quantity of liquor drained away, and a large cysterna cerebellaris posterior bulged forcibly into the incision. The arachnoid was torn in order to permit the egress of the liquor. With the patient in the sitting position and her head somewhat thrown backward, both cerebellar hemispheres presented to a very marked degree, and were rendered very accessible.

The entire region of the vermis was next inspected. After ligation and dividing a large and two smaller veins, running from the surface of the vermis to the sinus rectus, the inspection could be carried out to great satisfaction. The bystanders, who had never witnessed a similar operation before, were amazed to see how accessible the entire length of the superior vermis (nearly as far to the front as the corpora quadrigemina) was made by elevating the tentorium cerebelli with the cerebral spatula. Neither inspection nor palpation revealed anything of a pathologic nature.

The posterior surface of the left petrous portion of the temporal bone was now made accessible by displacing the left cerebellum medianward. The acusticus and facialis came to view. I was now successful in proceeding forward and medianward, along the upper border of the petrous portion of the temporal bone, close to the attachment of the anterior border of the tentorium cerebelli, until the brachia conjunctiva (crura

cerebelli ad cerebrum) were visible to the extent of over 1 cm. The free, half-moon shaped border of the tentorium cerebelli, situated mesially, was now distinctly visible. No pathologic condition could be recognized. The index finger gliding along the upper border of the petrous portion of the temporal bone for a distance of 6½ cm., discovered neither hardness nor fluctuation. I was able to palpate the pons immediately beneath the brachia conjunctiva; its consistency did not differ from that of the normal cerebellar substance. The pons was finally punctured with a long cannula passed through the brachium conjunctivum, and ½ $cm^3$. sero-sanguineous fluid aspirated.

The patient bore the tremendous operation well. The wound healed without disturbances. At the conclusion of the printing of this work, the girl was still alive, although the paralyses of the other side had commenced to progress.

### Corpora Quadrigemina and Vicinity

Of the other parts entering into the composition of the brain stem, the corpora quadrigemina have not as yet been the subject of surgical treatment. However, as stated before, it may be possible to interfere surgically by attacking that area through the posterior fossa of the skull. The same state of affairs exists with reference to neoplasmata in the region of the posterior end of the corpus callosum. Plate XXXVII, Fig. b, shows how such neoplasmata may be reached by operating from behind, advancing between the cerebellum and the cerebrum. In the case of a girl eight years of age the diagnosis was between hydrocephalus internus and tumor of the hypophysis, an operation was therefore desisted from. On separating the cerebral hemispheres at the post-mortem table, a tumor, the size of a plum, was found under the splenium corporis callosi. After ablating the pia, the tumor was exposed in its entire extent, and could be easily enucleated. It originated in the corpora quadrigemina and had displaced the splenium of the corpus callosum upward, the lingula cerebelli backward, both trochlear nerves running behind the corpora quadrigemina and the crura cerebelli ad cerebrum sideward, and had finally pushed the pulvinaris thalami optici to the front. The pineal body could no

longer be seen. Cross-section of the neoplasm showed that its consistency and color were that of the normal brain. All ventricles, especially the aquæductus *Sylvii* and the fourth ventricle, were considerably dilated.

It may be set down as a rule that neoplasmata in the posterior end of the corpus callosum or in its vicinity, as well as those situated in the roof of the fourth ventricle may, by exercising pressure upon the aquæductus *Sylvii*, easily and rapidly lead to a great accumulation of liquor within the ventricles of the cerebrum. I recall having seen the evacuation of at least 400 $cm^3$. of ventricular liquor from the infundibulum at the removal of a neoplasm in this region. Local symptoms, which may be of great significance for making a proper diagnosis, are, in these instances, overshadowed by the manifestations of the concomitant hydrocephalus internus that dominate the clinical picture. These conditions may of course be present in any tumor of the brain, especially those neoplasmata that are located at the base of the brain and in the posterior fossa of the skull. Whether puncture of the corpus callosum be advantageous in these instances by removing the hydrocephalus, must be established by further experiences. While the advantages and disadvantages of the method introduced by *Anton* and *von Bramann*[1] are still being discussed, I am not according this procedure a separate chapter, but give it here.

### Puncture of the Corpus Callosum

The object of this procedure is to establish a permanent communication between the large ventricles and the subdural space without much injury to the cerebral substance, and, in this way, obtain an equalization of pressure conditions. To accomplish this, the corpus callosum is bluntly divided in its anterior portion close behind the coronary suture. *Von Bramann* used to fashion a flap, on the right side, about 4 cm. square and about 1 cm. away from the sagittal and coronary sutures, and then reflect the flap of dura to the side. After double liga-

[1] *Anton* and *von Bramann*, Balkenstich bei Hydrocephalien, Tumoren und bei Epilepsie. "Münchener med. Wochenschr.," 1908, 11 August, No. 32, S. 1674, and Chirurgenkongress, Berlin, 1909-1911.

tion and division of a few veins of the arachnoid leading to the sinus longitudinalis, he pulled the large hemisphere away from the falx and guided a myrtiform cannula with olive-shaped point along the falx to its lower border, and carefully palpating pushed it forward near the fissura præcentralis, perforating the corpus until liquor appeared in a stream. By guiding the cannula to the front and back, he transformed the opening in the corpus to a longitudinal slit of about 1 to 1½ cm. length, and then withdrew it. He thereupon sutured the dura and the wound of the skin.

Much simpler is the more recent method of making an incision about 3 cm. long, a little posterior to the bregma and somewhat to the right of the median line, down to the bone, the periosteum pushed aside, and the skull perforated with *Doyen's* burr (largest size). Through a small aperture in the dura, the sound above mentioned is introduced between it, and the surface of the brain, carefully pushed forward without injuring the falx, and the operation completed in the above manner. In instances where the large fontanelle is still patent, as is frequently the case in hydrocephalus of large size, this opening is utilized for entering the skull. The incision of the skin and periosteum is, in such instances, made on its lateral border to the right, and the dura is opened in a place free from veins.

This method is made use of in hydrocephalus, neoplasmata with hydrocephalus and stagnation neuritis, also in pseudo-tumor, as well as in certain forms of epilepsy. Its beneficial influences manifest themselves in a disappearance of the symptoms of general cerebral compression, especially the cessation of the headaches, the improvement in the vision, and the postponement of the onset of blindness. It would be of the greatest importance if the hydrocephalus internus, accompanying neoplasmata and obscuring the local symptoms produced by the latter, could be removed, thereby making a topical diagnosis easier. However, the favorable influences of puncture of the corpus callosum are only brought to a successful issue when the subarachnoid spaces possess the ability to resorb the liquor reaching them. This is not always the case, as shown by the following observation.

## OBSERVATION VIII, 6

*Acquired Hydrocephalus Internus with a Cyst Sac Under the Pericranium. Puncture of the Corpus Callosum, Followed by Hydrocephalus Externus, Shown at the Post-Mortem Examination, Two Months Later.*

A child, two and a half years of age (at the time it was admitted to the hospital), was said to have been born perfectly well. At the age of seven months, it was noted that its head gradually grew larger, while the other parts of her body remained free from any disturbances of development. She learned to walk and speak at the age of one and a half years. In the last four weeks prior to the admission of the patient to the hospital, the circumference of the head grew visibly, so that the little patient carried it in the erect position no longer. At that time the mother of the patient noted that the baby was crosseyed. A course of treatment with potassium iodide for an extended period brought no results.

The largest circumference of the head was 77 cm., the length of the nasion-inion-line was 49.5 cm. The forehead was very prominent. The large fontanelle, the size of which was that of the circumference of the palm of the hand, communicated by a cleft in the bone, the width of a finger, with the small fontanelle which was the size of half a dollar. A bag, the size of the head of a child was seated over the right parietal bone. It was covered with skin which was very much stretched, and had the appearance of a hydrocele. It continued downward where it joined another bag of similar size. (See Figs. 142, 143.)

Both bags were covered with a network of large veins that was said to have developed within the last three weeks.

The other status showed, outside of a few signs of rickets, the following: Convergent strabismus, coarse nystagmus on lateral movements of the eyes, normal fundus oculi on both sides, and exaggerated tendon reflexes. Mental disturbances did not exist. The child was able to sit up or stand for a short while. It was also able to move its head freely, and there was

no trace of rigidity of the back of the neck. Its vision and power of hearing were apparently unaffected. These symptoms made it probable that the hydrocephalus was secondary to a neoplasm or to a solitary tubercle.

Since compression did not cause the resorption of the con-

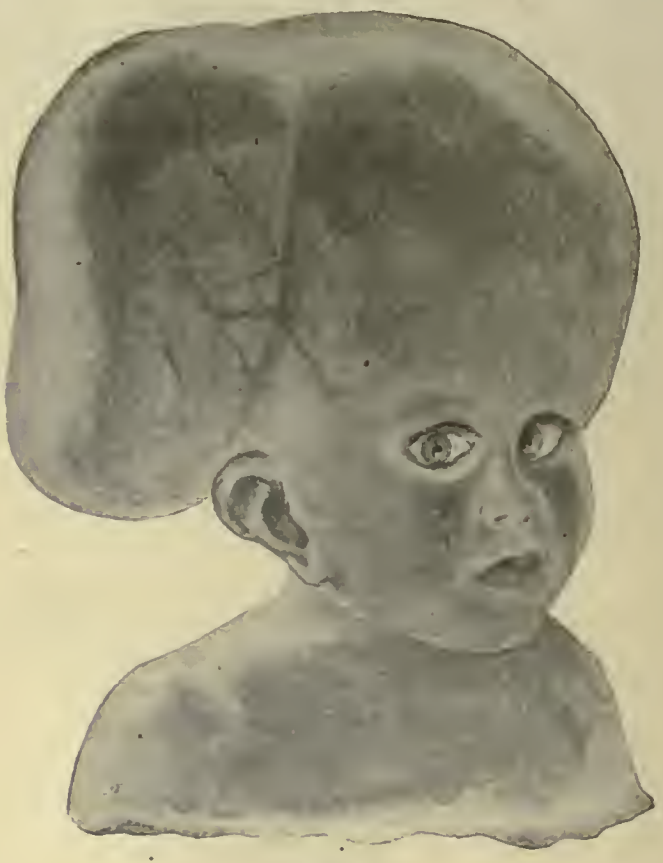

Fig. 142

tents of the bags, subcutaneous puncture with a very long cannula was performed on the 7th of December, 1909, and more than 1 litre of clear liquor evacuated. It was now shown that the floor of the bag everywhere consisted of bone. Only a few days later, the bags were filled again and had to be punctured anew. Aspiration was practised for the third time on the 19th of January, 1910. The last puncture was simultaneous

with puncture of the corpus callosum, that showed that no liquor was present between the dura and the surface of the cerebrum—hence, no hydrocephalus externus. The child withstood the operation well. The temperature subsequently rose some-

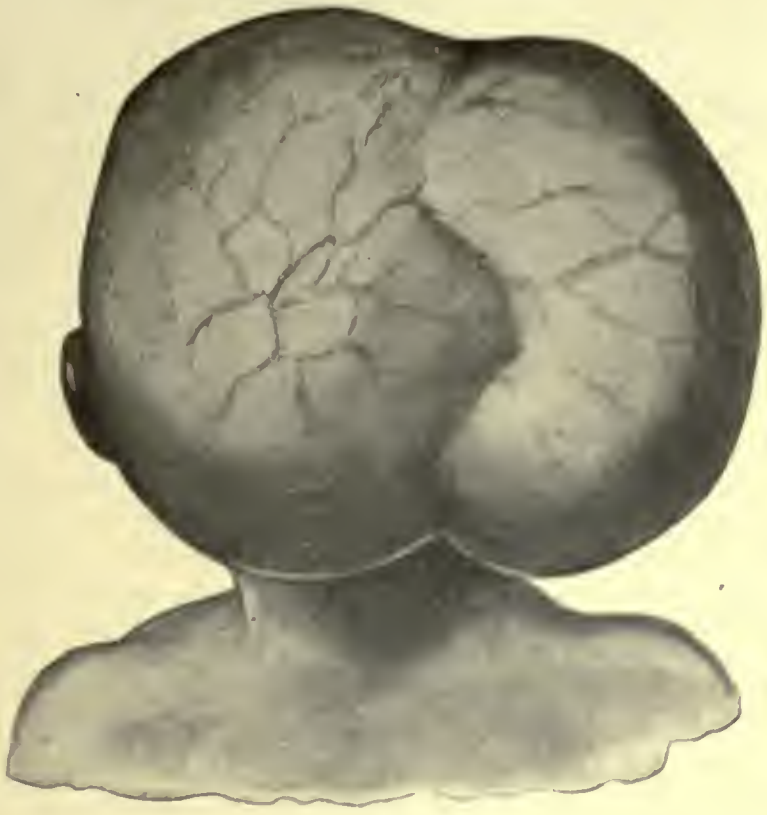

Fig. 143

what for a few days. The general condition of the patient remained good.

Thereafter the bags filled slowly and had to be punctured only twice within the next two months. The little patient became livelier and was at times able to sit up. This was evidently due to the decrease in the weight of the head. Its circumference, however, remained the same. On the morning of the 17th of March, 1910, a sudden rise of temperature to 39°,

set in. The region of the large fontanelle was extremely tense, and slight spasms and twitchings were noted in the upper extremities. Puncture in the region of the large fontanelle was, therefore, resorted to, and a quarter of a litre of clear liquor evacuated. This caused the twitchings to cease, and the child felt better. On the same evening, the temperature rose to 41.1°, and the child suddenly expired.

The autopsy (*Professor Dr. Oestreich*) showed a hydrocephalic cranium of enormous size. In the region of the large fontanelle of the right side a hernialike extroversion of the coverings of the skull was present. The detachment of the dura evacuated a large quantity of clear watery liquor, evidently found between the dura mater and the convexity of the brain. An opening, the size of the thickness of the little finger, through which liquor was draining, was found in the anterior portion of the corpus callosum. The puncture in the corpus did not show any signs of local reaction. The lateral ventricles were enormously dilated and moderately filled with clear liquor. The ependyma was granular. Numerous adhesions were present between the dura and the arachnoid and between both hemispheres. The tela chorioidea in the region of the third ventricle was much thickened. Focal disease of the brain did not exist. There was no suppuration. Slight rickets. All other organs negative.

The puncture of the corpus callosum in this instance was, therefore, successful. The finding of a moderate quantity of liquor in the enormously dilated lateral ventricles, contrasted with the great quantity of liquor (at least three fingers high) in the subarachnoid space, especially over the large cerebral hemisphere. This showed that the diminution in the size of the hydrocephalus internus was accompanied by the formation of a hydrocephalus externus, because the fluid within the subarachnoid space was not absorbed. This observation also teaches that the quantities of liquor entering into the subcutaneous tissues remained also unabsorbed. The method of permanent subcutaneous drainage (see Vol. I, p. 258) would have also proved a failure in this instance. I would like to add here, that gilded silver tubes heal without giving rise to any irritation whatever.

Such a tube has remained in the posterior horn, in the case of a child nine years of age, for the last four years. The parents of this child are opposed to having the cannula removed, because since its introduction, the hydrocephalic child had considerably improved both mentally and physically.

END OF SECOND VOLUME