HAND-BOOK OF DISEASES OF THE EYE

PARKER

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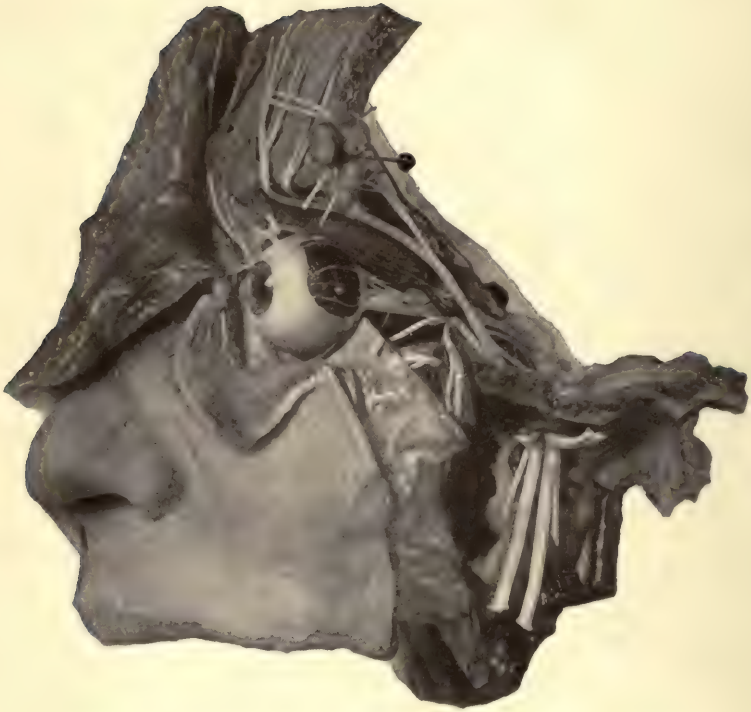

Dissection showing the Eye, its coats, nerves, blood-vessels, muscles, etc. (*Ramsey.*)

HAND-BOOK

OF

DISEASES OF THE EYE

A TEXT-BOOK FOR STUDENTS AND PRACTITIONERS

BY

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PREFACE.

THE object in presenting this small volume on the eye is to place before the student and the busy practitioner in a concise manner the results of recent investigations and their practical application. All unnecessary details have been omitted, and yet the common eye diseases and their treatment have been sufficiently elaborated.

The special chapter on bacteriology has been incorporated because of the great aid in the diagnosis, prognosis, and treatment we obtain from the bacteriological examination of the acute inflammatory diseases of the eye.

The chapter on refraction gives the details of modern methods necessary for preliminary work in this subject, and will serve as a groundwork for the finer tests which only experience can bring.

The chapter on the sclera gives the latest investigations on the tuberculous origin of most forms of inflammation which attack this structure, also some points on tuberculin therapy. As an appendix to this chapter the Calmette ophthalmo-tuberculin reaction and the von Pirquet cutaneous test are considered as methods of diagnosing tubercular diseases of the eye.

The chapter on the relation of the eye and the nose is a new departure in a purely ophthalmic text-book. It has become necessary because of the numerous eye affections now known to be dependent upon pathological conditions in the nose.

A formulary has been appended which contains forty-one practical prescriptions, which will be of value to the practitioner.

The colored drawings of the external eye diseases and some sketches are original. They were made from life, under my direction, by Miss Jane Rawls, to whom I am greatly indebted for her painstaking and excellent work.

This book is not in any sense designed for the specialist; the intention is to present the student and general practitioner with the modern methods of diagnosing ocular conditions, for the relief of which many patients first consult their family physician.

H. C. P.

Board of Trade Building,
Indianapolis, Ind.

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PRACTICAL HAND-BOOK

OF

DISEASES OF THE EYE.

CHAPTER I.

ANATOMY.[1]

The Orbit.—The bony orbits are described as pyramids, the bases of which are at the openings, so placed that the inner walls, formed largely by the os planum of the ethmoid, are parallel, and their axes diverge as they go forward. The outline of the base is formed above by the frontal, which at the outer side forms a prominent angle to join the ascending process of the malar. Near the inner angle, there is usually seen a prominence formed by the frontal sinus. At about the inner third of the supra-orbital edge is found a notch or a foramen for the supra-orbital nerve. The vertical outer border is continued onward by the sharp ascending edge of the superior maxilla, which at the inner side of the orbit forms the front border of the lachrymal canal. This sharp edge ends just before meeting the internal angular process of the frontal.

The floor is formed by the orbital plate of the superior maxilla, a portion of the malar and the orbital process of the palate bone. The roof, by the orbital plate of the frontal, except at the apex, where comes in the lesser wing of the sphenoid. The inner wall, by the os planum of the

[1] The writer wishes to state that in this Chapter he has freely used the chapter on "The Anatomy of Orbit and the Appendages of the Eye," by Dwight, in the Norris and Oliver "System of Diseases of the Eye," and also "Gray's Anatomy."

ethmoid; the nasal process of the superior maxilla anteriorly; and the orbital portion of the sphenoid posteriorly. The thinnest portions of this bony orbit are the inner wall, and the roof. This explains the numerous extensions into the orbital cavity from purulent inflammations of ethmoid and frontal sinus (see Fig. 1).

There are seven openings into the orbital cavity as follows: (1) Optic foramen, which transmits optic nerve and ophthalmic artery. (2) Sphenoidal fissure, which transmits third, fourth, and sixth nerves, three branches

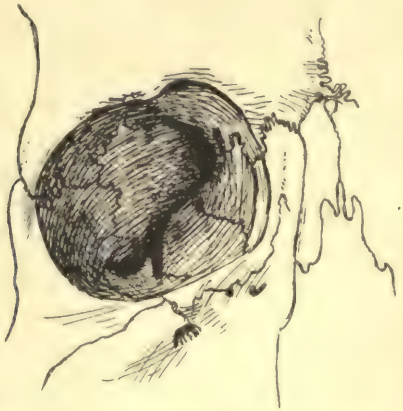


Fig. 1.—The various bones that enter into the formation of the orbit. (After *Meckel.*)

of the ophthalmic division of the fifth, and the ophthalmic vein. (3) Spheno-maxillary fissure, which transmits infra-orbital vessels and nerve and secondary branches from spheno-palatine, or Meckel's, ganglion and superior maxillary nerve and its orbital branches. (4) Infra-orbital canal, which transmits infra-orbital vessels and nerve. (5) Lachrymal canal, in which is contained the lachrymal duct through which tears are passed into the inferior fossa of the nose. (6) Supra-orbital foramen, or notch, which transmits the supra-orbital vessels and nerve. (7) Malar foramen, which transmits temporal and malar branches of orbital nerve.

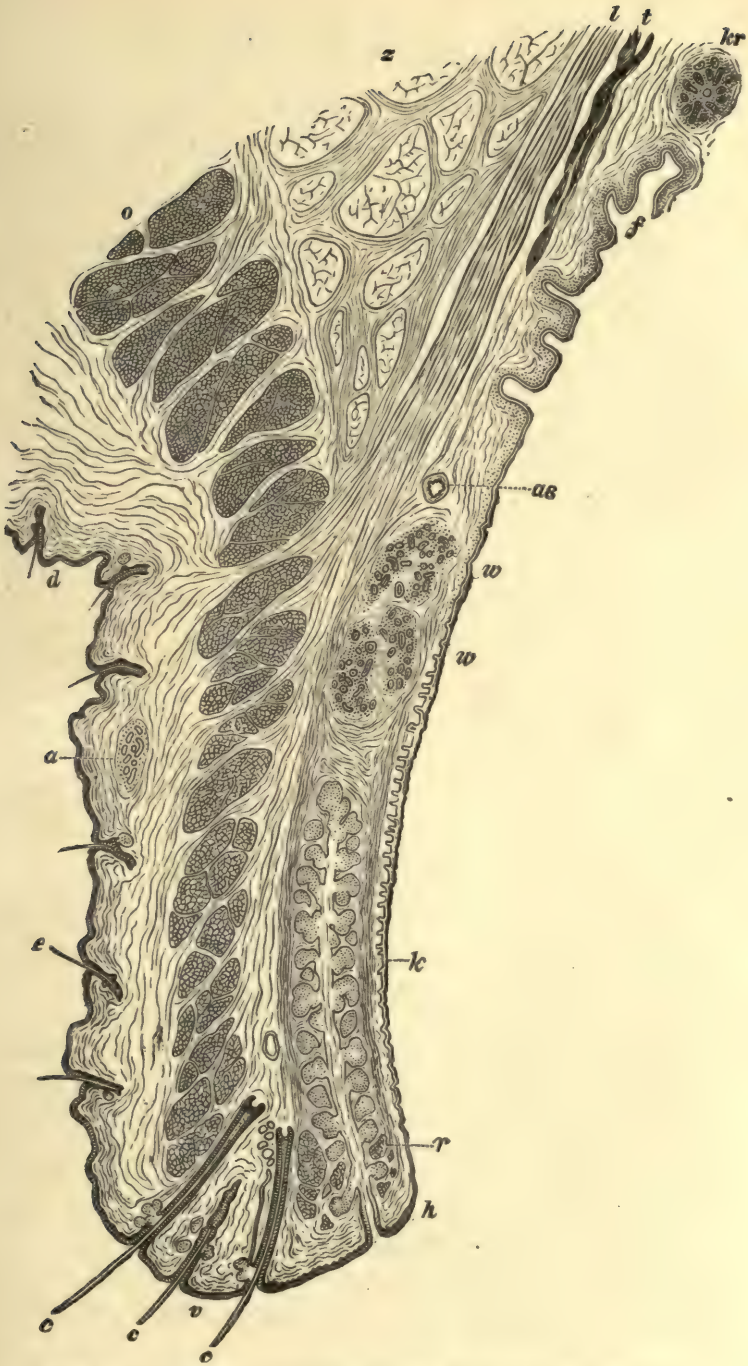


Fig. 2.—Perpendicular section through the upper lid (5 × 1).
(Fuchs.)

The Lids (Fig. 2).—The base of the cavity of the orbit, open in the skeleton, is closed in life by the lids. These consist of the tarsal plates, on the conjunctival surface of which are found the Meibomian glands. These plates and the membrane attaching them to the walls of the orbit form the greater part of the lids proper. Outside the tarsal plates are found the orbicularis muscle and skin. The plates are convex externally and concave internally, thus forming a natural splint for the eye, which is of great protective value after operation. The external palpebral ligament is a poorly marked thickening of the membrane, which attaches the tarsal plates to the edges of the orbit. It runs from the outer angle of the lids to the malar bone. The internal palpebral ligament is a true band. It runs from the inner ends of the tarsal plates to the superior maxilla in front of the lachrymal groove. This ligament is the same as the direct tendon of the orbicularis. The anterior border of the lids is rounding and has projecting from it the cilia (eyelashes), which are arranged in several rows one behind the other. Those of the upper lids are thicker and longer than the lower. The posterior border of the lids is sharp, and just in front of it is seen a single row of small puncta, which are the orifices of the Meibomian glands. The orbicularis muscle is divided into two portions, that which lies in the lid proper and is composed of circular fibers, and the second part spreads out beyond the margin of the orbit, where its fibers mingle with the muscles of the forehead and cheek. The muscle lies under the skin of the lids, practically throughout its entire extent. Nerve supply: facial. The levator palpebræ arises at the bottom of the orbit from the circumference of the optic canal, and from this point runs forward, lying upon the superior rectus, spreads out in a form of a fan, and is inserted by a short tendon into the upper margin and anterior surface of the tarsus of the upper lid. Nerve supply: motor oculi. Action: raises the upper lid (Fig. 4).

Situated on the inner border of the upper and lower lids near the inner canthus are found the puncta which lead

into the canaliculi. These in turn usually unite and enter the tear sac by a common opening. The direction of the canal is at first vertical for possibly 2 mm., then turns a sharp angle and runs horizontally for 5 to 7 mm., when it joins the other. This is of importance in passing a lachrymal probe (Fig. 3).

The conjunctiva of the lids lies in close apposition to the tarsal plates, and contains numerous small tear glands. The lachrymal gland is situated under the corner of the external angular process of the frontal in a shallow pit. It consists of two parts, the larger placed above and external to the smaller, the latter being frequently called the accessory gland. The ducts of the large gland pass through the small gland, and receive communications from it. These ducts,

Fig. 3.—Tear-sac from a metal cast in the Warren Museum of the Harvard Medical School. *(Norris and Oliver.)*

from 5 to 7 in number, pierce the conjunctiva under the outer part of the upper lid.

Capsule of Tenon.—This capsule lies between walls of the orbit and the eyeball, isolating it and allowing free movement. It is continuous behind through the optic foramen and the sphenoidal fissure with the dura mater, and in front with the subconjunctival connective tissue of the globe. It may be said to consist of two layers. The parietal, lining the cushion of fat on which the eye rests, and the visceral, which invests the eyeball from near the cornea to the optic nerve. Dwight mentions only the visceral layer. The tendons of the ocular muscles invaginate

the capsule and pierce it near their insertion, as do the ciliary nerves and the ducts of the lachrymal gland.

The Extrinsic Muscles of the Eyeball (Fig. 4) move the eye in various directions, and are six in number. The internal rectus, the external rectus, the superior rectus, the superior oblique, the inferior rectus, and the inferior oblique. *The internal rectus* arises from lower and inner part of the optic foramen (ligament of Zinn), and is inserted into the inner side of the sclera about 7 mm. from the corneal junction. Action: turns the eye inward; nerve: third cranial. *The external rectus* arises from two heads; the upper, from the outer margin of the optic foramen immediately beneath the superior rectus; the lower head, partly from the ligament of Zinn and partly from a small pointed process of bone on the lower margin of the sphenoidal fissure, and is

Fig. 4.—Muscles of the right orbit. *(Alger.)*

inserted into the sclera about 8 mm. from corneal margin. Between the two heads of this muscle pass the third, the nasal branch of the fifth and the sixth nerves, and the ophthalmic vein. Action: turns eye outward; nerve: sixth cranial. *The superior rectus* arises from the upper margin of the optic foramen, beneath the levator palpebræ and the fibrous sheath of the optic nerve, and is inserted into the sclera about 7½ mm. from corneal margin. This muscle passes over the superior oblique; action: turns the eye upward, with slightly inward deviation corrected by inferior oblique; nerve: third cranial. *The superior oblique* is a fusiform muscle placed at the upper inner side of orbit internal to the levator palpebræ; origin: inner margin of optic foramen, and passing forward to inner angle of orbit, terminates in a rounded tendon, which plays in a pulley

formed by cartilageous tissue (Frontispiece), then is reflected backward and downward, passing beneath tendon of superior rectus to be attached to the sclera, behind the equator of eyeball, between the superior and external recti. Action: rotates eye on its antero-posterior axis, and because of the insertion behind equator turns eye slightly down and out; nerve: fourth cranial. *The inferior rectus* arises from lower and inner part of optic foramen (ligament of Zinn), and is inserted into sclera about 7 mm. from cornea; action:

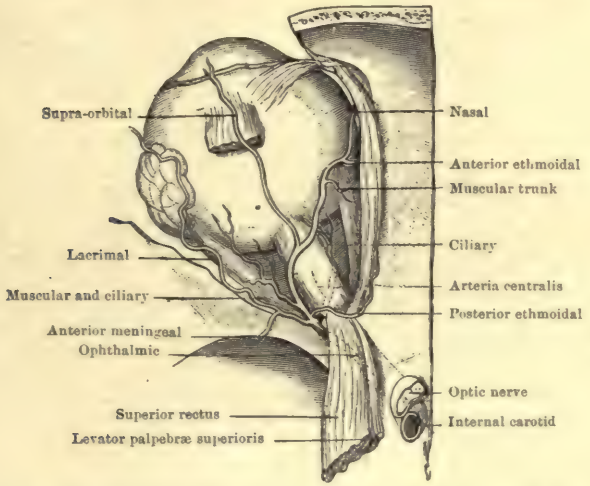


Fig. 5.—The ophthalmic artery and its branches. *(Ball.)*

turns eye down with tendency to inward deviation, which is overcome by superior oblique; nerve: third cranial. *The inferior oblique* arises from orbital plate of superior maxilla to be inserted into the sclera near the insertion of superior oblique between the external and superior recti; action: rotates eye on its antero-posterior axis; nerve: third cranial.

The Arteries, Veins, and Lymphatic Vessels of the Eye and Orbit (Fig. 5). *Arteries.*—The ophthalmic artery arises from the internal carotid artery just as that vessel is emerging from the cavernous sinus, and enters the orbit through the optic foramen below and on the outer side of

the optic nerve. It then passes over the nerve to the inner wall of the orbit, and then horizontally forward, beneath the lower border of the superior oblique muscle, to a point behind the internal angular process of the frontal bone, when it divides into two terminal branches, the frontal and the nasal. The branches are divided into two groups, the orbital and ocular:—

Orbital.	Ocular.
Lachrymal,	Short and
Supra-orbital,	Long ciliary,
Posterior ethmoidal,	Anterior ciliary,
Anterior ethmoidal,	Central artery of retina,
Internal palpebral,	Muscular.
Frontal,	
Nasal.	

The ocular group most intimately concerns us. *The short ciliary arteries* (6 to 12 in number) surround the optic nerve as they pass forward to pierce the sclerotic coat around the entrance of the nerve, to supply the choroid and ciliary body. *The long ciliary arteries* (two in number) pierce the sclerotic at some little distance from the optic nerve, and run forward along each side of the eyeball, between the sclera and choroid, to the ciliary muscle, where they divide into two branches (Frontispiece). These form an arterial circle, the circulus major, around the circumference of the iris, from which numerous radiating branches pass forward in its substance to the free margin, where they form a second circle, the circulus minor, around the pupillary margin.

The anterior ciliary arteries are derived from muscular branches; they pass to the front of the eyeball in company with the tendons of the recti muscles, form a vascular zone in the ciliary region beneath the conjunctiva, and then pierce the sclerotic a short distance from the cornea to terminate in the circulus major of the iris.

The central artery of the retina is a small branch of the ophthalmic, which runs first in the dural sheath of the nerve, but about half an inch behind the eyeball it pierces

the optic nerve obliquely and runs forward in the center of its substance, and enters the globe of the eye to supply the retina, dividing into four or five branches (Fig. 6).

The muscular branches (two in number) supply the extrinsic ocular muscles.

The orbital arteries need but brief mention. *The lachrymal* supplies the lachrymal gland and gives off two malar branches. *The supra-orbital* passes out through the supra-orbital foramen, or notch, to supply surrounding structures. *The posterior ethmoidal* passes through the posterior ethmoid foramen to ethmoidal cells. *The an-*

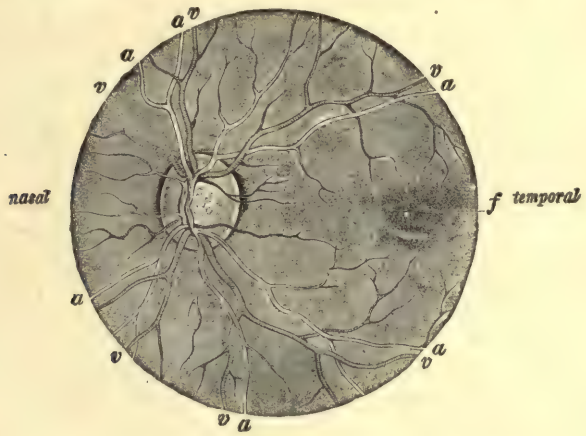


Fig. 6.—Normal fundus of the left eye, seen in the erect image. *(Fuchs.)*

The optic disc, which is somewhat oval longitudinally, has the point of entrance of the central vessels somewhat to the inner side of its center. That portion of the papilla lying to the inner side of the point of entrance of the vessels is of darker hue than the outer portion; the latter shows, directly to the outside of the vascular entrance, a spot of lighter color, the physiological excavation, with fine grayish stippling, representing the lacunæ of the lamina cribrosa. The papilla is surrounded, first by a light-colored ring, the scleral ring, and externally to this by an irregular black stripe, the chorioidal ring, which is especially well marked on the temporal side. The central artery and vein divide immediately after their entrance into the eye into an ascending and descending branch. These branches, while still on the papilla, split into a number of smaller divisions, and fine offshoots from them run from all directions toward the macula lutea, which itself is devoid of vessels, and is distinguished by its darker color. In its center a bright punctate reflex, *f*, is visible.

terior ethmoid passes through anterior foramen and supplies anterior ethmoid cells and frontal sinus. *The palpebral* supplies the lids. *The frontal* to the muscles and skin of the forehead, and *the nasal* to lachrymal sac and nose.

The veins of the eyeball emerge through the sclera as the venæ vorticosæ, and soon unite with the other veins forming two main trunks, the superior and inferior ophthalmic veins, which unite, usually, in a common trunk pass out the sphenoidal fissure to empty into the cavernous sinus.

The lymphatic system is divided in anterior and posterior, and consists of lymph channels and lymph spaces. The anterior portion is that which occupies the anterior and posterior chambers of the eye, communicating by means of the pupil. The lymph is derived from the iris and ciliary body, and is discharged by being filtered through the ligamentum pectinatum into the canal of Schlemm, and from there into the episcleral lymph space, from which it is carried into the intracranial lymph spaces.

The posterior lymphatic system includes the hyaloid canal, the perichoroidal space, and space between the two portions of the capsule of Tenon. At the edge of the cornea is a lymphatic net work which communicates with that of the sclera, from which the cornea receives its nourishment, lymph being disseminated through numerous small poorly defined canaliculi in the corneal substance.

Nerves of the Eye (Fig. 7) are the nerve of special sense (sight), the optic or second cranial nerve; motor nerves, the third, fourth, and sixth cranial, and filaments of common sensation from the ophthalmic division of the fifth cranial nerve; there are also branches from the sympathetic. *The optic nerve,* the special nerve of the sense of sight, is distributed to the retina. It is divided into three portions for convenience of description. (1) The optic tract, (2) the optic commissure, and (3) the optic nerve.

The optic tract has a deep and superficial origin. The deep origin is beneath the internal geniculate body; the superficial from the external geniculate body, optic thalamus, and the superior corpus quadrigeminum. The tract

passes forward along the posterior inferior surface of the thalamus, crosses the crus, and in front of the infundibulum unites with the optic tract of the other side, forming the optic commissure, which rests upon the superior surface of the sphenoid bone in the optic groove. The optic commissure is made up of three groups of fibers (by some authors four); the decussating; straight, and intercerebral. Those claiming four give the inter-retinal. The decussating fibers, the most numerous, form the central portion of the optic tract, and are continued into the nerve of the opposite side.

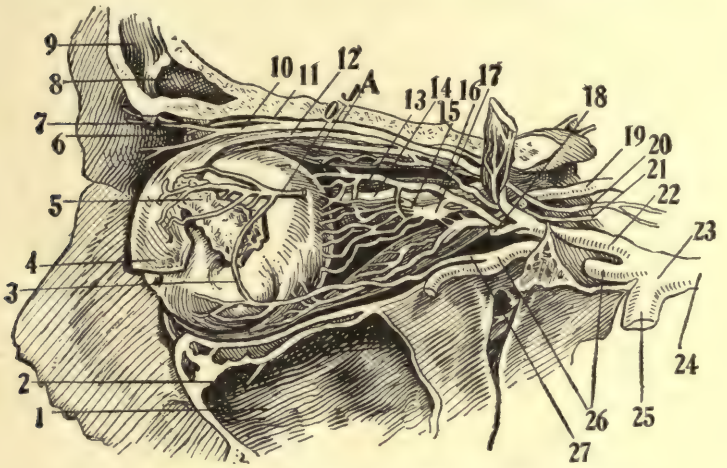


Fig. 7.—Nerves of the orbit and the ophthalmic ganglion, side view. *(Ball.)*

1, Antrum. *2*, Bristle in the antrum. *3*, Loop between orbital and lacrimal nerves. *4*, Tarsal plate. *5*, Lacrimal gland. *6*, Tendon of superior oblique. *7*, Pulley of the same. *8*, Infundibulum. *9*, Frontal sinus. *10*, Supraorbital nerve. *11*, Supratrochlear nerve. *12*, Levator palpebræ muscle. *O*, Lacrimal nerve. *J*, Superior rectus muscle. *A*, Frontal nerve. *13*, Internal rectus muscle. *14*, Optic nerve. *15*, Short ciliary nerve. *16*, Nasal nerve. *17*, Ciliary ganglion. *18*, Lacrimal nerve. *19*, Motor oculi nerve. *20*, Patheticus nerve. *21*, Abducens nerve. *22*, Ophthalmic division of fifth nerve. *23*, Gasserian ganglion. *24*, Fifth nerve. *25*, Inferior maxillary nerve. *26*, Superior maxillary nerve. *27*, Orbital nerve.

The straight fibers form the outer portion of the optic tract and continue to nerve of the same side. The intercranial form the inner side of the tract, and run from one side of

the brain to the other, not entering at all into the formation of the optic nerves. The relation of these fibers is important in localizing tumors, and lesions at the base of the brain.

The optic nerve arises from the fore part of the commissure, becomes rounded in form, and is enclosed in a sheath derived from the pia mater and the arachnoid. As the nerve passes through the optic foramen it receives a sheath from the dura mater, which as it enters the orbit divides into two layers, one of which becomes the periosteum of the orbit, and the other, the proper sheath of the nerve, surrounds it as far as the sclerotic. The nerve passes

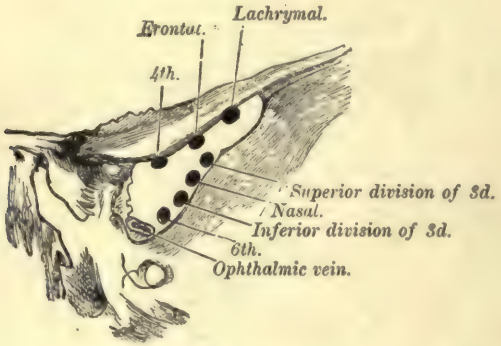


Fig. 8.—Relations of structures passing through the sphenoidal fissure. *(Gray.)*

outward and forward through the orbital cavity, pierces the sclera and choroid at the back of the eyeball, about an eighth of an inch to the nasal side of its center and expands into the retina. The right halves of the retinæ are supplied by the right optic tract, and the left halves of the retinæ by the left optic tract.

The third nerve supplies all the muscles of the eye except the superior oblique, and the external rectus; it also supplies through its connection with ciliary ganglion the sphincter muscle of the iris, and the ciliary body.

The fourth nerve supplies the superior oblique muscle.

The sixth nerve supplies the external rectus muscle.

The ophthalmic division of the *fifth nerve* is the only branch we need consider. It is a sensory nerve supplying the eyeball, the lachrymal gland, the mucous lining of the eye and nasal fossæ, and the integument of the eyebrow, forehead, and nose. It arises from the upper part of the

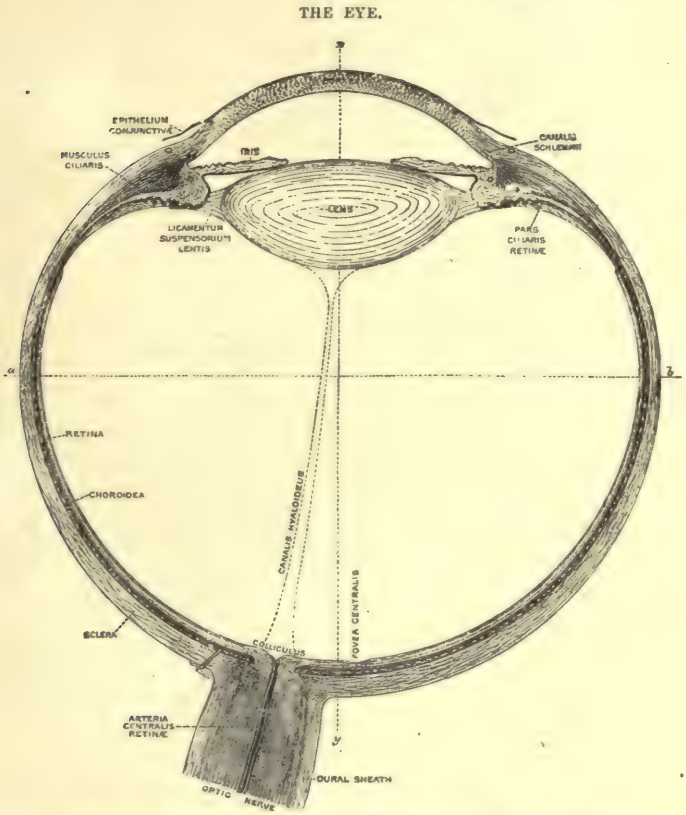


Fig. 9.—Horizontal section of the eyeball. *(Quain.)*

Gasserian ganglion, passes forward along the outer wall of the cavernous sinus below the other nerve, and just before entering the orbit through sphenoidal fissure, divides into the lachrymal, frontal, and nasal nerves (Fig. 8).

The Eyeball (Fig. 9; also, Frontispiece) is contained in the cavity of the orbit, in which it is securely protected

from injury, yet its position is such as to insure the most extensive range of vision.

The eyeball is composed of three coats and three refracting media. From without inward we have (1) sclera and cornea; (2) choroid, ciliary body and iris; (3) retina.

The Sclerotic (hard) has received its name from its density and toughness (Frontispiece); it is a firm unyielding, fibrous membrane, which serves to maintain the form of the globe. It is much thicker behind than in front, and presents two surfaces for study, the external and internal. The external surface is white and serves for the attachment of the muscles of the eye. It is in contact with the inner surface of the capsule of Tenon. The inner surface is stained brown, and is grooved for the lodgment of the ciliary vessels and nerves; this is loosely connected by a fine cellular tissue with the choroid. An extensive lymph space intervenes between the sclera and choroid (peri-choroidal). Posteriorly, and slightly to the nasal side, the sclera is pierced by the optic nerve. At the point where the optic nerve passes through the sclera, this coat forms the lamina cribrosa, a sieve-like membrane, which separates the nerve filaments. One opening larger than the rest, in the center, transmits the central artery of the retina. Around the lamina are numerous small apertures for the transmission of ciliary vessels and nerves. In front the fibrous structure of the sclera is continuous with the cornea. In structure the sclera is formed of white fibrous tissue, which contains a few elastic fibers, and some connective tissue corpuscles. Nerves and vessels are few in number.

The Cornea is the projecting, transparent part of the external coat of the eye, and forms about the anterior sixth of the globe. It is convex anteriorly, and projects from the sclera much in the same manner a watch crystal does from the case. In thickness it varies from $^1/_{20}$ to $^1/_{30}$ of an inch. Its posterior surface is more perfectly circular in outline than the anterior, and exceeds the anterior slightly in extent, from the latter being overlapped by the sclera. It is composed of five layers as follows (Fig. 10):—

1. Conjunctival epithelium.
2. Anterior elastic layer (Membrane of Bowman).
3. Thick fibrous layer (Cornea proper).
4. Posterior elastic layer (Membrane of Descemet).
5. Endothelium.

The conjunctival epithelium, which covers the front of the cornea proper, is composed of several strata of epithelial cells. The deepest are columnar; then follow two or three layers of polyhedral cells, the majority of which have finger-like processes; superficially there are four layers of squamous epithelium. This conjunctival epithelial layer is continuous with the conjunctiva.

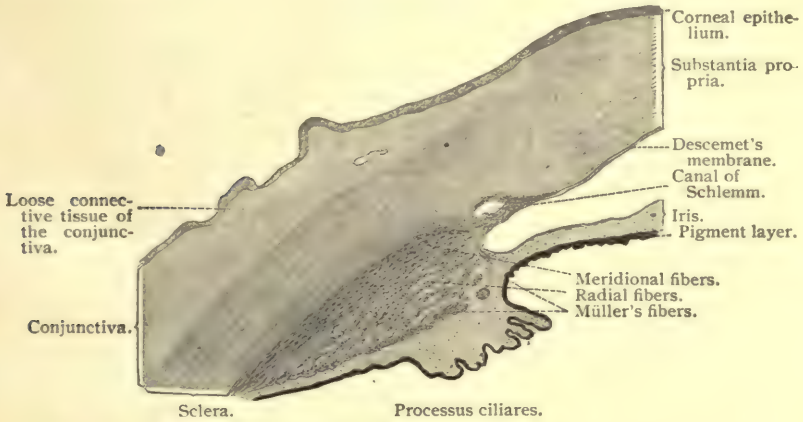


Fig. 10.—Shows various layers of the cornea, and the relations of cornea, sclera and ciliary body. *(Bohm, Davidoff, Huber.)*

The cornea proper is fibrous, tough, unyielding, and perfectly transparent, and is continuous with the sclera. It consists of about sixty flattened laminæ, connected by interstitial cement substance, in which are the corneal spaces. These spaces are stellate and have numerous projections by which they communicate with each other, and each contains a corneal capsule.

The anterior elastic membrane is really a part of the cornea proper, its only difference lying in the fact that it contains no corneal corpuscles.

The posterior elastic membrane (Descemet's) covers the posterior surface of the cornea proper. Its most remarkable property is extreme elasticity combined with great toughness.

The endothelial layer is composed of a single layer of flattened endothelial cells, similar to those lining other serous cavities. It is reflected on to the front of the iris. The structure of the cornea is non-vascular, being nourished by lymph. It is bountifully supplied by branches of the ciliary nerves.

The Choroid (Frontispiece) is a dark reddish brown, highly vascular membrane, which invests the posterior five-sixths of the globe. It is continuous forward with the ciliary body and iris to form the second, or middle, coat of the eye. It is attached externally to the sclera, and on its inner surface the retina is supported. Behind it is pierced by the optic nerve, around which point it is much thicker than anteriorly. The structure of the choroid consists of a dense capillary network, and is divided into two layers, the external and internal. On its external surface is a thin membrane, the lamina superchoroidea, consisting of delicate non-vascular lamellæ, among which are branched pigment cells. The spaces between the lamellæ are lined by endothelium, and open freely into the perichoroidal lymph space. Internal to this choroid proper we have the short ciliary arteries, which run forward between the veins, before they bend in to terminate in the capillaries. Interspread between the vessels are dark star-shaped pigment cells. The inner layer consists of a fine capillary network or plexus, and known as the lamina chorio-capillaries. Lying between these two layers, and connecting them, is the intermediate membrane. On the inner surface of the chorio-capillaries is a thin structureless membrane called the lamina basalis, which separates the choroid from the pigment layer of the retina.

The Ciliary Body is made up of the orbiculus ciliaris, the ciliary processes, and the ciliary muscle. The orbiculus connects the choroid with the ciliary processes. *The ciliary*

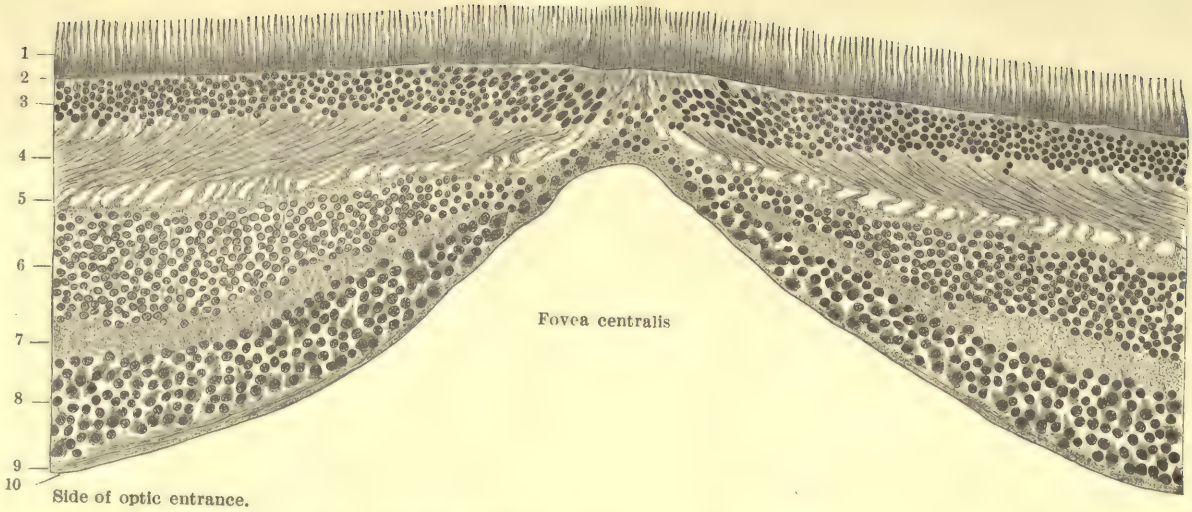


Fig. 11.—Horizontal section through the macula and the center of fovea. *(Stöhr.)*

1, Cones. 2, External limiting membrane. 3, Nuclei of cones. 4, Henle's fiber-layer. 5, External reticular layer. 6, Inner granule layer. 7, Inner reticular layer. 8, Layer of ganglion-cells. 9, Nerve-fiber layer. 10, Internal limiting membrane. (From a preparation by Prof. Haab, drawn by Schaper.) The nerve-fiber layer, like all the layers, is thicker on the side toward the entrance of the optic nerve than on the opposite side; in the latter situation the nerve-fibers in transverse section appear as minute dots.

2

processes are a series of 60 to 80 pigmented vascular processes arranged circularly around the lens behind the iris. Their anterior surface is turned toward the back of the iris, with the circumference of which they are continuous. The posterior surface is connected with the suspensory ligament of the lens. In structure they are similar to the choroid. *The ciliary muscle* consists of unstriped fibers; it forms a grayish circular band about one-eighth of an inch broad, on the outer surface of the fore part of the choroid. It consists of two sets of fibers, the circular and radiating. The radiating fibers, much the more numerous, arise at the point of junction between cornea and sclera, which passing backward are inserted into the choroid opposite the ciliary processes. The circular fibers are internal to the radiating ones, and have a circular course around the attachment of the iris. The ciliary muscle is the muscle of accommodation; its contraction, by drawing on the ciliary processes, relaxes the suspensory ligament of the lens and permits the anterior surface, by its own elasticity, to become more convex.

The Iris is a thin, circular, contractile curtain suspended in the aqueous humor behind the cornea and in front of the lens, being perforated at about its center by a circular aperture, the pupil, through which light is transmitted. It is continuous by its circumference with the ciliary body, also connected to choroid and cornea. The anterior surface of the iris is variously colored in different individuals, and is marked by lines which converge toward the pupil. The iris is composed of the following structures: (1) In front a layer of flattened endothelial cells continuous with the endothelial covering of the membrane of Descemet. (2) Stroma, which consists of fibers and cells. (3) Muscular fibers of two kinds, radiating and circular. The radiating fibers (dilator pupillæ) converge from the circumference toward the center, and there blend with the circular fibers near the pupillary margin. The circular fibers (sphincter pupillæ) surround the margin of the pupil on the posterior surface of the iris. (4) Pigment. In

blue eyes of various shades the only pigment cells are situated on the posterior surface of the iris, and continuous with the pigmentary lining of the ciliary processes. The color of the eye in these individuals being due to more or less coloring matter showing through the texture of the iris. In the albino this pigment is absent. In darker eyes than blue, pigment granules are found in the stroma, and even in the epithelial layer. *The arteries* are derived from the long and anterior ciliary, and from the ciliary processes. *The nerves* are the long ciliary, and ciliary branches from the *lenticular ganglion.* The circular fibers are supplied by the motor oculi, and the radiating by the sympathetic. *The membrana pupillaris* is a thin membrane, which in fœtal life occludes the pupil. At birth only a few fragments remain attached to the pupillary margin. It occasionally persists and may cause partial or complete blindness.

The Retina is a delicate nervous membrane that may be considered as an expansion of the optic nerve, on the surface of which images of external objects are received. Its outer surface is in contact with the choroid, and its inner surface with the vitreous. It gradually diminishes in thickness from behind forward, and extends as far as the ciliary body, where it ends in a jagged margin, the *ora serrata.* It is soft and semi-transparent in the fresh state. Exactly in the center of the posterior part, corresponding to the axis of the eye, is found a round, yellowish spot, called the macula lutea of Sömmerring. This area is free from large blood-vessels, and has a central depression at its summit, the fovea centralis. The retina at this situation is so thin that the dark color of the choroid shows through (Figs. 6 and 11). About $^1/_{10}$ of an inch to the nasal side of the macula is the entrance of the optic nerve, through the center of which appears the central artery of the retina. The structure of the retina is exceedingly complex, and when examined microscopically is seen to be composed of ten layers, which, named from within outward, are as follows (Figs. 11 and 12):—

(1) *Membrana limitans interna* lies in contact with the hyaloid membrane of the vitreous. It is derived from the supporting framework of the retina.

(2) *The fibrous layer* is made up of nerve fibers, the direct continuation of the fibers of the optic nerve.

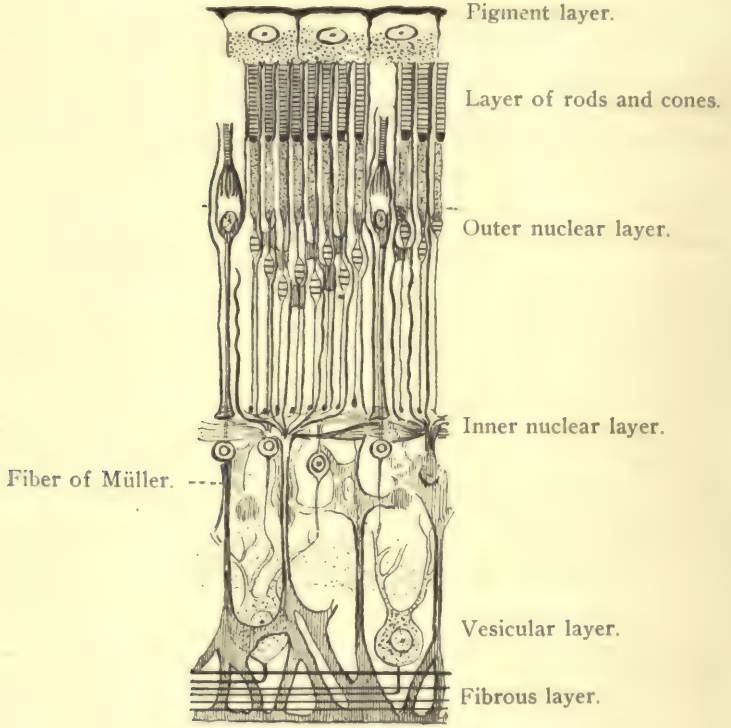


Fig. 12.—The layers of the retina (diagrammatic). (After *Merkel.*)

(3) *The vesicular layer* consists of a single layer of large ganglion cells, except at the macula lutea, where there are several layers. These cells are flask-shaped, and are continuous with the fibers of the optic nerve.

(4) *The inner molecular layer* consists of a stratum of granular-looking substance. It is made up of a dense reticulum of minute fibrils, intermingled with the fine pro-

cesses of the ganglion cells, and also processes derived from the next inner layer.

(5) *The inner nuclear layer* is made up of nuclear bodies, of which there are three different kinds: (*a*) large oval nuclei, which are regarded as bipolar nerve cells; (*b*) a stratum of cells not branched; (*c*) a few cells connected with the fibers of Müller.

(6) *The outer molecular layer,* thinner than the inner, presents the same granular appearance as the latter, but differs in that it contains branched stellate cells.

(7) *The outer nuclear layer* is composed of several layers of nuclear cells of two kinds: The rod granules, and the cone granules, both continuous with the rods and cones of Jacob's membrane, being the nuclei and modified bodies of the specialized epithelial cells, of which the rods and cones are the processes.

(8) *Membrana limitans externa,* like the internal limiting membrane, is derived from the supportive tissue of the retina.

(9) *The layer of rods and cones* (Jacob's membrane) is more numerously supplied with rods than cones, except in the macular region, where there are no rods. The rods are solid, of nearly uniform size, and are arranged perpendicularly to the surface, and consist of two portions; the outer striated and the inner granular. The cones are flask-shaped with their pointed extremities toward the choroid. They also show a striated outer portion and a granular inner portion.

(10) *The pigmentary layer,* the most external layer of the retina, consists of a single layer of hexagonal epithelial cells loaded with pigment granules. The radiating fibers of Müller are connected together by a sort of supporting connective tissue, from which the membranæ limitans interna et externa are derived, and serve to connect the various layers of the retina together.

The Vitreous Humor is a thin jelly-like transparent fluid, which fills about four-fifths of the entire globe (Fig. 9). It is hollowed out in front for the reception of

the lens and its capsule, and is enclosed in the hyaloid membrane. A delicate supporting reticulum extends throughout the vitreous, especially in the fœtus. The vitreous has no blood vessels in the adult, nutrition being derived from the retinal vessels and the ciliary body. The hyaloid canal extends in the fœtus, from the optic nerve to the lens, and transmits a small artery to the lens capsule. It is absent after birth, but in some instances a remnant remains on the posterior capsule giving rise to a posterior polar cataract.

The Aqueous Humor completely fills the anterior and posterior chambers of the eyeball (Fig. 9). It is a transparent fluid closely resembling water. The anterior chamber is bounded in front by the cornea and behind by the iris. The posterior chamber is a small space between the anterior capsule of the lens and the posterior surface of the iris near its attachment. The two chambers are connected through the pupil. The posterior surface of the iris, throughout practically its entire extent, lies in contact with the lens.

The Lens is a biconvex, transparent, elastic body enclosed in its capsule, which is connected laterally with the suspensory ligament, and is encircled by the ciliary body. The posterior surface is more convex than the anterior, and lies in the hyaloid fossa of the vitreous. The lens measures about $^1/_3$ of an inch in the transverse diameter, and $^1/_4$ of an inch in its antero-posterior diameter. It consists of concentric layers, of which the external are soft (cortical); those beneath firmer, the central ones form a hardened nucleus. The capsule of the lens is a transparent, friable, elastic membrane, which encloses the lens, and is held in position by the suspensory ligament. Its anterior layer is thicker than the posterior, and is attached to the lens by a layer of polygonal, nucleated cells, which break down after death to form the liquor Morgagni. *The canal of Petit* is about $^1/_{10}$ of an inch wide, traversing the circumference of the lens. It is bounded in front by the suspensory ligament and behind by the vitreous. The suspensory ligament, or *zonula of Zinn,* is a thin transparent structure placed at first between the vitreous and ciliary processes, and then

passes from these to the anterior surface of the lens near its circumference. The lens is devoid of blood vessels, and receives its nourishment through lymph from the ciliary body.

In the fœtus the lens is nearly spherical in shape; its color is slightly reddish, and is not perfectly transparent, and is so soft as to readily break down on the slightest pressure. In the adult it is more convex on its posterior surface, is perfectly transparent and firm in texture. In old age it becomes flattened on both surfaces, is slightly opaque, and of an amber tint, which increases in density. This gives the pupil in elderly people a slightly grayish look, which may be mistaken, without examination with reflected light, for a beginning cataract.

CHAPTER II.

PHYSIOLOGY.[1]

In considering the physiology of the eye it will be always understood that the normal, or emmetropic, eye is meant. The deviations from the normal will be taken up in subsequent chapters under their special classifications.

The eye is popularly compared to a camera, which it in reality so greatly resembles, and consists of a series of surfaces and media arranged in a dark chamber; the iris serving as a diaphragm; the lens, similar to the lens of the camera; and the retina is to the eye what the sensitive plate

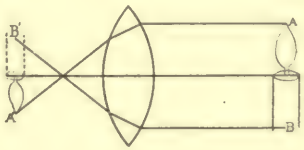


Fig. 13.—Formation of image by convex lens. *(Alger.)*

or ground glass plate is to the camera. The eye is so constructed that images of external objects are brought to a focus on the retina, the stimulation of which by light starts the visual impulses along the optic nerve. It is also so constructed that in any position of the eye the rays of light proceeding from a portion only of the external world fall upon the retina, and the portion so seen is called the visual field for that position. The image thrown on the retina is an inverted one, so that the top of an actual object is represented by the lower, and the bottom by the upper part of the retinal image (Fig. 13). Similarly the right-hand side of

[1] Foster's Text-book of Physiology has been quoted in parts of this chapter; also Guenther's Physiology and Fuch's Text-book of Ophthalmology.

the actual object corresponds to the left-hand side of the retinal object, and vice-versâ. This is called projection, and is made use of in a pathological condition, later to be described.

When we look at an object, though two retinal images are produced, one in each eye, we perceive but one. This is the essential of binocular, or stereoscopic vision (Fig. 14). When certain parts of each retina are stimulated at the same time we are conscious of one sensation only, not two; and the parts of the two retinæ which, stimulated at the same time, give rise to one sensation are spoken of as corresponding parts. That is, the temporal side of the right eye corresponds to the nasal side of the left eye, and the nasal side of the right to the temporal side of the left.

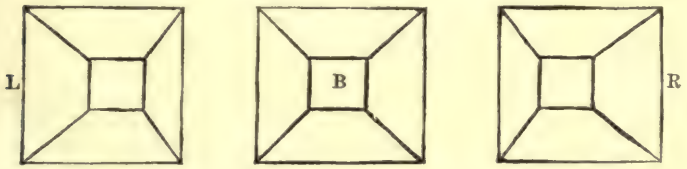


Fig. 14.—Illustrating the principle of the stereoscope and binocular vision. *(Guenther.)*

In likening the eye to a camera we must consider what happens to rays of light which pass through the lens, and how the eye overcomes, by its perfect arrangement of parts, faults which would interefere with distinctness of vision.

Spherical Aberration is due to the fact that rays passing through the edge of a lens have a shorter focal distance than those passing near the center. In the camera this is overcome by cutting off the outside rays by means of a diaphragm. In the eye the iris acts as the diaphragm.

Chromatic Aberration.—In a camera the edge of the lens represents the outer angle of a prism. White light falling on it is decomposed into the spectral components. Objects seen on the ground glass plate have an iridescent hue. In the eye this trouble is obviated in two ways; the first, by the fact that the edge of the lens is more angular and less curved, and second, by the iris, as in spherical aberration.

Visual Angle.—Helmholtz has stated that the visual angle is really the angle enclosed by the visual lines. These lines arise from a point in space and pass through the pupil and converge at the center of the macula lutea. The apparent size of the object depends upon the visual angle, and acuteness of vision is inverse to the size of the visual angle. Snellen's test types are constructed on this principle, and are adjusted to be seen under an angle of five minutes.

Contraction or Dilatation of the Pupil is a reflex act, the afferent impulse goes through the optic nerve, while the motor impulse for contraction goes through the third cranial nerve to the circular fibers of the iris, and the motor impulse for the radiating fibers passes through the sympathetic. Drugs act in controlling the action of the iris. Atropine, locally or internally, dilates the pupil; opium taken internally, and eserine or pilocarpin locally, contract the pupil.

Muscæ Volitantes.—Under certain conditions a number of objects lying within the eye itself become visible. They have the form of beads, streaks, patches, and casts, and have an independent motion, which is increased as the eye moves. In most cases they are fœtal remnants, supposedly remains of the hyaloid artery, etc. They are brought out more strongly when looking steadily at a white background. If the eye is strongly illuminated from the side, branching figures are seen, which are due to the shadow of the retinal vessels, which fall on the rods and cones. In looking at the sky for some time the corpuscles are quite plainly seen traveling slowly through the capillaries. All these intra-ocular images are variously classed as muscæ volitantes, several authors stating that muscæ are wholly within or on the cornea. This is an error according to the usual use of the term.

"Under normal conditions the *pupil* appears as a black spot. This is explained by the fact that the source of light and the retina lie in conjugate foci, so that any light which escapes absorption by the retinal pigment is reflected back whence it came. Therefore, the eye of the observer, who views it from another direction, will see no light coming

from it. By means of the ophthalmoscope or retinoscope, however, a light is thrown into the back of the eye, which upon reflection is viewed by the observer through a small hole in the reflector (Fig. 34). The fundus is seen to have a reddish background in which the retinal vessels are visible." (Guenther.)

Where the optic nerve enters the eye there are no rods and cones, and hence no vision. This can easily be demonstrated by means of a simple illustration (Fig. 15). Cover the left eye and look, with the right eye, at the small cross; the large circular spot may be seen at the same time only less distinctly. Move the book slowly forward and backward, and soon a point will be found where the black spot entirely disappears. Its image has then fallen on the optic nerve and is unseen.

Fig. 15.—Test for blind spot in the eye. *(Ball.)*

At the center of the macular region we find the fovea centralis (Fig. 6). This minute spot is really the only part of the retina with absolutely sharp vision. Look at any small word on this page of only three or four letters and you will be surprised to see that but one or possibly two of the letters in the word are distinctly seen. We read largely by form and not by seeing each letter in the word distinctly. This is illustrated by the fact that any of us in coming across an unfamiliar word will stop to spell it. We must stop in order to see the letters clearly, thus showing that we read almost entirely by form. The rest of the retina receives images, but they decrease in acuteness in proportion to the distance from the fovea.

Duration of Retinal Stimulation.—Light impresses the retina, but the excitation does not cease immediately with the disappearance of luminous vibrations. They persist in proportion to the intensity of the excitation. An example

of this is the blending of black and white stripes painted on a disc to a uniform gray when the disc is rapidly rotated. Or when looking at the landscape from a rapidly moving train for some time, upon the train coming to a stop the landscape continues to move for some appreciable time.

Visual Purple is a reddish coloring matter, which is contained in the outer part of the rods. This coloring matter must be kept in the dark, for it bleaches as soon as light strikes it. The color will again return if the eye is brought into a darkened chamber. This explains largely the fact that color details are more clearly brought out on a dull day, or at early evening, than in the bright sunlight. In other words, too strong light bleaches the visual purple, and in this manner destroys contrasts, which are more easily seen in a softer light.

Color-Vision.—Ordinary white light is composed of rays of different refrangibility by reason of the different length and duration of the luminous rays. These rays falling on the retina result in the individual sensations which correspond to colors. White light is decomposed by means of a prism, into the colors of the spectrum. They are violet, indigo, blue, green, yellow, orange, and red. Each primary color cannot be further decomposed, but all can be reunited by a biconvex lens so that white light again results. Colors other than the seven primary colors are due to the mixture of two or more primary colors in various proportions. The ultra-red (thermal) and the ultra-violet (chemical) rays do not make any impression on the retina since with vibration rates beneath 435,000,000 per second the retina is not stimulated; the latter color produces no color-sensation because above 734,000,000 vibration rates a second are insensible to the retina.

Theories of Color-Vision.—Young and Helmholtz assumed three chemical substances in the retina corresponding to the three fundamental colors, red, green, and blue, and that these chemical substances responded to these colors, transmitting the sensation to the brain. According to the Young-Helmholtz theory of color-blindness, there is a de-

fect corresponding to the three color-perceiving fibers, and thus there are four kinds: red, green, violet, and complete blindness in colors. Hering assumed three substances corresponding respectively to white or black, red or green, and yellow and blue light. In his theory, white, red, and yellow rays are catabolic in their effects on their individual recipient substances, and black (absence of light), green, and blue are anabolic. According to the Hering theory there are four kinds of color-blindness: (1) complete, (2) blue-yellow, (3) red-green, and (4) incomplete. Mrs. Franklin assumes in her theory that early in life the eye possesses no color-perception, but merely the power of distinguishing white and black. The substance responding to this luminosity is called gray-perceiving. As the development progresses, some of the gray is differentiated in the course of development into a red and a green-perceiving substance. This theory explains more readily than the others the cases of congenital (so-called) color-blindness being due to lack of development of the gray-perceiving substance, rather than, as in the other theories, an absence of one or more of the color-perceiving substances. Males are much more likely to be color-blind than females (16 to 1). Only one woman in 400 is color-blind. The reason for this is that the color-sense is probably developed by training, and in boys this education is neglected, while girls have sufficient practice early in life in matching colors for dolls' dresses, etc.

Movements of the Eye.—The eyeball may be considered as an articulated spherical globe, which turns upon three axes that cross each other. Six voluntary muscles affect the three rotations of the eye; the rectus internus and externus when acting alone, turn the eye from side to side; the superior and inferior recti give to the globe an up and down movement; and the superior and inferior obliques rotate the eye on its antero-posterior axes when acting alone. The two eyes always move co-ordinately in order to maintain parallelism or convergence of the visual lines. The visual line is that line which passes from an object through the center of the pupil and the center of rotation of the

ocular globe. For accommodation at a distance the two lines are parallel; in accommodation for near objects they are convergent.

Accommodation of the Eye.—The mechanism of accommodation was mainly determined by Helmholtz. It depends upon the elasticity of the lens, owing to which the latter always tends to approximate to the shape of a sphere. The lens is enclosed in a capsule, which is attached by means of the zonula of Zinn to the ciliary body. These fibers are tightly stretched, and hence exert a uniform traction on all sides of the capsule, so that the lens is well flattened. The

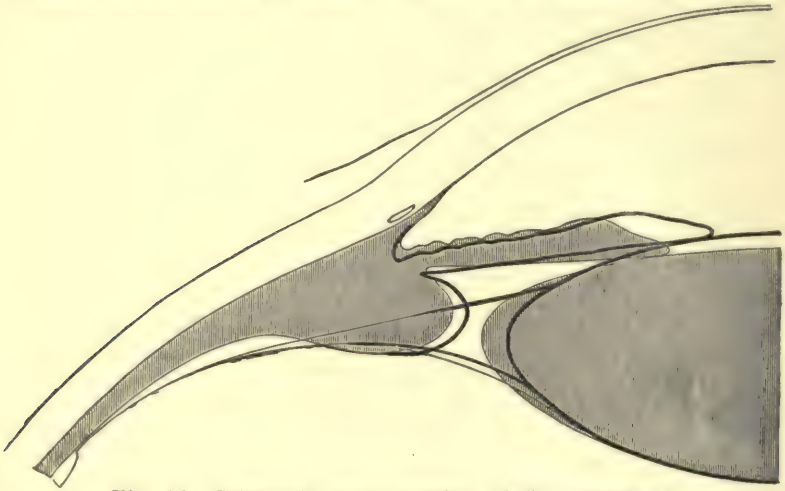


Fig. 16.—Schematic representation of the process of accommodation. *(Fuchs.)*

The relation of the parts when accommodation is at rest is designated by the shaded portions, and the relation when there is an effort of accommodation, by the thick black line. In the drawing it looks as if the zonula fibers were running through the ciliary process. In reality the fibers of the zonula for the most part lie in the depressions between the ciliary processes, and hence run to the lateral slopes of the ciliary process that is represented in the drawing. With these slopes they are connected by numerous fibers and hence, when the ciliary processes advance toward the sagittal axis of the eye, the zonula fibers are taker along with them and are likewise pushed upward; and to a corresponding amount the equator of the lens recedes toward the sagittal axis of the eye. Both surfaces of the lens become more curved and the anterior surface is advanced. The iris is broader and at its pupillary border is displaced forward; at its ciliary border backward.

elasticity of the lens can only make itself manifest when the capsule, through the fibers of the zonula, is relaxed. This is accomplished by the contraction of the ciliary muscle, when the anterior surface of the lens bulges forward (Fig. 16). The contraction of the ciliary muscle is accomplished as follows: The longitudinal fibers have their anterior fixed insertion in the corneo-scleral margin, while their posterior extremity loses itself in the movable choroid. By contraction of these fibers the flat portion of the ciliary body, and the anterior portion of the choroid are drawn forward and thus the fibers relaxed. The main part of the work is, however, accomplished by the circular fibers, which in contraction bulge out the point of the ciliary body to which

Fig. 17.—A stereoscopic card for testing binocular vision. *(Wells.)*

the zonula is attached. This accounts for the fact that these fibers are so well developed in people who have to accommodate so much (*i.e.*, hypermetropes). The contraction of the ciliary body causes the pupil to contract in size, and the bulging of the lens causes a narrowing of the anterior chamber. Combined with the accommodative effort we have a convergence of the eye in order that the image looked at will be thrown upon corresponding points in the two retinæ and thus preserve binocular vision. (After Fuchs.)

Binocular Vision.—In binocular vision we not only perceive the two images, one on each retina, as one, but we also have an extended visual field, which corresponds laterally to about 180 degrees. One can readily determine how the field is lessened by closing one eye. Monocular vision may be compared to binocular vision, as the flat photograph is to the stereoscopic picture. In the former we judge of

depth by comparison of size, familiarity, etc.; in the latter we really perceive depth; the foreground stands out distinctly from the background. A simple test for binocular vision is the bar reading test: Hold a pencil before the eyes in the median line in reading a page, and if binocular vision is present we will see *through* the pencil, if absent the letters behind the pencil will be unseen. Another test is by means of the stereoscope. By placing in the stereoscope a card similar to Fig. 17 the images *A* and *B* are fused to make one complete picture if binocular vision is present. If absent the patient will see either *A* or *B* depending upon which eye is focused on the card.

CHAPTER III.

BACTERIOLOGY.

Bacteriological examination of various ocular diseases aids the clinician greatly in his diagnosis, prognosis, and treatment of many conditions. It also shows that the mild boracic acid and normal salt solutions are just as good as the stronger antiseptics used in the preparation of an eye for operation. In fact bacteriological examination has proved that bichloride and other similar remedies do not render the conjunctiva sterile. We have learned, therefore, that thorough irrigation of the conjunctival sac just before operation, with mild solutions, gives a cleaner field than with the weak solutions of antiseptics, which do not destroy the bacteria, but only lead to a false feeling of security.

Ocular Asepsis.—As Gifford aptly says in his article, "The Essentials and Non-essentials of Ophthalmic Asepsis:" "There are two fundamental propositions which should be kept in mind in our attempt to do aseptic eye surgery: First, that the conjunctival sac in the great majority of cases, and probably always, contains germs which are pathogenic, or which can, under certain circumstances, become so. Second, that to rid the conjunctival sac of these germs is an impossibility. Although this fact has been asserted often enough, many operators still dote on the idea that by rinsing out the sac with sublimate 1 to 5000, or some other equally harmless mixture, they can obtain an aseptic operative field." The bacterial examination of cultures taken from the conjunctival sacs of cases so prepared show many and various germs.

Bossalino tested bacteriologically the conjunctival sacs of eighteen patients who had been operated upon for

cataract. His cultures were all taken on the first and second day after operation, and he succeeded in isolating fourteen times the staphylococcus aureus, twice the staphylococcus citreus, twice the staphylococcus cereus, and once the sarcina lutea, and from each culture he inoculated the cornea of a rabbit, always with negative results. He deducted from this that although the bacteria assumed all the morphological and biological characters common to staphylococci, they lose their power of pus formation. He carried his investigation further to ascertain if these germs had completely lost their virulence, or if they could, under certain conditions, regain their activity. With this object in view he made cultures from a patient in whom extirpation of the sac for dacryocystitis had been performed preliminary to cataract extraction, in which case all secretion had disappeared. The cultures showed numerous colonies of staphylococcus aureus and a few staphylococcus albus. Pure cultures were made, and with all due precautions were dissolved in a solution of sodium chloride, and small quantities were injected into different parts of rabbits and on the corneæ, with negative results. Another culture not diluted in sodium chloride was injected under the skin and in the peritoneal cavity, which resulted in a swelling, from which a sero-fibrinous exudate was obtained. This liquid was used for the formation of new cultures, from which injections were made under the skin, into the peritoneal cavity, and on the corneæ of guinea pigs. The animals died in four hours of septicæmia. On the corneæ abscesses appeared, which spread rapidly, producing loss of the eyes through panophthalmitis. His conclusions were: (1) It is impossible to render the conjunctiva aseptic; (2) the eye has no more power of resistance to infection than any other organ; (3) the tears and the mild antiseptics used before and during the operation decrease the number of germs and render these less virulent; (4) under favorable conditions these germs are apt to become active and virulent, producing disastrous results in ocular surgery.

It has been my experience in preparing an eye for

surgical operation that the less antiseptics are used, the better. A solution of 1 to 5000 bichloride is worse than useless, in that it is prone to irritate some conjunctivæ. Careful irrigation with sterile boracic solution or normal salt solution the evening before and the morning of the operation is all that is necessary for the conjunctiva. The lids may be carefully washed with a weak alcohol solution, especially in the region of the lashes, after which a bland ointment may be applied. The solutions used in the eye and for instruments should be freshly prepared and sterile. This is especially necessary in solutions of cocaine and atropine. The instruments should be boiled at least ten minutes and the knives should be dipped in boiling water for twenty or more seconds, after which they should be placed in 60 per cent. alcohol. The hands of the operator and assistant should be made as thoroughly aseptic as possible, and all persons dealing directly with patient or instruments should wear sterile gowns. The upper part of the patient, except the field of operation, should be covered with a sterile sheet, and the head should be wrapped in a sterile towel. All post-operative dressings should be carried out with rigid aseptic precautions. I might add one word in regard to the use of other drugs than boracic acid or salt solution in the conjunctival sac, and that is the recommendation of Cheney on the use of argyrol for several days preliminary to cataract extraction. I have used this drug for several years in this way, and think it is of decided benefit. It is used simply as a collyrium for several days or a week before the operation. I am certain it does not increase the chance of infection, and believe it decreases it.

Bacteriological investigations have revealed the fact that we cannot make the conjunctiva aseptic, but that we obtain the best operative results and the minimum chance of infection if we use the utmost care in regard to ourselves, the instruments, the solutions, and the dressings.

Conjunctivitis is caused by a vast majority of germs, the most important of which will be enumerated and described.

Gonorrhœal Ophthalmia is due to the gonococcus, which causes a severe, destructive inflammation of the conjunctiva and the cornea. This disease is highly contagious and of grave prognosis, especially in adults, so that the necessity of making an accurate diagnosis is plainly evident. Smears taken from the discharge in this disease and stained with methylene-blue will reveal the typical kidney-shaped diplococcus *within* the pus-cells (Plate 1, Fig. 6). As the pneumococcus and staphylococcus may present at times a similar microscopic appearance it is necessary to be certain of our diagnosis. This we do by means of the Gram stain, as the gonococcus is easily decolorized by this method, and stains with the weaker counter stain. The pneumococcus and staphylococcus both stain by Gram.

The culture method is another method of distinguishing between the gonococcus and other pus cocci, as the former does not grow, or at least in the rarest instances, on ordinary media. Blood agar, human serum, and Wertheim's medium have given satisfactory growths. The colonies appear late, usually after thirty-six or forty-eight hours. The cultures can be obtained pure if the loop of pus is obtained from deep into the conjunctival sac.

Diphtheritic Conjunctivitis is a rare disease, but cases have been frequently incorrectly called diphtheritic because the conjunctiva has shown a membrane, and examination of smears and cultures has shown a bacillus, which resembles the Klebs-Löffler bacillus morphologically. Clinically, diphtheritic conjunctivitis shows a dense tenaceous gray membrane, which when detached leaves numerous bleeding points. The local symptoms are those of intense inflammation, with, usually, a coincident nasal or pharyngeal membrane, and severe constitutional symptoms. The pseudodiptheritic conjunctivitis, on the other hand, shows much less intense local symptoms, and usually no constitutional symptoms. The membrane may be gray, but is usually yellowish. It is easily detached, and leaves few, if any, bleeding points. The nose and pharynx show no membrane. Smears made from the discharge in a case of diphtheritic con-

PLATE I.

Fig. 1. Streptococci from smear. Stained with eosine.

Fig. 2. Pneumococci from culture. Stained with eosine.

Fig. 3. Diplobacillus of Morax Axenfelt from culture. Stained with eosine.

Fig. 4. Weeks's bacilli from smear. Stained with eosine.

Fig. 5. Methylene-blue stain of Klebs-Löffler bacilli from culture.

Fig. 6. Gonococci from smear stained with methylene-blue. Typical arrangement in pus cells plainly seen.

PLATE I.

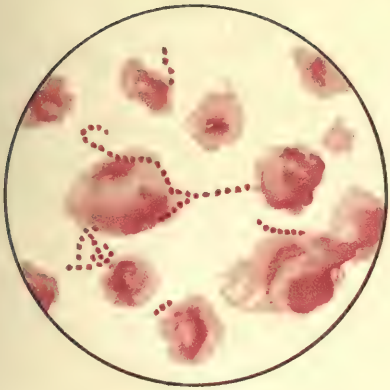


Fig 1.

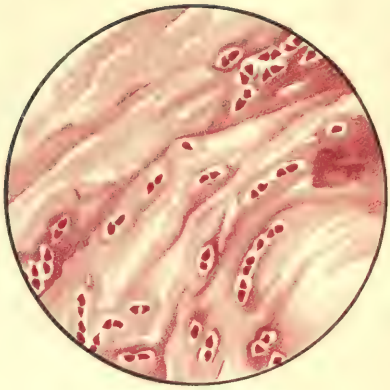


Fig. 2.

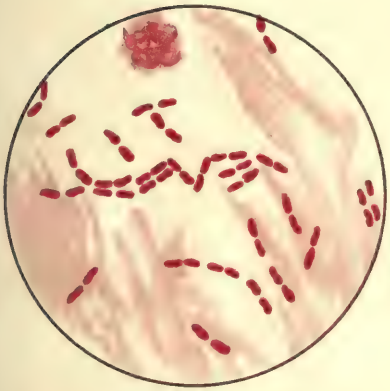


Fig. 3.

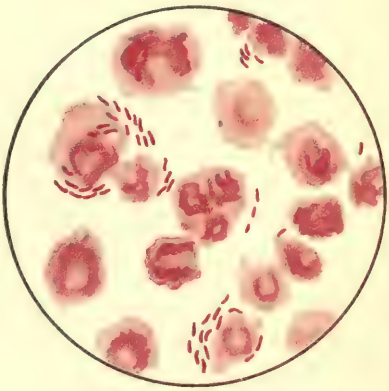


Fig 4.

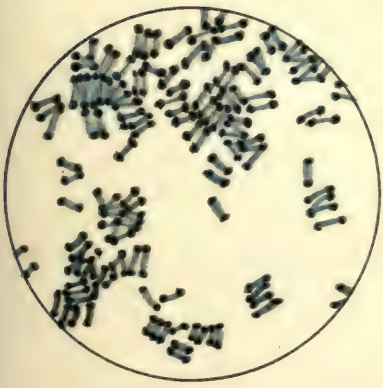


Fig. 5.

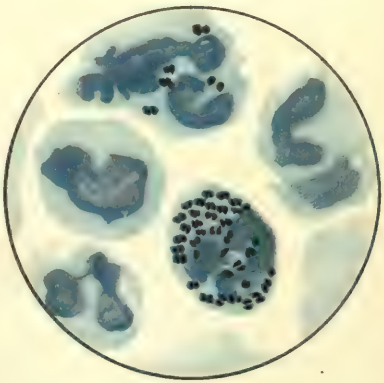


Fig 6.

junctivitis may show the Klebs-Löffler bacillus mixed with numerous other germs. The bacillus stains bipolarly especially with methylene-blue. It is usually necessary, and always better, to make cultures. On agar or blood serum the colonies appear quickly, usually before twenty-four hours. They almost invariably appear before colonies of other bacteria. Cover slips obtained from these cultures and stained with Löffler's methylene-blue reveal the morphological characteristics shown in Plate 1, Fig. 5.

Subcutaneous injection in guinea pigs of pure culture of Klebs-Löffler bacilli usually causes death in thirty-six hours. Resort to this method may in some cases be necessary to differentiate the diphtheritic bacillus from the Xerosis bacillus.

The Xerosis Bacillus was first demonstrated by Kreschbert and Neisser in a case of Xerosis conjunctivæ. The bacillus presents the same morphological and cultural appearances as the Klebs-Löffler bacillus. They appear the same under the microscope when stained with methlyene-blue. They both retain the stain by Gram, and they appear the same on culture media. The Xerosis bacillus is, however, non-pathogenic to animals, and, according to Eyre, does not produce an acid reaction in neutral bouillon. The Xerosis bacillus is found in numerous inflammatory diseases of the conjunctiva and is frequently found in the normal secretions. Doret has noted that cultures of the Xerosis bacillus are always richer and more virile when grown on an inflamed than on a healthy conjunctiva. Its virulence was also increased when in the presence of the various pus cocci. He injected pure cultures into the cornea of rabbits, which caused a slight, rapidly healing infiltration; when injected into the anterior chamber they produced iris hyperæmia, or iritis with cloudy exudate, which, however, cleared up rapidly under the use of atropine.

Croupous Conjunctivitis, or membranous conjunctivitis, is produced by all or nearly all of the bacteria, which gives rise to purulent conjunctivitis. The differential diagnosis between membranous conjunctivitis and true diph-

theritic conjunctivitis is made by bacterial examination combined with the clinical picture. In 1904 I made a clinical and bacterial study of most of the cases of membranous conjunctivitis appearing in the clinic of the Massachusetts Charitable Eye and Ear Infirmary, and I found definite, so-called, false membranes in cases where the bacterial examination showed the gonococcus and staphylococcus albus and aureus, the pneumococcus, the bacillus of Morax-Axenfelt, and the streptococcus. In a few cases the presence of the Xerosis bacillus mixed with the other bacteria led to a questionable diagnosis of diphtheria until the bacillus could be obtained in pure cultures and injected into a guinea pig. Usually, however, in these cases the clinical picture hardly warranted a diagnosis of diphtheria. The local symptoms were all more severe than in the ordinary acute catarrhal form of conjunctivitis, except the gonorrhœal cases, but not so severe as in cases of diphtheritic conjunctivitis. Bach, Vossius, Jessup, Stevenson, and others regard the bacteriological findings as conclusive evidence in the differential diagnosis between true diphtheritic conjunctivitis and pseudo-diphtheritic, or the so-called croupous, conjunctivitis.

Acute Catarrhal Conjunctivitis is an acute purulent or mucopurulent inflammation due to bacterial infection. There is no specific organism found, although in certain instances there is an epidemic of this disease in which a large proportion of the cases are apparently due to one kind of bacteria.

The Weeks Bacillus gives rise frequently to an epidemic of this disease. Pollock gives an analysis of 204 cases of conjunctivitis in which microscopic examination had been made. There were 145 cases of acute muco-purulent conjunctivitis, and of these 108 showed the bacillus of Weeks. Weeks's cases of acute conjunctivitis also show a high percentage caused by the bacillus which bears his name. I have examined microscopically over 100 cases in which the Weeks bacillus was found in only two, and Derby, of Boston, did not find as high a percentage in his cases as

found in New York by Weeks. Gifford, of Omaha, has found comparatively few cases due to this bacillus in his locality.

Morphologically the Weeks bacillus resembles the influenza bacillus, also the resemblance in culture media renders it very hard, if not impossible, to differentiate them. They are both short rods about .5 to 1.0 microns long and .25 microns in diameter, with both ends rounded. Both occur in great numbers in the secretions, and smears show colony-like groups, or they may occur in double chains (Plate 1, Fig. 4). Both decolorize by Gram, and it is a common coincidence that both grow more rapidly in the presence of the Xerosis bacillus. The culture medium on which they grow best is boiled agar, with 1½ per cent. human placental blood, or hæmoglobin; although they will grow on ½ per cent. agar, especially if mixed with the Xerosis bacillus. Inoculation experiments with the two bacilli give the same general symptoms in animals and the post-mortem findings are identical. As a consequence of this similarity, Rymowicz and Jundell claimed the germs to be identical.

This conclusion explains the prevalence of this form of conjunctivitis during an epidemic of influenza. Morax and Zur Nedden among others consider the Weeks bacillus and the influenza bacillus as different organisms, as shown by slight cultural differences. They agree with Rymowicz and Jundell that the morphological characteristics are the same.

The Diplobacillus of Morax-Axenfeld has been carefully studied in this country by many ophthalmologists, excellent articles on this bacillus having been written by Gifford, Pusey, Shumway, and Weeks. Erdmann observed 342 cases of diplobacillus conjunctivitis out of 14,783 patients or 2.3 per cent. The percentage of cases increasing from 1.5 in 1900 to 3.02 in 1904. Polloch observed the diplobacillus in 21 out of 204 cases of acute conjunctivitis. This organism not only causes an acute purulent or mucopurulent conjunctivitis, but it causes severe, and sometimes

dangerous, ulceration of the cornea. In Erdmann's cases 30 had corneal involvement. He also demonstrated the presence of the diplobacillus in the nasal secretion of 64 out of 142 cases examined. The organism lives in the nasal mucous membrane for a long time, and may in this way spread the contagion to others. Paul reports 26 diplobacillus ulcers of the cornea in one and one-half years, and Stoewer also observed 26 cases. Several observers have found the diplobacillus in normal eyes.

This organism averages about 2 microns long and 1 wide. They occur usually in pairs, end on (Plate 1, Fig. 3). They stain readily with the ordinary stains, and do not stain by Gram. The best culture media are blood serum or serum agar. It is well to observe here, parenthetically, that zinc is a specific remedy in inflammation caused by this bacillus.

The Pneumococcus is frequently the cause of acute conjunctivitis. Gifford has found numerous cases in his practice, and they are found in nearly every series of cases examined microscopically. The conjunctivitis is not usually severe, and is not so contagious as the conjunctivitis caused by the Weeks bacillus. This organism, however, occasionally attacks the cornea and when this occurs the result is serious. Many traumatic ulcers with hypopyon give pure cultures of the pneumococcus, especially in grain workers and stone cutters. The frequency in which the pneumococcus was found in serpent ulcer of the cornea led Römer and Zeller to immunize their patients by injecting the anti-pneumococcic serum. Römer gives 80 per cent. of cures in cases where the serum was given early. The dose is 5 c.c. Zeller concludes that the injection of serum is justifiable in early cases, which may in this way be saved from a corneal perforation, panophthalmitis, or the necessity of a Saemisch operation.

The pneumococci are small lance-shaped, oval cocci, about 1 micron in their longest diameter, and are generally arranged in pairs. The cocci are surrounded by a capsule, which usually appears as an unstained halo (Plate 1, Fig.

2). The organism stains readily with all ordinary stains, and stains by Gram. Cultures are easily obtained on blood serum and agar.

The Staphylococcus is found in many cases of acute conjunctivitis, either in pure culture or as a mixed infection. They do not attack the cornea, and the inflammatory condition is not as a rule severe. They grow readily in ordinary media, and stain readily with the usual stains. They do not decolorize by Gram. In smears they clump together in groups. Staphylococci are very frequently found in the normal conjunctival cavity. This is especially true in cases of blennorrhœa of the lachrymal sac, where these organisms remain inactive as long as the conjunctiva and cornea are intact.

Should the cornea be injured or operated upon under these conditions the chance of infection is very great, and an ulceration of the cornea becomes exceedingly resistant to treatment, and frequently ends in partial destruction or loss of the eye.

The Streptococcus causes a severe conjunctival inflammation with a strong tendency toward corneal ulceration. Pseudo-membranes are commonly seen in this form of infection, and there is usually swelling of the preauricular gland. Schottelius examined the conjunctival secretion in 80 cases of measles, 40 of which were fatal. Among the 40 non-fatal cases staphylococcus aureus was found in 25, or 60 per cent., the streptococcus in 6, or 14 per cent. In regard to the streptococcus he remarks that this organism was found only in the severe cases. Of the 40 fatal cases the streptococcus was found in 20, or 50 per cent., which seems to indicate a relationship between this organism and the severity of the disease.

The streptococcus grows in ordinary media at body temperature, and stains readily with the usual stains. It does not decolorize by Gram. Morphologically it appears as a round coccus, with a strong tendency to chain formation. This is easily seen in cover slips taken from cultures (Plate 1, Fig. 1).

Panophthalmitis, due to the streptococcus, staphylococcus and pneumococcus has been frequently reported. The introduction of the germs may be through the perforation of a corneal ulcer, by penetrating wounds of the eye, and by the infection of operative wounds. The hypopyon, which is frequently seen in an eye as a complication of serpent ulcer of the cornea has been repeatedly found to be sterile; and so this in itself cannot be the cause of a panophthalmitis. Cases operated upon for serpent ulcer of the cornea, as advised by Saemisch, rarely run into a panophthalmitis. In 12 cases of ulcer of the cornea in gonorrhœal ophthalmia reported by the author, and in 6 cases subsequently operated upon, not one showed any tendency toward panophthalmitis. Johnson reports two cases both of which showed the pneumococcus. One case followed cataract extraction in a patient who had had pneumonia a few weeks previous to operation, and the other case occurred in a stab wound of the globe. De Berandinis observed one case of panophthalmitis in which the streptothrix was isolated.

The Tubercle Bacillus has been occasionally observed in tuberculous tissue removed from the eye, but, as a rule, the organism is exceedingly hard to demonstrate. Verhoeff and Bull have proved the tuberculous nature of cases of scleritis and episcleritis, but have never been able to isolate the organism in the excised nodules examined microscopically.

The Organism of Trachoma has never been successfully isolated. Müller found an influenza-like bacillus in 59 out of 155 cases of trachoma examined, and he never found this bacillus in non-trachomatous eyes. Zur Nedden refutes Müller's assertion, and thinks that the influenza bacillus was simply superimposed on a trachoma. Arnold Knapp bears out Zur Nedden. The former examined 120 cases of fresh trachoma and found the influenza-like bacillus in 8. This organism could not be differentiated in any way from the true or pseudo-influenza bacillus.

Other organisms have been occasionally found in the conjunctival secretion, but their presence has been largely

accidental, and they have added nothing to our bacterial knowledge of ocular inflammation.

Microscopic examinations of all inflammatory conditions of the eye should be made that we may be able to more correctly classify these conditions, and perhaps through these findings be able to more intelligently treat the individual case.

CHAPTER IV.[1]

EXAMINATION OF THE EYE.

BEFORE proceeding to the examination of the patient's eyes a careful history of the case should be taken and put in the records. It is too frequently the custom of oculists to look for and see only that which lies in their particular portion of the anatomy, and neglect what is frequently of the utmost importance, the patient's general condition, habits, occupation, previous history, both ocular and general, and especially the condition of the heart, kidney, liver, stomach, generative organs, and, of great importance, the condition of the nose and its accessory sinuses and the nasopharynx. Upon these frequently depend the ocular trouble, which will not be relieved until the cause is removed.

Objective Examination.—In making the ocular examination it is necessary to proceed with system, otherwise important matters can very readily be overlooked. The trained observer will take in at a glance the facial expression, the position, and superficial condition of the eyes themselves, and then will proceed from the superficial parts inward.

The Lids are examined as to their mobility, their position, and their power of closing; the edges, especially, where pathological changes are most prone to appear. Aside from symptoms of inflammation we may find the edges have lost their sharp contour, the cilia may be missing or in a faulty position; we see whether the puncta turn properly into the conjunctival cavity or are occluded. At the same time the condition of the lachrymal canal and tear sac is noticed; should inspection reveal nothing we may often, by pressure of the finger on the area of the sac, make the diseased contents exude through the puncta. Blepharo-

[1] In this chapter some ideas are taken literally from Fuchs (American Edition, Duane) as expressing concisely the points covered.

spasm, or forcible squeezing together of the lids, may render difficult the examination of the *eyeball.* Forcible separation in these cases must be undertaken with great care, lest the examiner cause the sudden perforation of the corneal ulcer or even the expulsion of a lens from the eye. By first dropping a solution of cocaine between the slightly parted lids, we can frequently reduce the sensitiveness; care, however, must be taken that the eyes are not suddenly exposed to a strong light, which will only increase the spasm. An ordinary lid retractor is gently inserted under the upper lid, avoiding the globe if possible, the lower lid is pulled down with the finger or thumb, the pressure being made

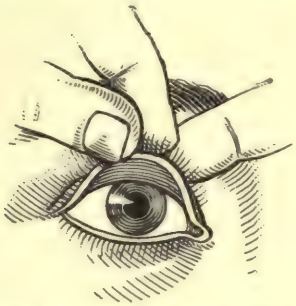


Fig. 18.—Method of eversion of the upper lid. *(Ball.)*

against the orbital ridge, not against the globe. With practice a rapid glance is sufficient to reveal the condition of the conjunctiva, cornea, iris, and possibly the lens. Cases not having blepharospasm can be easily seen without the use of the elevator. It is of great importance that the cornea and iris be seen, so the elevator must be resorted to if ordinary methods fail to reveal these structures. Use of lid elevators is more frequently needed in children, but they should be used only as a last resort (Fig. 63).

The Conjunctiva of the globe can be inspected by the previous method, but that lining the lids can only be seen by everting them. If the lids are not too much swollen the lashes may be grasped with the fingers of the left hand, and the point of a pencil or match, held in the right hand, is

placed firmly just above the upper border of the tarsal plate, and the lid easily everted (Fig. 18). It is necessary to acquire this facility, for the conjunctiva of the upper lid is frequently the only part diseased, or at any rate shows the most typical lesions of the disease. The small area of concavity of the tarsal plate is a frequent site for the lodgment of foreign bodies.

The Cornea is examined by four methods: (1) The corneal magnifier, or what is better the + 12 to + 16 lens of an ophthalmoscope; (2) the corneal reflex; (3) oblique illumination; and (4) fluorescine stain. (1) *The corneal magnifier* simply enlarges the portion examined, and enables the observer to more clearly make out the condition, whether superficial, deep or interstitial. (2) *The light reflex* is obtained by directing the eye in such a manner that the reflection of a window placed directly opposite is visible on the cornea. By having the eye follow a finger the reflection is gradually brought on all parts of the cornea, of whose curvature and smoothness we may in this way get an impression. (3) *Oblique illumination* (Fig. 19) is obtained by focusing rays of light upon the cornea by means of a convex lens, a + 16 lens usually being used for this purpose. A light is placed at the side between the observer and the patient and the rays concentrated by the lens to a cone of light, the apex of which falls upon the portion of the cornea to be examined. The point of illumination stands out clearly because of the concentration of light, and in this way we may recognize conditions which are not visible by other methods. The iris and part of the lens can be examined by oblique illumination by simply varying the depth to which the light is projected. (4) *Fluorescine,* 2 per cent. solution, dropped into the eye or applied to the cornea will stain green any portion of the cornea devoid of epithelium. This is of value in marking out definitely the extent of superficial loss of substance or ulceration not seen plainly by other methods. To test the *sensibility* of the cornea, touch lightly with the end of a piece of thread.

The Anterior Chamber is examined as to its depth, *i.e.*, whether shallower or deeper than normal, or of unequal depth; also examined for the presence of blood, pus, exudate, or foreign bodies.

The Iris is examined as to its color, and the clearness with which its markings are made out. The reaction of light and accommodation are obtained, also the character of this reaction whether active, sluggish, or absent. We next determine whether or not there are any attachments to the cornea *(anterior synechiæ)* or to the lens *(posterior synechiæ)*. The latter may only be determined by dilatation of the pupil with homatropine or atropine. This, of course,

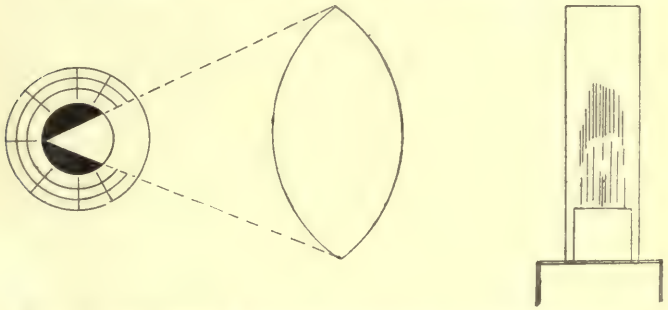


Fig. 19.—Method of oblique illumination in examination of the eye. *(Ball.)*

would not be resorted to unless there was just cause to suspect adhesions. *Direct reaction* to light is obtained by holding the hands over both eyes and quickly exposing the eye to be examined to the light, when the pupil should contract. *Consensual reaction* to light is the contraction of the pupil of the eye examined when the other eye is quickly exposed to light.

The Lens can be partially examined by oblique illumination, which brings into view the anterior surface and slight depth which lies in the pupillary area. This is of value in showing the depth of the shadow cast by the iris, which will be more fully explained in the chapter on cataract. The center of the lens can be seen by reflected

light through a small pupil, but to examine the lens extensively we must dilate the pupil with homatropine or cocaine. If the lens is transparent or semi-transparent the ophthalmoscope enables us to arrive at the best conclusion in regard to its condition. The presence or absence of the lens is best determined by means of the Purkinje-Sanson's reflex images. If a candle be placed in front and to the side of the eye, two brilliant reflexes will be observed: the first, clear and shining, will be on the anterior surface of the cornea and is upright; the second reflex is quite as bright, but is small and inverted. It is situated on the pos-

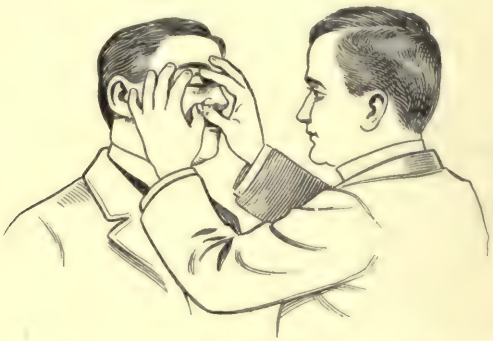


Fig. 20.—Method of testing the tension of the eye. *(Ball.)*

terior capsule of the lens, and is distinguished by moving in an opposite direction to the light, when the latter is moved. This second inverted image will not be seen in the absence of the lens.

The lens (mostly), vitreous, and fundus, which includes optic nerve, retina, and choroid can only be examined by means of the ophthalmoscope, so this instrument, and the way in which it is used, will be described. Before proceeding to the ophthalmoscopic examination the *tension* of the eye should be taken. This is done by palpating the globe through the upper lid with the two index fingers, while the patient looks down (Fig. 20). The eye will feel, as compared with a normal eye, soft or hard. The increased tension is usually classed as + 1, + 2, and + 3; + 1 is

above normal, + 2 is harder than + 1, but the eye can still be indented; + 3 is stone hard, on which the fingers can make no impression.

The ophthalmoscope (Fig. 21) is an instrument composed of a series of concave and convex lenses correspond-

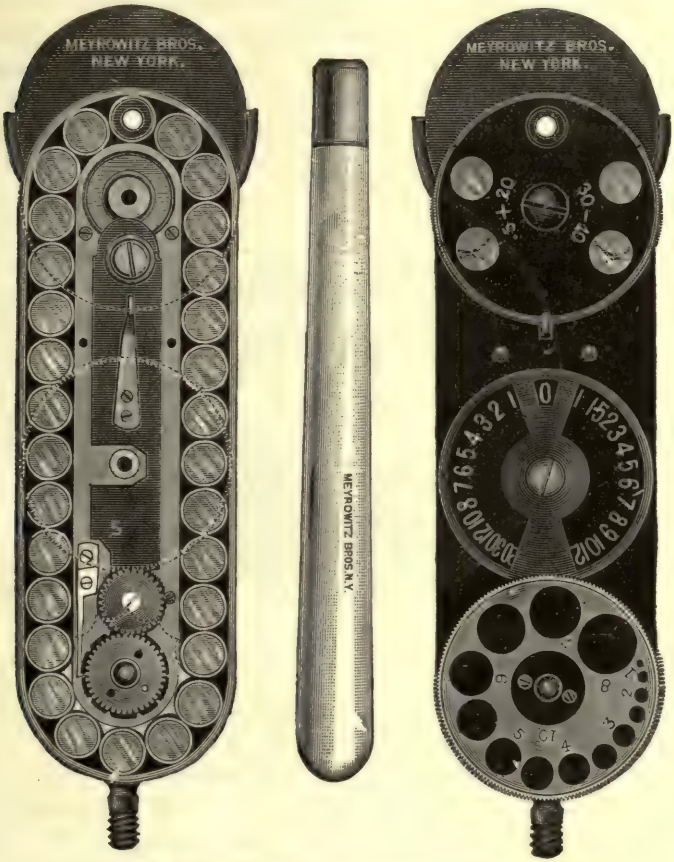


Fig. 21.—The ophthalmoscope. *(Ball.)*

ing to possible refractive errors of an eye to be examined by the direct method, and a tilting mirror, usually concave, for reflecting the light into the eye to be examined. This mirror has a centrally placed hole through which the examiner

is enabled to see into the interior of the eye. The room in which the examination is made is darkened, and the light is placed at the side of and slightly behind the patient. The light is thrown into the back of the eye by the mirror of the ophthalmoscope, which is held close to the observer's eye; the rays of light reflected from the fundus return in part to the source of light and partly, through the hole in the mirror, to the eye of the observer. There are two methods of examination with the ophthalmoscope. In the first, the *direct method* with upright image, the observer places

Fig. 22.—The direct method of examining the fundus with the ophthalmoscope. *(Ball.)*

himself and the mirror directly in front of the eye to be examined (Fig. 22). If the mirror is correctly arranged so that the light is reflected into the patient's eye, the observer will immediately get a clear distinct view of the fundus in normal cases. If the patient be myopic, the concave lens to suit his refraction is rotated behind the hole in the mirror; if hypermetropic, convex lenses are so placed. A beginner will usually accommodate somewhat himself; so, in order to obtain a clear image of the fundus, it will be necessary for him to overcome this accommodation by using concave lenses in the ophthalmoscope. One soon

learns, however, not to accommodate any more than in looking through a microscope.

The indirect method (Fig. 23), with inverted image, is conducted with the aid of a strong convex lens, usually + 16 D. This lens is held in front of the eye at a distance of about 6 cm. The fundus of the eye is then illuminated by means of the ophthalmoscope mirror, which is held by the observer at a distance of about 30 cm. from the patient's eye. The rays reflected from the fundus pass out and are collected by the + 16 lens, and an inverted image is seen between the lens and the ophthalmoscope (23). In order to see this

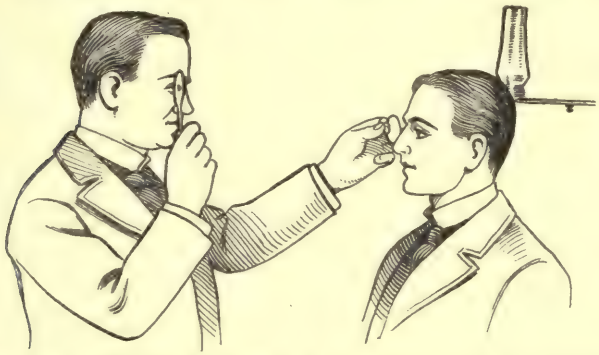


Fig. 23.—The indirect method of ophthalmoscopic examination. *(Ball.)*

image clearly it is usually necessary to use a + 3 or a + 4 lens in the ophthalmoscope. Both methods have their advantages. The erect image is highly magnified, about fourteen times, while the inverted image is magnified but about four times, consequently the former is of advantage in examining more minutely. The indirect method on the other hand gives a much larger field of view. It also gives a more luminous image, and will, for that reason, render a fundus visible, when the refracting media are turbid, which could not be seen with the direct method. In myopia of high degrees it is impossible to see the fundus with the direct method, but with the indirect the details are plainly made out.

The ophthalmoscope is used for testing the transparency of the media of the eye. The ophthalmoscope is held at about reading distance from the eye to be examined, and if the media are clear, the pupil shines with a uniformly red reflex. If there are places in the media which are opaque, such stand out on the red background as dark points or spots. This is the case even when opacities are light colored, white or gray. In making an examination of the fundus it is customary to begin at the optic disc. In order to bring this into view the patient is instructed to look a little toward the side of the examiner which corresponds to the eye examined. That is, for the right eye, the patient looks toward the examiner's right ear, and for the left eye the patient looks toward the left ear. The nerve comes into view as a grayish- or reddish-yellow circle or spot in a red background, through the center of which can be seen entering the branches of the central artery of the retina. About the disc may frequently be seen two rings, distinct in color (Fig. 6); the inner ring next the disc, or papilla, is white, and is called the scleral ring, because in this position the sclera is exposed to view; the outer ring, usually incomplete, is quite black, and is called the choroidal ring or crescent. The demarcation of the disc is usually less distinct on the nasal side, for the reason that a greater number of nerve fibers pass over the disc margin on this side and thus obscure it. For the same reason the inner half of the disc looks redder, the outer half paler, because the layer of nerve fibers over the inner half is thinner and thus allows the lamina cribrosa to show through.

The optic disc, normally, is on the same plane as the retina except in its center, where it usually shows a central depression or cupping. This is produced by the fibers of the optic nerve separating from each other quite early, and in this way leaving a central depression, which is funnel-shaped. The central artery enters on the nasal side of the funnel. This depression may assume, in normal cases, the shape of a real excavation, which frequently extends to the inner margin of the disc, and shows clear white (lamina

cribrosa) at the bottom. This physiological cupping is differentiated from the pathological cupping by the fact that the latter always involves the entire disc.

The arteries are readily distinguished from the veins by the fact that the former are bright red, narrower, and run a straighter course than the veins. The region of the macula is devoid of large vessels; the larger trunks, running above and below, send finer branches into it (Fig. 6). The larger vessels show a white shining streak running along the top. It is somewhat more noticeable in arteries than veins and is called the *vessel reflex*. *A pulsation* is sometimes seen in the vessels as they emerge from the disc. A venous pulse, however, is physiological, while an arterial pulse is pathological and is seen in the condition known as glaucoma. The living healthy retina is not seen with the ophthalmoscope, except the blood vessels which pass through it, because of its transparency. About two disc diameters to the temporal side of the disc, we find the macular region, in the center of which is a bright spot enclosed by a line of brownish-red. This spot is the *fovea centralis,* and can usually only be made out with a dilated pupil. The red background of the retina is the choroid, the individual vessels of which, are not seen except in the albino. This red background is darker in dark complexioned people and lighter in blondes.

The Vitreous and Lens, with dilated pupil, are examined first through the open hole of the ophthalmoscopic mirror. Any opacity of the lens will be made out as a black spot in the otherwise transparent field. Opacities on its posterior surface will move in the opposite direction to that of the eye. Opacities in the vitreous will appear as floating specks or webs, especially on movement of the eyes. To examine the vitreous or lens more minutely a convex lens of 7 D. or 8 D. is placed behind the sight hole of the ophthalmoscope.

The optic nerve, retina, and *choroid* are examined as described under the use of the ophthalmoscope.

In the Subjective Examination we are largely limited to the statements of the patient, and so are dependent upon his co-operation. *Visual acuity* is the ability to recognize the form of objects; *color-sense* is the ability to distinguish colors; and *light-sense* is the ability to distinguish various

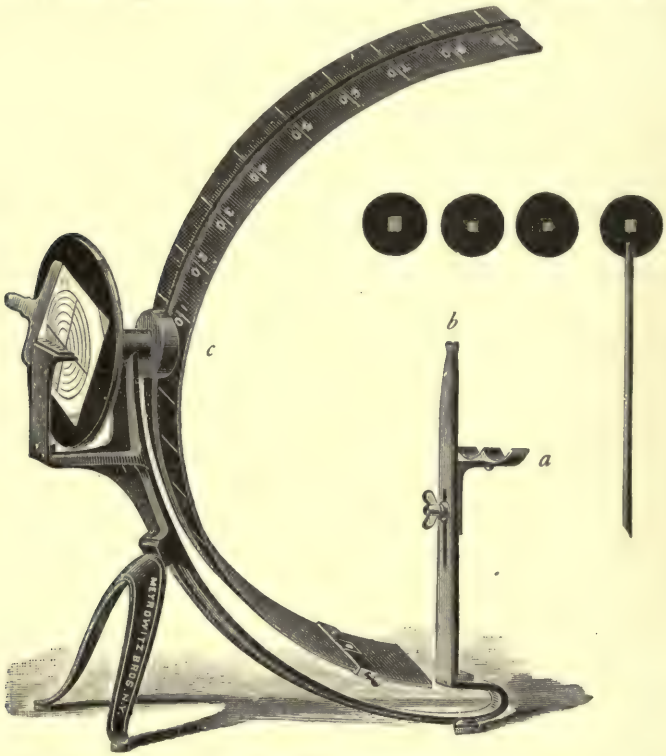


Fig. 24.—The perimeter.

a, Chin rest. *b*, Position of eye to be examined. *c*, Central white dot for fixing vision.

degrees of brightness. These three faculties are present throughout the retina, but in varying degrees; hence we have *central* and *peripheral vision.* Central or direct vision is the vision of the fovea centralis, so that, when we wish to see an object distinctly, we fix it; that is, we make the image of the object fall upon the fovea. It is with reference to this central vision that the refraction, the

accommodation, and the visual activity is rested. Peripheral, or indirect, vision is the vision of that part of the retina outside the fovea. This vision is less distinct; an illustration of which is, when we look at a person on the street the individual is seen clearly, while those about him are indistinctly seen. The farther from the fovea the more indistinct the image. For perception of motion, however, as well as slight differences in luminosity, the periphery of the retina is more sensitive than the center. The use of peripheral vision, though indistinct, is manifold, as is well illustrated in those unfortunates who suffer from a disease called retinitis pigmentosa. With them the only portion of the retina which functionates is the fovea. They may read the finest type, but are unable to go on the street alone because of bumping into things. Therefore peripheral vision gives us orientation. We receive constant warnings on the periphery of the retinæ which enables us to avoid objects obstructing our path, and thus avoid danger.

The Field of Vision is determined for each eye separately, and may be obtained in two ways; one is by using the hand, or a candle, as the test object. The examiner places himself in front of and a short distance from the patient, who looks with the eye to be examined at the examiner's eye opposite. They both close the other eye, and the examiner slowly moves his hand from without inward over the limits of the field of vision; the patient telling as soon as the hand comes into view. The examiner has his own eye as a means of judging the patient's field; which, if normal, will be seen at the same time the examiner sees it. This method answers for rough work, or when fine test objects are unable to be seen. For fine work we have the perimeter (Fig. 24), which marks off on a chart provided for the purpose (Fig. 25) the limits of the field of vision. The perimeter is equipped with different colored squares, so that, if necessary, the limits of color-vision may also be determined with it. The patient supports his chin on the rest (Fig. 24, *a*), so placed that the eye to be examined is in front of the center of curvature of the semi-circle carrying the disc of white or colors (Fig. 24, *b*). The eye is fixed

on the central part of the semi-circular arc (Fig. 24, *c*). A scale of degrees marked on the arc enables the examiner to read at what situation the square is first seen, and this can be marked on the chart.

The normal field of vision does not extend equally in all directions (Fig. 25). It stretches farthest to the temporal side, the nasal side being limited by the nose, the upper side by the eyebrow, and the lower by the cheek. Pathological changes are noticed in a narrowing of the whole field, or only part of the field. A peculiar variety is found in hemianopsia, in which exactly half the field is

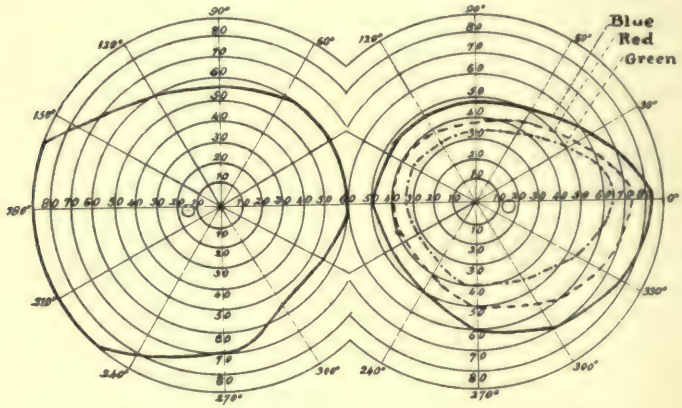


Fig. 25.—Normal field for form and colors.

wanting (Fig. 90). Other defects are variously shaped islands of absence of vision known as scotomata. One island is normal; that which marks the entrance of the optic nerve, or the blind spot.

The Color Fields (Fig. 25) are narrower than the field for form or white. Blue giving the widest field, red the next, and green the smallest of all. The tests for color perception are best made with a series of skeins of colored wool. The patient assorts these various colors without naming them. If color-blind he will expose his defect by placing together, or confusing, certain colors or shades which to the normal eye appear quite different. The most common form is the red-green.

The refraction of the eye and disturbances in motility will be taken up separately in subsequent chapters.

A Test for Color-Blindness.—In making any test for color-blindness the examiner must be certain that the patient does not cleverly cover up this defect. This deception is usually found in those men who wish to enter any service where accurate color perception is necessary.

A very good test is that of Oliver's, which consists in placing a table covered with a black cloth about a yard in front of the patient, on which are placed the test skeins which come with Oliver's test set. Each eye of the patient is to be tested separately. One of the pure colors such as green, red, or yellow is handed the patient and he is told to select from the pile of mixed and confusing colors the skeins which nearly match the skein handed him, and place them beside the first skein in the order chosen. The lettering on the tags attached to the skeins are taken note of in the order of their choice, and all then replaced in the general pile and mixed up. Four or five pure colors are matched by the patient in this way. A glance at the record at the end of the test will enable the examiner to determine the kind and character of the color-blindness.

Tests for Central Color Scotoma.—The most active method is by means of the perimeter. The patient is seated before this instrument, as in the test for the field of vision, but instead of a white square, a blue, red, or green is placed as an object. It will be noticed that the little green square is called green by the patient when it falls outside the center of the field of vision, but no color is distinguished when the square occupies the area about the center of the field. Definite outlines of central color scotomata may be obtained in this way.

Another simple test which is reasonably accurate for quick work, is to cut a small round hole in a piece of white cardboard, and have the patient look at this hole, with one eye at a time, and call the various colors as the examiner rotates them behind the hole. This test is an excellent guide, and may be used preliminary to the more exact perimeter test.

CHAPTER V.

REFRACTION.

In the refraction of a normal eye we mean the state of its refraction in a condition of rest. The normal eye is so constructed that parallel rays come to a focus on the retina; which condition is called emmetropia (Fig. 26). The emmetropic eye having no refractive error, external objects are distinctly seen without the aid of artificial means, and for distance, without accommodative effort. Variations from the normal, from a refractive standpoint, are called hypermetropia, myopia, astigmatism, and presbyopia.

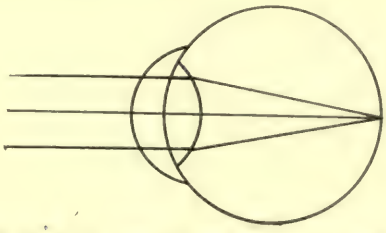


Fig. 26.—The focus of parallel rays of light in the normal eye. *(Ball.)*

In refraction we speak of a patient having *n* diopters of hypermetropia, myopia, or astigmatism, depending upon the lens, numbered in the metric system, necessary to correct the refractive error. If a patient's correction for his refractive error is + 1 sphere ⌒ + 1 cylinder axis 180° he is said to have 1.00 diopter of hypermetropia combined with 1.00 diopter of hypermetropic astigmatism. The usual abbreviation of diopter is D.

Hypermetropia, or far-sight, is that condition of the eye which is anatomically short, hence only convergent rays come to a focus on the retina. Parallel rays come to a

focus behind the retina (Fig. 27). For this reason, the image thrown upon the retina is indistinct, and a diffusion circle is formed there. In young people who have active accommodation, this is overcome by the ciliary muscle contracting for distance and, by thus increasing the convexity of the lens, the parallel rays are brought to a focus on the retina. This can only be done, however, in hypermetropia of moderately low degree; not higher usually than 4 or 5 D. In hypermetropia of higher degrees than 5 D., the eye fails to respond, and the person with far-sighted eyes is really short-sighted in the sense that they do not see clearly.

This anatomical condition of the eye gives rise to numerous *symptoms* depending upon the degree of hyper-

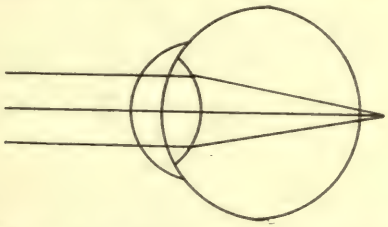


Fig. 27.—Focus of parallel rays in hypermetropia. *(Ball.)*

metropia. Patients suffering from far-sightedness of less than 4.5 D. complain of headache, which is usually frontal in type, and comes on most frequently after the use of the eyes. Symptoms largely depend, of course, upon the age, for the younger the individual the more readily can he accommodate and overcome, as a rule, without symptoms, hypermetropia of low degree. The headache is seldom or never present in the early part of the day, because of the fact that during sleep the ciliary muscle has become rested. The double strain put upon the ciliary muscle for near work gives rise to symptoms of blurring, pain, and headache, especially in those required to do more or less reading, writing, or fine near work during the day. Clerks frequently give the history of constant headache and pain in the eyes every day in the week except Sunday. This points to

a refractive error, usually hypermetropia. Another symptom is that presbyopia sets in much earlier than in emmetropic eyes, and, as the patient grows older and the lenses become less elastic, the correction of the hypermetropia becomes imperative, in order that distant objects may be distinctly seen. Almost all new-born children are hypermetropic. As the child grows the eye grows, and becomes normal or even myopic, or it may remain permanently hypermetropic and give rise to symptoms described above. High degrees of hypermetropia frequently cause no headaches, or other nervous symptoms; patients complaining simply of poor sight. They usually say that they are very near-sighted.

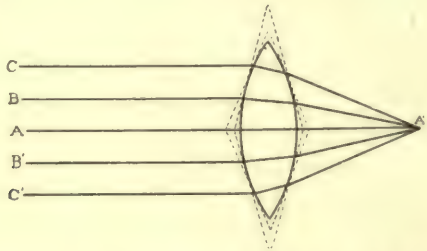


Fig. 28.—Union of parallel rays effected by a convex lens. *(Fuchs.)*

Hypermetropia cannot be cured, we can only relieve the symptoms by the proper fitting of lenses. It is best to correct the hypermetropia and render the eye as nearly emmetropic as possible, and for this reason, in persons complaining of symptoms other than those occurring during near work, the glasses correcting hypermetropia should be worn constantly; certainly until symptoms are relieved and no longer recur when the glasses are simply worn for near work. Hypermetropia is corrected by plus (+) or convex lenses, the eye needing a lens which converges rays of light (Fig. 28). Rays of light passing through a prism are deflected toward its base; hence a convex lens may be considered as two prisms placed base to base.

To test the vision the patient is placed 6 meters (20 feet) from a test card, the letters of which are so mathe-

matically formed (Snellen; Fig. 29) that the seventh line of letters should be distinctly seen at that distance by the normal eye (Fig. 29). The card should be well and equally illuminated, preferably by artificial light, as this is constant. The first line, the E should be seen by the normal eye at 200 feet, the third line at 70 feet, the seventh line at 20 feet. So a patient able to read but the top letter would have but $^{20}/_{200}$ or $^{1}/_{10}$; if able to read no lower than

Fig. 29.—Test card after Snellen (reduced). *(Ball.)*

the third line, the vision would be $^{20}/_{70}$ or $^{2}/_{7}$; if able to read the seventh line the vision would be $^{20}/_{20}$ or 1, or normal. Illiterate test cards are made for those who cannot read (Fig. 30). Hypermetropes, especially under 2 D. usually see $^{20}/_{20}$ or better, due to accommodative effort. Convex lenses placed in the trial frame will, up to a certain strength, increase the visual acuity slightly, or at any rate will not diminish it. The strongest convex lens which gives the best visual acuity corrects the *manifest hypermetropia*. Owing to the active accommodation and the

increased development of the ciliary muscle, the manifest hypermetropia is but a portion of the real hypermetropia, and a correction of the manifest hypermetropia will not relieve, or at least only in part, the symptoms. The difference between the full amount of the hypermetropia and the manifest hypermetropia is called the *latent hypermetropia,* and this is brought out only by the use of a cycloplegic. In young people atropine is the agent used in ½ per cent. solution twice a day for a week. In older people homatropine in 2 per cent. solution instilled into the eyes every half hour for six or seven times is usually sufficient to produce enough mydriatic and cycloplegic effect. Homatropine has the advantage over atropine in that the mydriatic effect lasts but from twenty-four to thirty hours, while with atropine the effect lasts a week or ten days. When there remains persistent ciliary spasm after the use of homatropine, with a resultant unsatisfactory test, it becomes necessary to use the more powerful and more certain mydriatic, atropine.

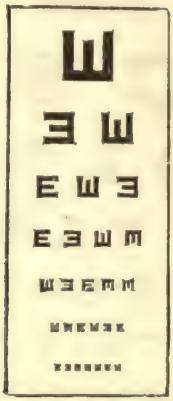


Fig. 30.—Test chart for illiterates.

There are several ways of determining the full amount of hypermetropia, but it will be sufficient to know two, which combined make a satisfactory test. The first is at the trial case (Fig. 31), which is a case filled with lenses suitable for the correction of all kinds of refractive errors.

hypermetropic, myopic, and astigmatic. The lenses (Fig. 32) are numbered in the metric system, that is a + 1 D. has a focal length of 1 meter, and they range in strength from .12 D. to 20 D. It will be found upon placing the patient, whose eyes are atropinized, before the test card that his vision is diminished considerably from that which he was

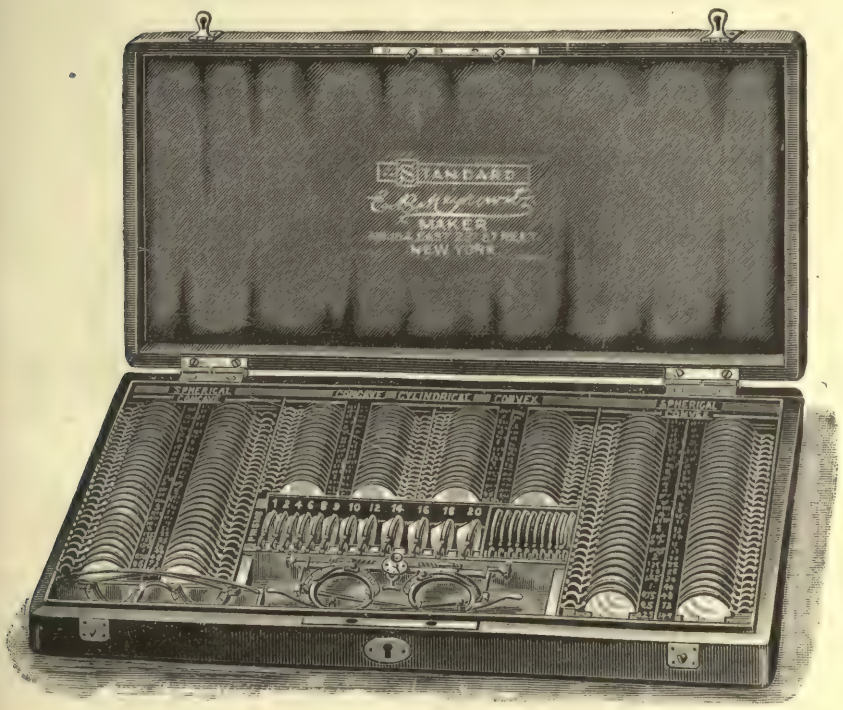


Fig. 31.—Trial case.

able to see without atropine. This is because the atropine has paralyzed the ciliary muscle, and it is no longer able to overcome the hypermetropia. So that instead of seeing $^{20}/_{20}$ the patient may frequently only see $^{20}/_{200}$ or even worse. This gradually increases to better vision by placing convex spheres before the eyes, until we reach normal or better. The *highest* plus lens necessary to give clear cut vision will

correct the hypermetropia. At this point in the test, increase the glass correcting the full amount by 1 or 1.5 D., and work back gradually by use of weak concave spheres until clear vision is established. In this way one frequently gets the patient to accept a higher plus glass than by working from below upward. It is hardly necessary to say that but one eye should be examined at a time. The trial frame (Fig. 33) should be absolutely adjusted to each individual patient, so that before proceeding with the examination the eyes should be in the exact center of the circles for the support of the lens. If care is not taken in this particular the result will be inaccurate.

Fig. 32.—Samples of test lenses.

The second way of determining the amount of hypermetropia, and the only way it can be determined in those who are unable to read, especially children, is by means of the retinoscope. The room is darkened, as described under the use of the ophthalmoscope, and the patient seated near the source of light, which preferably should come from behind and to the side, through the opening in a Thorington chimney. This chimney is made of asbestos and is blackened; placed opposite the portion of the flame of an argand burner, which gives the most light, is a round hole, controlled by an adjustable diaphragm, through which the light comes. By means of this diaphragm we are able to regulate

the amount of light. The retinoscope, also Thorington's (Fig. 34), is then placed before the examiner's eye and held at about 1 m. distance from the patient's eye; the light is thrown into the back of the eye to be refracted, and there comes into view the red reflex seen with the ophthalmoscope. The mirror of the retinoscope is plain, and upon moving this mirror we get a shadow on the red background, which in hypermetropia moves in the direction of the mirror (Figs. 35, 36 and 43, *a*). This light area is hard to describe, for it must really be seen to be appreciated. It is best described as a faint, light, cloud-like haze on a red back-

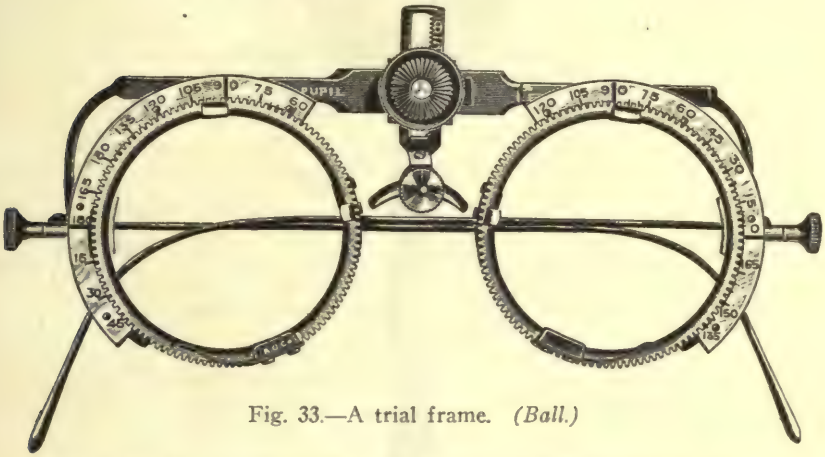


Fig. 33.—A trial frame. *(Ball.)*

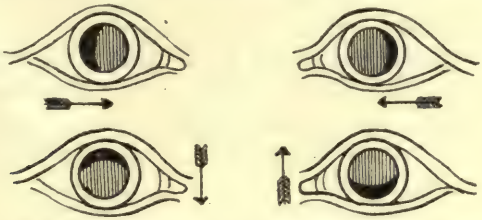
ground. It, at any rate, is a cloudy effect that moves as the mirror moves. The slower the movement of the light area the greater the refractive error. One examining eyes by retinoscopy constantly, soon acquires the ability to estimate quite accurately the extent of the refractive error at a single glance. Convex lenses are placed before the eye, as at the trial case, and increased in strength until the motion of the light area ceases, or, better, until the next highest strength lens makes the light area go in the *opposite* direction. This is the point of reversal, or neutralization, and by it we determine the exact amount of hypermetropia. The light area is neutralized in two principal meridians of the eye, the vertical

and horizontal. The number neutralizing the light area is ascertained, and to this number is added — 1 D., to allow for the 1 meter's distance we held the retinoscope from the eye, or, better, to allow for the rays projected into the eye from a meter distance, when we wish to determine the refraction of the parallel rays. Should the light area have neutralized with a + 4.50 D., we add — 1.00 D. for the amount of

Fig. 34.—Thorington's retinoscope.

hypermetropia for the eye. The patient is again placed before the test card, and, if the retinoscopy has been accurately done, a + 3.50 spherical lens should give the best visual acuity, or should at least be the strongest convex lens giving the best visual acuity. It is best to use both methods, and check one by the other. In this way the end result becomes more accurate. By these tests have been determined the complete hypermetropia. Should, however, this

lens be prescribed for a patient the vision would be very much blurred after the cycloplegic effect had worn off, which might give rise to symptoms more aggravating to the patient than those previously complained of. It is the custom, therefore, to deduct from this full amount .5 D. or 1 D., depending upon the degree of hypermetropia, or individual judgment. Such lenses worn constantly should bring relief from all symptoms caused by the hypermetropia.



Figs. 35 and 36.—Diagrammatic representation of the retinoscopic illumination in hypermetropia.

Myopia, or short-sightedness, is that refractive condition of the eye in which parallel rays come to a focus in front of the retina (Fig. 38). The eye is anatomically longer in its antero-posterior diameter than the emmetropic eye, hence rays strike the retina that have already become divergent, and thus form a diffusion circle, which gives a blurred image. Hence it is that a distinct image is formed upon the retina only when the rays are divergent, as is the

Fig. 37.—Retinoscopic illumination in myopia.

case when they emanate from a nearby object (Fig. 38, *D*). Accordingly, the far point of a myopic eye lies at a finite distance, in contrast to the far point of an emmetropic eye, which lies at an infinite distance. The greater the degree of myopia, the greater must be the divergence of the rays in order to unite on the retina, hence the nearer the object must be in order that it may be distinctly seen.

From the foregoing it can be plainly seen that the only way in which myopia can be corrected, and the patient enabled to see distant objects clearly, is by making parallel rays of light divergent. The concave glass may be considered as two prisms placed apex to apex (Fig. 39), hence myopia is corrected, according to its degree, by concave spherical lenses, which are arranged in a series in the trial case from .12 D. to 20 D., and are called minus lenses. The patient is tested in two ways, as in hypermetropia, with the test card and trial case, and by retinoscopy. Should we determine a patient's far point to be, say 50 centimeters, we should use to correct his myopia a lens with a focal length of 50 centimeters, or — 2 D. This would have the effect of making parallel rays diverge to a similar angle of the rays

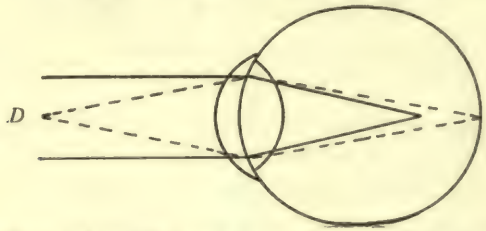


Fig. 38.—Focus of parallel rays in myopia. *D*, far point. *(Ball.)*

emanating from 50 centimeters distant, and thus parallel rays would come to a focus on the retina, and the myopic eye would be put in a condition of emmetropia. The glass correcting the myopia is determined by placing in front of the eye tested concave spherical lenses until normal visual acuity, or better, is obtained. As in hypermetropia accommodation comes into play, although to a much less extent, and the manifest myopia may exceed the total myopia. Roughly, the concave lens of *lowest* strength giving the best visual acuity corrects the manifest myopia. It is best, therefore, to use a cycloplegic, especially in young people, to accurately determine the myopia. Patients frequently show a somewhat better visual acuity, without glasses, when the eye is under the influence of a cycloplegic than before the cycloplegic is used. A cycloplegic should always be used in cases

of sudden development of myopia because the majority of such cases are not due to a real myopic eye, but to spasm of the ciliary muscle, producing an artificial myopia. These cases, of course, should be treated some time preliminary to the final test with ½ per cent. or 1 per cent. atropine two or three times a day. It will usually be found that the lowest strength concave lens giving the best acuity is lower than without a cycloplegic. Should the lowest minus lens found without a cycloplegic be given it would improve the vision considerably, but might bring on symptoms similar to those of hypermetropia. With the retinoscope the light area appears much the same as in hypermetropia with this great difference, however, that it moves in the *opposite* direction

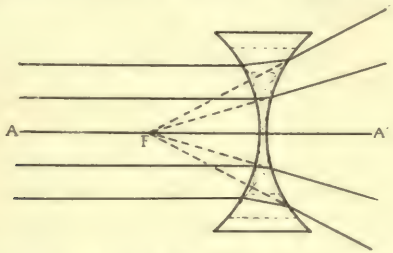


Fig. 39.—Dispersion of parallel rays by a concave lens. *(Alger.)*

to the plane mirror (Fig. 37 and Fig. 44, *a*). Its point of reversal, or neutralization, is obtained by placing concave lenses before the eye of increasing strength until the motion reverses; *i.e.*, goes with the mirror. The next lowest will then give the point of reversal. Should this be, for example, with a —6.5 D. we add —1 D., as in hypermetropia, for our meter's distance, and the myopia will be —6.50 D. + —1.00 or —7.50 D. Should our retinoscopy be correct —7.50 D. will be the weakest concave lens giving the best visual acuity.

Myopes, especially of high degrees, do not accommodate much, and we frequently find atrophy of the ciliary muscle from disuse, in cases not previously corrected by glasses. This has led many oculists to prescribe a weaker concave lens for near, or they have allowed their patients to

go without a glass for near work. This is faulty treatment, and will not prevent the continued development of the disease. The eye should be placed in as nearly an emmetropic condition as possible, both for distance and near, and by training, force the ciliary muscle to do its proper amount of work. I have in my records two cases of progressive myopia in children under fourteen years of age, who came to me wearing lenses which did not correct a third of their total myopia, and with a history of quite rapidly diminishing vision for six months and a year. One had a myopia of 19 D. and the other of 18 D., which was determined by cycloplegic test, and they were given at once the full correction to be worn constantly. This they were able to do with comfort after a week or ten days. At the end of a year, the myopia in one case had increased but .50 D. in one eye, and .75 D. in the other; the second case showed no advancement of the myopia. Give lowest concave glass that gives best visual acuity under cycloplegic, for constant use.

Symptoms of myopia are practically confined to those arising from poor vision.

Astigmatism is that anatomical condition of the eye in which the two principal diameters of the eye are unequal, hence parallel rays of light entering such an eye have not a common focus. In other words in regular astigmatism the diameter of the eye corresponding to 90° is greater than the axis 180°, or *vice versâ*. It must be understood, as will be brought out later, that the two principal diameters are not confined to these two axes. There are many kinds of astigmatism, of which simple, compound, mixed, irregular, operative, and spastic will be considered.

Simple Astigmatism is of two kinds, hypermetropic and myopic. Hypermetropic astigmatism is that refractive condition of the eye in which one diameter is hypermetropic, the other normal. The astigmatism is said to be with the rule (usual), when the axis 180 is hypermetropic, and the axis 90 normal. This astigmatism may be of such high degree, that the patient suffering from it can only tell, in the natural position of the head, when the hands of a clock

are vertical, as for instance 6 o'clock. Myles Standish, of Boston, advanced the theory, in a stereoptician lecture given before the Art Club of that city, that the original impressionistic pictures must have been painted by artists whose astigmatism was uncorrected by glasses. This was demonstrated in one artist whose pictures suddenly became as the normal eye would see things. Upon investigation it was found that he had put on glasses, after which things had become right. Myopic astigmatism is a refractive condition of the eye in which one of its principal diameters is myopic, the other normal. Myopic astigmatism, with the rule, is when the axis 90 is myopic, the axis 180 normal.

Compound Astigmatism is also of two kinds, compound hypermetropic and compound myopic astigmatism. In both these forms a hypermetropia or a myopia, as the case may be, is superimposed upon an astigmatism of its own kind. A compound myopic astigmatism is that refractive condition of the eye in which both axes of the eye are myopic, but one axis, usually that of 90 is more myopic than 180. A compound hypermetropic astigmatism is where both principal axes are hypermetropic, but one axis, usually 180, is more hypermetropic than 90.

Mixed Astigmatism is that refractive condition of the eye in which one principal axis is hypermetropic and the other myopic. The hypermetropic axis is usually 180, the myopic axis 90.

In testing for the forms of astigmatism previously mentioned, three methods are combined; the trial case, retinoscopy, and astigmatic charts. The test cards and trial case are used as described under hypermetropia. The visual acuity without glasses will depend upon the degree of astigmatism; the greater the astigmatism the lower the visual acuity. Place before the eye to be tested + spherical lenses of increasing strength until improvement ceases to be noticed. This will not correct the hypermetropia necessarily, but serves as a guide in determining the character of the case. Should the weakest + sphere diminish the vision use — spheres, as in the trial-case test for myopia, until no further improvement is noticed. This also serves as a guide

simply. Should there be no improvement with + or — spheres, we proceed at once to the astigmatic chart test, to be described shortly. If the patient's vision improves with + spheres, increase the strength of the best glass by 1.00 or 1.50 D.; this will cause everything to be blurred, because the eye has been rendered artificially myopic. In place of the test card have the patient now look at the astigmatic chart (Fig. 40). This chart is arranged in the shape of a fan, the ribs of which are placed exactly 10° apart. The patient will see one, two, or three of the lines much more clearly

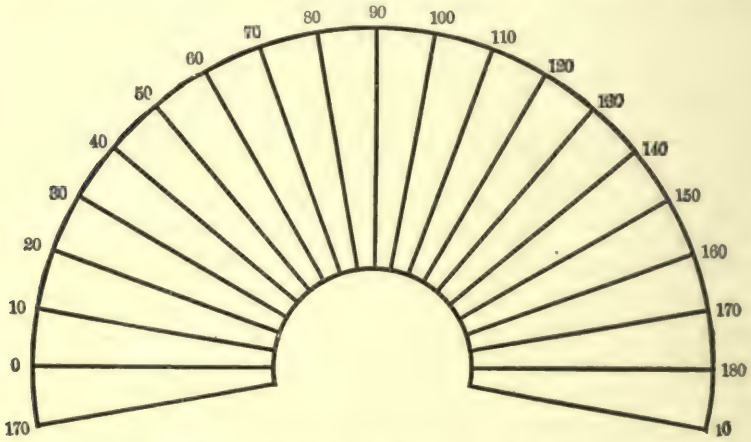


Fig. 40.—Author's astigmatic chart No. 1.

than the others should the eye be astigmatic, and the axis corresponding to the line seen most distinctly, or the axis lying between two lines, if two are seen equally clearly, will be the axis in which the cylindrical lens should be placed to correct the astigmatism, should it be hypermetropic. If, for example, the patient sees most clearly the lines marked 110 and 120 the cylinder to correct the astigmatism will be placed in the trial frame, axis 115 (Fig. 33). Should the 90 be the only clear line, that will be the axis of the correcting lens. In order to determine the strength of the lens needed to correct this astigmatism the second chart is placed before the patient. This chart (Fig. 41) consists of a

circular disc, which is rotary. The short heavy black line shown at 90° is turned into the position of the blackest line chosen on Fig. 40. The fine lines running in the same direction as the short line will be clear and distinct, while those at right angles will be blurred, or not even seen. The object now is to make the small lines of equal density. This

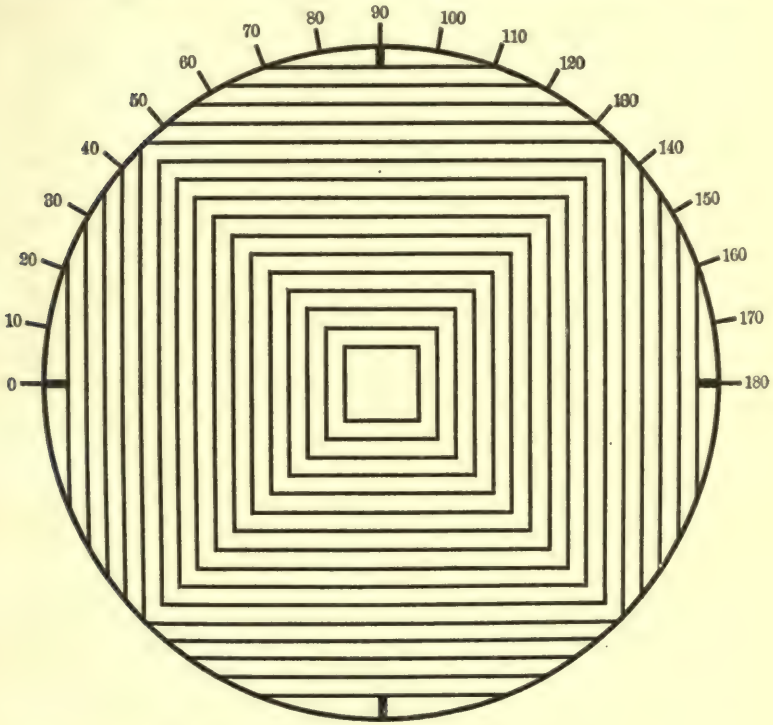


Fig. 41.—Author's astigmatic chart No. 2.

is done by placing before the eye, on top of the sphere already there, minus cylinders in the opposite axis to the position in which we have put the clearly marked lines. For example, should the patient have chosen axis 115 on Fig. 40, and we had rotated the disc in Fig. 41, so that the small lines running in the same direction were placed in the axis 115, the cylinder is placed in the trial frame at axis 25.

We gradually increase the strength of the cylinders until the lines forming the squares are of equal density. The figure may then have definite perspective; *i.e.*, the small central square will seem farther away than the others, or it will look simply like a nest of boxes. The strength of the cylinder by which this result was determined is ascertained, and a + cylinder of the same strength is put in the front of the trial frame in the opposite axis to the one in which the — cylinder had been previously placed. The strength of the sphere in the trial frame is now reduced until the best visual acuity is obtained. The glass made from the two lenses remaining in the frame at that time will be the glass which will correct the compound hypermetropic astigmatism. For example, the patient's vision improved with the addition of + spheres up to 1.00 D.; + 1.25 blurred. Then + 2.00 was put in trial frame and the test with astigmatic charts made; patient saw line 100 clearest, astigmatic chart No. 2 (Fig. 41) was then rotated so that one set of fine lines corresponded to axis 100, and the fine lines at opposite axis, 10, were not made out; — cylinders were then placed in the trial frame in axis 10, up to the strength of — 1.00, when lines in axis 10 became of same density and clearness as the lines in axis 100. The cylinder was then removed and a + cylinder, strength 1.00 D. was placed in trial frame axis 100, and the + 2.00 spherical reduced in strength until the letters on the test card in line 7 or 8 became clear and distinct. This, we will say, was when the strength had been reduced to + .75. The glass correcting this compound hypermetropic astigmatism would be a + .75 spherical combined with a + 1.00 cylindrical lens in the axis of 100 degrees. This is abbreviated and written on a prescription as follows: + .75 Sph. ⊃ + 1.00 Cyl. 100°.

Astigmatism being a difference in the focal length of the two principal diameters of the eye, we must correct one diameter more than the other, and this is done by means of a cylindrical lens, which refracts rays of light only at right angles to its axis (Fig. 42). Supposing we determine the

axis of an astigmatism to be 10, the cylinder correcting that would be placed before the eye in axis 100, as in the foregoing example.

In myopic or compound myopic astigmatism we proceed somewhat differently than in hypermetropic. In simple myopic astigmatism, where the addition of a + sphere gives little or no improvement, we add a weak + sphere to blurr the normal diameter slightly, and then after picking out the best line, as in the previous test, we make the lines in chart No. 2 equally clear or equally blurred with a — cylinder. The cylinder is left in the trial frame,

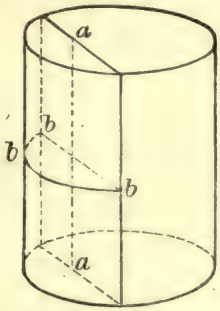


Fig. 42.—The convex cylindrical lens considered as a segment of a cylinder. *(Fuchs.)*

and the weak + sphere removed. If there be but simple myopic astigmatism, the — cylinder neutralizing the lines will give the best visual acuity. Should there be a compound myopic astigmatism a — sphere will have to be added to the — cylinder to give the best visual results. As in pure myopia this should be the lowest — sphere giving the best visual acuity. If there be a high myopia combined with astigmatism, we first find the — spherical lens giving the best vision, then reduce this by 1.00 or 1.50 and proceed as in simple myopic astigmatism.

In mixed astigmatism the charts are used as in other forms, but usually the most satisfactory test is by retinoscopy. It is understood that in these tests, the eyes, espe-

cially in young people, are under the influence of a cycloplegic. The astigmatic tests are more reliable if a cycloplegic is used; there are many tests though, which give satisfactory results without a cycloplegic examination. The light area seen in retinoscopy of the astigmatic eye differs from that of pure hypermetropia or myopia. It frequently shows as a definite band (Figs. 43, *b* and 44, *b*) in hypermetropic astigmatism, which moves slowly in the horizontal meridian with the mirror, and more rapidly in the vertical meridian; this being the case if the astigmatism is with the rule. In well-marked cases of mixed astigmatism the light area will move with the mirror horizontally and against the mirror vertically, or *vice versâ*. In myopic or compound myopic astigmatism the light area forms a band most

Fig. 43.—*a*, Hypermetropic astigmatism, off axis. *b*, Astigmatic band, showing scissors movement.

marked at right angles to the axis of the astigmatism (Fig. 44, *b*). This light area moves slowly against the mirror in the axis at right angles to the light band, and less slowly in the axis of the light band. There follow three examples of astigmatic lenses determined by retinoscopy; one for each of the three previously mentioned forms. The cross represents the two principal diameters of the eye and the numbers the strength glass necessary to neutralize the shadow in that meridian. O.D. stands for right eye; O.S. for left.

	O.D.		O.S.
—	+ 1.50	—	+ 1.25
+	+ 2.75	+	+ 2.75

To these results we add — 1.00 for the meter's distance the examiner sits from the patient, and hence the figures must be changed as follows:—

O.D.	O.S.
+ 0.50	+ 0.25
+ 1.75	+ 1.75

In the right eye in the example given, there is a hypermetropia of 0.50 D. in the vertical meridian and 1.75 D. in the horizontal meridian, and therefore if we place a + .50 spherical lens before the patient's right eye we correct the hypermetropia in the vertical meridian and 0.50 D. of the hypermetropia in the horizontal meridian, thus leaving in the horizontal meridian 1.25 D. of hypermetropia uncorrected. This 1.25 is the amount of the astigmatism, and is corrected by placing a + 1.25 cylinder in front of the patient's eye, with the axis at right angles to the horizontal meridian. From this it can readily be seen that the glass

Fig. 44.—*a*, Myopic astigmatism, off axis. *b*, Diagrammatic representation of the retinoscopic illumination in hypermetropic astigmatism.

correcting such an error is written + .50 Sph. ⊃ + 1.25 Cyl. 90°. The left eye is determined in the same way. A good rule to remember in determining the amount of astigmatism from retinoscopy is: If signs are alike subtract; if unlike add. In the preceding example the shadow was neutralizd in both meridians by a + sphere, therefore the astigmatism was the difference between the two results.

2. Compound myopic astigmatism.

O.D.	O.S.
— 6.00	— 6.50
— 3.00	— 3.00

Here again we add — 1.00 and get

— 7.00	— 7.50
— 4.00	— 4.00

Signs are alike, so we subtract to obtain amount of astigmatism which in right eye is 3.00 and in the left eye 3.50.

The myopia in both is 4.00, so the glasses correcting such an error are written O.D. — 4.00 S. ⊃ — 3.00 Cyl. 180° and O.S. — 4.00 S. ⊃ — 3.50 Cyl. 180°, because the cylinder is placed at right angles to the astigmatism which is 90.

3. Mixed astigmatism.

	O.D.		O.S.
—|—	— 2.00 + 3.00	|—	— 1.75 + 3.00

After adding a — 1.00 to these results we get

—|—	— 3.00 + 2.00	—|—	— 2.75 + 2.00

In this case the signs are unlike, so we add to get the amount of the astigmatism. In the right eye it would be 5.00, and in the left 4.75. This can be corrected by three combinations of lenses. The right eye only will be taken as an ex-

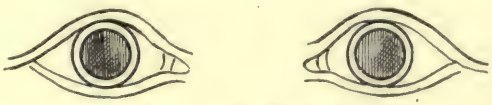


Fig. 45.—Fundus reflex.

ample. (*a*) The vertical meridian shows a myopia of 3.00 D., so we place before the eye in the trial frame a — 3.00 sphere. The horizontal meridian is hypermetropic 2.00 D., and by placing before the eye a — 3.00 sphere we have artificially increased the hypermetropia 3.00 D., making a total of 5.00. This is the amount of the astigmatism previously determined, and we place a + 5.00 Cyl. axis 90 over the — 3.00 sphere. The result will thus be — 3.00 Sph. ⊃ + 5.00 Cyl. 90°. (*b*) The horizontal meridian shows a hypermetropia of 2.00 D., so we place before the eye in the trial frame a + 2.00 spherical lens. This corrects the hypermetropia in horizontal meridian, but has caused a total myopia in the vertical meridian of 5.00. Here again is the amount of the astigmatism, and the glass necessary to correct may be written + 2.00 Sph. ⊃ — 5.00 Cyl. 180°. (*c*) Crossed cylinders corresponding to the two principal meridians. The vertical meridian is myopic 3.00, so we

place a — 3.00 Cyl. 180° in the trial frame. The horizontal meridian is hypermetropic 2.00, so we place a + 2.00 Cyl. 90° over the myopic cylinder in the trial frame, with the result that the correcting glass may be written: — 3.00 Cyl. 180° ⊃ + 2 Cyl. 90°.

Irregular astigmatism is that refractive condition of the eye in which the curvature in any single meridian is not everywhere alike, so that rays passing through the same meridian are never united at one point. This, to a very slight degree, is physiological, and is not noticeable. As a pathological condition it is found in beginning opacity of the lens, and is frequently of such amount as to give marked trouble. As the refractive power of the different sectors

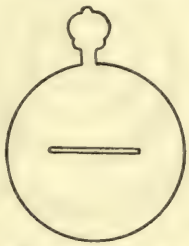


Fig. 46.—Stenopeic slit.

of the lens becomes different, the image produced by them recedes farther and farther apart, so that ultimately they may become separate images and thus produce monocular polyopia. A very high degree of irregular astigmatism is produced in subluxation of the lens when part of the pupil still has the lens in it and part is aphakic. These forms of irregular astigmatism are impossible to correct by glasses. A stenopeic slit or a pinhole disc may be of service for making out minute objects.

Most irregular astigmatism, seen in patients who present themselves for refraction, is corneal, and is due to nebulæ, leucomata, facets, flattening, or ectasis following ulcers or injuries of the cornea. Many of these forms can be materially improved with glasses, the refraction being determined by use of the stenopeic slit (Fig. 46). This slit

is placed before the eye in the trial frame, and slowly rotated through an arc of 180 degrees, the patient meanwhile looking at the letters on the test card, and stating in which axis the vision is most acute. By then placing behind the slit + or — spheres depending upon the hypermetropia or myopia present, a material improvement may be obtained. A cylinder of corresponding strength is then placed in the trial frame at the axis found by means of the stenopeic slit to be best, and frequently the vision is improved when the cylinder alone remains before the eye. The amount of hypermetropia or myopia may be roughly determined by means of a pinhole disc (Fig. 47). This placed before the eye will almost immediately result in much improvement in

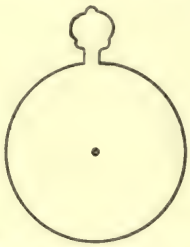


Fig. 47.—Pinhole disc.

vision because all rays of light passing into the eye through the pinhole are correctly or nearly correctly refracted. The usual result in these cases is that when the disc or slit is removed the vision again falls very much in spite of correction of the refractive error.

Another form of irregular astigmatism which should be considered here is *conical cornea*. In this condition of the eye the cornea is bulged forward in the shape of a cone, giving rise to very marked irregularity in refraction, depending upon the degree of conicity; many cases being reduced to a condition of mere perception of large objects held near the eye. The apex of the cone is rarely at the exact center of the pupillary area, and until quite late in the disease is transparent. Later it becomes opaque and prevents the refraction of rays of light. The cone is observed by

inspection, especially in profile, and also with an instrument known as the keratoscope (Fig. 48). This instrument held before the eye of the observer with the figure side toward the patient, will reflect on the patient's cornea an irregular image. It is also of value in determining the axis in which the greatest astigmatism occurs, and in this way we are enabled to get the axis for a cylinder, which in cases not far advanced will give some improvement. The majority of cases which have not advanced to opacity of the apex, and

Fig. 48.—Keratoscope. *(Ball.)*

whose vision is reduced to the counting of fingers at a few feet, will frequently see $^{20}/_{30}$ or even $^{20}/_{20}$ through a pin-hole disc. This is for the same reason noted in other forms of irregular astigmatism. Glasses in certain cases give some improvement, but the improvement is temporary only, as these cases progress without operative interferences to almost total blindness.

The Ophthalmometer is an instrument devised to measure astigmatism, by reflecting the images of two illuminated mires (Fig. 49) on the cornea. By means of a screw connecting the two mires, they are so placed that the

black horizontal line in each mïre forms one straight line, and the two edges of the mïres just touch (Fig. 50). One mïre is arranged in steps (Fig. 49), and when the arc carrying the mïres is rotated 90 degrees from the position in which they just touched, the steps overlap, one step for each diopter of astigmatism (Fig. 51). If all cases of astigmatism were corneal, this instrument would simplify refraction considerably, but, unfortunately, in the vast majority of cases the astigmatism lies in the cornea, lens, and retina, the one neutralizing or partly overcoming the other, and hence the results obtained by the ophthalmometer are very misleading, even the axis frequently being at fault. It is an instrument greatly overrated, and not to be compared for

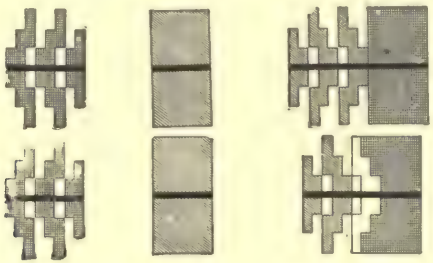


Fig. 49.—The mïres of an ophthalmometer.

an instant with other means of refraction. It is an aid in, but not necessary to, the diagnosis of conical cornea. In this condition it is impossible to approximate the images of the mïres on the conical cornea. The images are distorted, and in most cases pulsate synchronous with the beat of the heart.

By *operative* astigmatism is meant the astigmatism produced by corneal incision for cataract, glaucoma, foreign bodies, etc. This incision in healing contracts, and produces an hypermetropic astigmatism at right angles to the cut. As the cut is usually made above, the astigmatism resulting is vertical, and the cylinder correcting it is placed before the eye in a horizontal axis. Following an operation for glaucoma, it can be determined by methods previously described, or, should we know the previous refractive condi-

tion, the cornea could be measured with the ophthalmometer. This instrument is of most value in measuring the corneal astigmatism after cataract extraction, where there is no lens to counteract it. The axis and amount can in these cases be quite accurately determined. Operative astigmatism diminishes in amount as time elapses, and may altogether disappear.

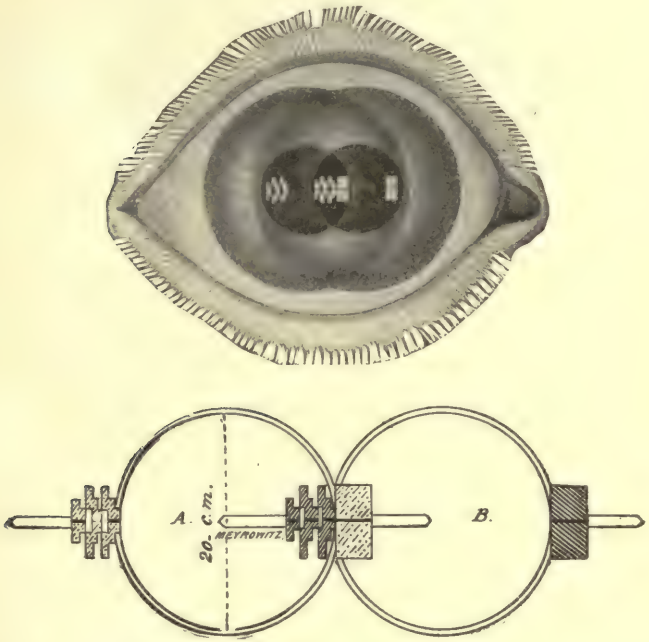


Fig. 50.—Appearance of mires on the cornea in axis at right angle to the astigmatism, if hypermetropic. *(Alger.)*

Spastic Astigmatism is an astigmatism produced almost wholly in the lens by an irregular contraction of the ciliary muscle, and is brought on entirely by reflex irritation, chiefly from the nose and its accessory sinuses. It is but briefly mentioned here, as the relation of the eye and the nose and the treatment of ocular conditions arising from nasal reflexes are considered in a special chapter on that subject.

Presbyopia.—The power of accommodation diminishes with age, and this diminution in the range accommodation does not become troublesome until the near point recedes so

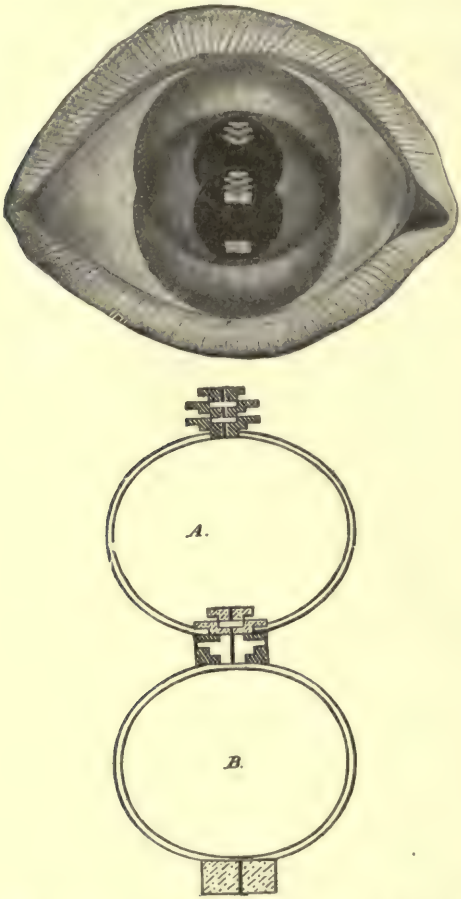


Fig. 51.—Appearance of mires on the cornea in the axis of the astigmatism, if hypertropic. *(Alger.)*

far that reading, writing, or the finer kinds of near work become difficult or impossible. This condition is known as *presbyopia,* and occurs, roughly, about the age of forty; appearing earlier in hypermetropia and later in myopia. A

guide for the correction of presbyopia is to add to the distance correction + 1.00 sphere for every five years after forty. For example, a patient of forty-seven years of age presents himself for examination, complaining simply of inability to see fine print. The distance correction is found to be + .50 sphere in both eyes; to this add + 1.25 sphere or + 1.50 sphere, whichever gives the greatest range of accommodation, and the result will be, if + 1.25 sphere is added, + 1.75 sph. for near use.

At about the age of sixty many patients find their near glasses troubling them; this is not because they need a

Fig. 52.—Lens measure. *(Alger.)*

stronger lens, but that there is a senile swelling of the lens which diminishes the amount of presbyopia and a weaker glass for near is indicated. This swelling of the lens may go on to second sight, so called, but is rarely found except in myopes, or just before development of a senile cataract. A patient's refraction should be tested every two or four years depending upon symptoms, whether the refractive condition be that of hypermetropia, myopia, astigmatism, or presbyopia.

The Neutralization of the Lens.—A spherical lens held a short distance before the eye and moved in every direction

will cause a movement of objects seen through the lens; if the object moves against the spherical lens, the lens is convex; if it moves with the spherical lens it is concave. Plane glass will, of course, cause no movement. Given a convex lens to determine its strength, hold over it concave lenses of increasing strength, until, upon motion of the lens, no motion of the object seen through the lens is observed. A cylinder will be as a plane glass in its axis; at right angles to its axis objects seen through it will move either with or against, depending upon whether it is myopic or hypermetropic. Cylinders are neutralized by cylinders of the opposite power, which are placed in the same axis. Another method of determining the strength of the lens is by means of the lens measure (Fig. 52), which, when rotated on both sides of the lens, gives a reading on the dial corresponding to the glass, when both are added.

The Optical Center of the lens may be determined by looking through a lens at two lines crossed at right angles. When the lens is so placed that the lines outside the lens are continuous with those seen through the lens, the point where the lines cross is the optical center.

CHAPTER VI.

MUSCLES.

In considering the disturbances in motility of the eyes there are four forms which will be described in the simplest possible way, using the least number of terms necessary to an understanding of the subject. They are classified as *functional anomalies, strabismus, paralysis,* and *nystagmus.*

The functional anomalies are irregularities of the muscle-balance giving rise frequently to quite severe symptoms, but which do not cause, except in high degree, diplopia. Binocular single vision is maintained frequently, however, with an effort. In these cases the visual acuity is usually good and about equal in both eyes. The refractive error is occasionally insignificant, or in the refractive error we may find the cause for the irregular muscle-balance. There are several ways of testing the muscle-balance, but we will confine ourselves to two for each form.

Esophoria is that condition of the muscles in which there is a turning in of the eyes, not sufficient to produce a squint, nor is binocular vision lost. It is most accurately determined by the *cover test.* Have the patient sit at the trial case as for testing refraction, and place before the eyes, at a distance of twenty feet, a candle or a small light. In the trial frame place over one eye a dark green glass, and over the other a red glass. Cover with a shield first one eye and then the other, having the patient look constantly at the small point of light. If esophoria is present it will be noticed that the eye behind the shield will rotate in as the other fixes on the light. This motion is only observed just at the moment the shield is placed over the eye. The degree of esophoria is now determined by placing before one eye prisms, base out, of increasing strength until there is no motion observed in the eye back of the shield. A second

test is by means of the Maddox rod (Fig. 53). This rod is placed before one eye, usually the right (it is best to use one eye as a routine procedure), with the rods horizontal. The patient looks at the small point of light as before, and there is seen a red broken line running vertically. If esophoria is present the line will be at the right of the light (if the rod is over the right eye), and as in the cover test the amount is determined by placing prisms, base out, before the other eye until the vertical red line goes through the light. The Maddox rod test is not as accurate as the cover test, for the patient can, by accommodation or muscular action, change the position of the red line, and

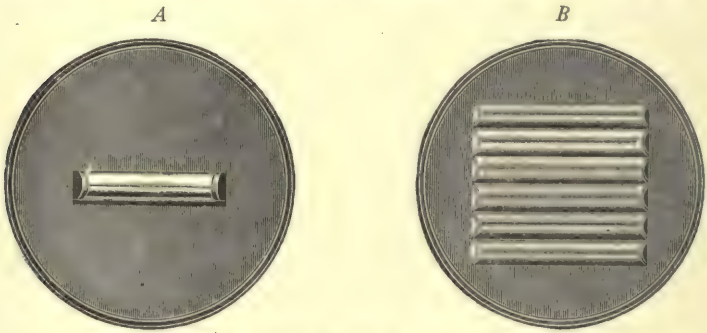


Fig. 53.—The Maddox rod. *(Ball.)*
A, The single rod. *B*, Multiple rod.

frequently fuse it with the light without the aid of the prisms. The diplopia produced by the Maddox rod is *homonymous* in esophoria, *i.e.*, the false image is on the same side as the eye over which the rod is placed. Esophoria of from 2 to 4 prism degrees may be considered within normal limits. A prism degree is equal to but half a perimeter degree.

Exophoria is a deviation of the eyes outward. It, as in esophoria, is not accompanied by diplopia, nor is it as marked as a squint. Two tests are by the Maddox rod and the cover test, overcoming the irregularity by prisms placed, base in, before one eye of increasing strength until the eye behind the shield no longer rotates outward. Diplopia in

exophoria, in the Maddox rod test, is *heteronymous* or crossed, *i.e.*, the false image is on the side opposite the rod. Instead of prisms necessitating frequent manipulation we can place before one eye a rotary prism, such as the one devised by Risley (Fig. 54); this being placed at the neutral point can be rotated up to the strength of 30 prism degrees. Exophoria of more than 4 prism degrees usually causes considerable trouble, and may need correction with prisms or operation. Esophoria, in hypermetropes, may be largely overcome by the constant use of glasses correcting the refractive error. Exophoria, in myopes, is frequently overcome by correcting the myopia. Before correcting a

Fig. 54.—Risley rotary prism.

muscle error by the use of a prism, or certainly operation, the condition of the nose and its accessory sinuses should be ascertained, and should a pathological condition be found there, this should be treated first. This will be discussed in detail in a chapter devoted to that subject.

Hyperphoria is an up or down irregularity in the muscle-balance and is determined by the Maddox rod placed before the right eye, with the grooves vertical. This produces a red broken line, which in muscle-balance runs horizontally through the light. If the red line is below the light the condition is right hyperphoria. It is corrected by prisms; for right hyperphoria the prism is placed base down before the right eye; for left hyperphoria base up before the right eye. Hyperphoria needs correction with prisms, or in

marked cases operation, more frequently than esophoria or exophoria, because correction of the refractive error has no effect upon this muscle error. As in the other forms the nose should receive first consideration. Far too much operating has been done on the ocular muscles for the relief of esophoria, exophoria, or hyperphoria. The vast majority of cases are relieved by less radical measures, and no risk is run that the effect produced by an operation on an external muscle does not cause a marked opposite effect, when the real cause of the difficulty is removed. The history of all the muscular neurasthenics is that they obtain little or no relief from operation, and in a great many instances they are made infinitely worse. There should be the greatest conservation shown before proceeding to what is now known to be a radical measure, that of operating upon a case which has binocular single vision, for a muscle error.

Tests for Reading Distance.—One or two near tests for muscular insufficiency should always be combined with the tests for distance. One of the best is the *dot test.* A card on which there is a small black dot is held at a comfortable reading distance by the patient. In the trial frame an 8° prism is placed base down before the right eye. This causes a diplopia and one dot will appear above the other. Should the dots appear directly above each other there will be orthophoria, or muscular balance, for near. If there is esophoria the upper or false image will appear to the right; in exophoria to the left. To test the hyperphoria the prism is placed base in, which will cause a lateral diplopia. In right hyperphoria the false image will be below the horizontal line, and in left hyperphoria above. The degree of imbalance is determined in each case by placing before the eye prisms of increasing strength until the dots are in a straight line.

All tests to determine muscular relations should be undertaken when the refractive error is approximately corrected. This is especially true of esophoria and exophoria. If possible tests with and without a mydriatic should be compared.

Symptoms of all functional anomalies are those of eye strain. The eyes tire readily; headache is common; concentration of the attention either for distance or near is maintained with difficulty. There may also be mild conjunctival injection and some epiphora. Constitutionally these patients are of the neurotic type, and this must be kept in mind in the treatment, as the correction of small errors may give infinite relief.

Treatment should be directed toward the underlying cause. Refractive errors should be corrected by lenses and glasses worn constantly. This may in itself be sufficient to overcome most of the symptoms. As suggested above, the nose and its accessory sinuses should be examined, and if found diseased this condition should receive appropriate treatment before resorting to the use of prisms, or operation. Prism exercises may be of benefit in some cases. This is done as follows: In a case of esophoria an 8° prism is placed *base in* before one eye, producing a marked homonymous diplopia when looking at a point of light 20 feet away. The patient approaches the light until it becomes possible to fuse the two images. He then backs away until the diplopia is again noticed. This exercise should be tried in selected cases, a few minutes each time, three or four times a week. At each trial the patient can back farther away from the light until finally he can fuse the images at 20 feet. The prism is placed base out for prism exercises in exophoria.

The constant wearing of prisms does not decrease in any way the amount of muscular insufficiency. In fact it is liable to increase the amount, and for this reason the constant use of prisms gives but temporary relief and is in no sense curative.

To correct muscle error by prisms there should be prescribed a slightly weaker prism than is found by test, and the prism should be divided equally between each eye. Prisms are placed base out for esophoria, base in for exophoria, base down in the right eye or up in the left eye

for right hyperphoria, and base down in the left eye and up in the right eye for left hyperphoria.

Operation should be resorted to only when other means of relieving the muscular insufficiency have failed. Esophoria of over 10°, exophoria of over 6°, and hyperphoria of over 4° or 5° may be operated upon. In esophoria the internal rectus may be wholly or partially cut from its attachment to the sclera, or the external rectus may be advanced. The reverse is true of exophoria. In right hyperphoria the superior rectus of the right eye may be cut or the inferior rectus of the left eye. The reverse is true of left hyperphoria. The technique of these operations and the instruments used are described under operations for strabismus.

Strabismus, or squint, is divided into three principal kinds; internal or convergent strabismus, external or divergent strabismus, and alternating strabismus.

Convergent Strabismus is by far the most common form; it practically always appears early in life, and in nearly every case the eyes are hypermetropic.

Etiology.—Donders's theory is that the abnormal accommodation in hypermetropes causes a strong tendency to convergent squint, and this theory is the one usually accepted by most authors. Worth, however, points out that the vast majority of children are hypermetropic, and of these hypermetropic children only a small proportion have convergent strabismus. There are probably forty or more hypermetropes who do not squint for one who does. We also know that the majority of high hypermetropes do not squint; squint not increasing proportionate to the increased degree of hypermetropia. Undoubtedly hypermetropia is a strong etiological factor, but is not by any means the chief cause. In the same way irregularities in the refractive error of the two eyes, as well as the rare case of congenital amblyopia of one eye, have some etiological relation, but only a slight relation, to the true cause. Worth in his theory points out that the faculty of fusing the two images on the retina is well advanced by the twelvth month and

completed by the sixth year. When this faculty is well established nothing short of actual paralysis will cause squint, and therefore the essential cause of squint is a defect or absence of the fusion faculty, and hence absence of binocular vision. Measles, scarlet fever, whooping-cough, and other diseases of childhood are usually given by parents as the cause of the squint. They are probably coincidences or that the weakened condition caused by these diseases may have precipitated a squint that might otherwise have been delayed for sometime in its appearance. Amblyopia is given as a cause of convergent squint, probably because most cases that present themselves for examination have an amblyopia in the squinting eye. I agree with Worth that amblyopia of the squinting eye is a result of the squint, not a cause. Because of defect in the fusion faculty, aided, perhaps, by hypermetropia, and possibly debility from disease, one eye shows an occasional transitory squint. This at first produces a diplopia from the fact that the two images do not fall on corresponding spots of the retinæ. The eyes right themselves by muscular effort to parallelism to avoid this diplopia, but this power is soon lost, and the image of the squinting eye is suppressed, at first much as we would suppress the image falling on the left retina when we are looking through a microscope with the right eye; finally the squint becomes constant, diplopia no longer is noticed, and the retina of the squinting eye ceases to functionate. This condition is properly called *amblyopia ex anopsia.*

Treatment.—All cases should have treatment as soon as the slightest squint becomes manifest in order that the function of the retina of the squinting eye may be preserved. In testing early cases the sight in the squinting eye is usually found to be excellent. This can be ascertained in small children by having them count fingers at a 20- or 30-foot distance, or by rolling ivory balls of various sizes in a direction away from the child and noticing how long the ball rolled will hold their attention. This is at best rough, but it serves as an excellent guide. The squint is measured by cover test as in esophoria, or by the perimeter, which is

measured off in degrees for determining the angle of the squint. Both eyes should then be atropinized with a ½ per cent. solution of atropine instilled twice a day for a week. At the end of that time the patient should return for observation and for refraction. It will frequently be noticed that the squint is less or that the eyes are parallel, which shows that the squint may be overcome by correcting the hypermetropia. The hypermetropia is ascertained by retinoscopy, and as nearly full correction as possible given. The amount of convergence is measured with the correcting glass on, and compared with the previous amount before a cycloplegic was used. The vision of the squinting eye is carefully noted, and constant care must be exerted that the vision in this eye does not go backward. This is accomplished in two ways: either the good, non-squinting eye is covered for a portion of each day, thus throwing all the work during that time on the squinting eye, or the non-squinting eye is atropinized with a weak solution of atropine, and thus prevented from seeing near objects at all, and distant objects indistinctly. Care should be taken in this latter treatment that the patient gets no toxic effects from atropine absorption. The patient should report frequently for observation, which should include testing of the vision of the squinting eye with glasses on, and measurement of the degrees of squint, also with glasses on. This treatment will, in a great number of cases, result in preserving the function of the good eye, and in reëstablishing parallelism. Should, however, parallelism fail to reëstablish in from six to eight months, tenotomy of the internal rectus of the squinting eye should be performed, or, if a marked squint, tenotomy of the internal rectus combined with advancement of the external rectus, or advancement of the external rectus alone.

If a patient having convergent strabismus should apply for treatment when the squinting eye is amblyopic, *i.e.*, vision of $^{1}/_{20}$ or lower, the treatment is much the same, although little can be hoped for in the way of revising the function of the retina in the amblyopic eye. This should be

tried, however, in every case, especially in young people. The glasses correcting the refractive error should be worn constantly from six to eight months before operating. Many cases report for observation with a diminished squint and a few with parallelism, but this is rare when the squinting eye is amblyopic. At this time should a squint still be present the operation is indicated, depending upon the degree of convergence.

Divergent Strabismus is much less common than convergent, and occurs but rarely in infancy and childhood.

Etiology.—Myopia, old injured eyes, blind eyes, monocular amblyopia accompanying myopia or normal vision in the non-squinting eye.

It should be treated early in its appearance, by careful cycloplegic test of the eyes, and if this reveals a myopia, some effect might be hoped for in the use of glasses, in that they would stimulate accommodation and its accompanying convergence for near. Astigmatic and hypermetropic cases would get no benefit from glasses. The operation for divergent strabismus is indicated depending upon the refractive condition found. If the patient is myopic in both eyes, with good vision in the squinting eye, something can be hoped for without operation. Should glasses fail to lessen the squint, and the vision becomes less in the squinting eye through the suppression of the image, an operation is at once indicated. In all other cases operation is indicated at once for cosmetic reasons. In divergence of low degree a tenotomy of the external rectus of the squinting eye may be sufficient. In higher degrees an advancement of the internal rectus must be combined with the tenotomy of the external rectus, or in certain cases advancement of the internal alone.

Alternating Strabismus may be either convergent or divergent. The refractive error may be hypermetropic, myopic, or astigmatic. In quite a few cases there is no refractive error. The vision is usually equally good in both eyes. It is caused by a congenital absence of the fusion center, and these patients as a consequence have no binocular

vision, even when parallelism is restored. Naturally glasses have but little effect on this form of squint, the two eyes never working in common. Diplopia is never complained of because of the perfect suppression of the image on the retina of the squinting eye. The Maddox rod and diplopia tests never permit fusion of the images, and it is impossible for these patients to see anything but the flat photograph in looking through a stereoscope. They readily learn to use either eye at will. Glasses should be worn in cases having sufficient refractive error to benefit by their use. Operation is indicated as early in life as the diagnosis is certain. In convergent cases the squint should be under-corrected, to allow for a natural tendency of these cases to, partially at least, right themselves. After an alternating strabismus is

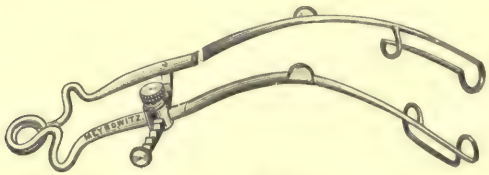


Fig. 55.—Eye speculum.

corrected there is never a development of binocular vision. This is determined by the bar-reading test, which is made by holding a pencil vertically between the patient's eyes and a printed page; the letters or words behind the pencil are unseen, while a person having binocular vision sees through the pencil. These patients have no true perspective and are unable to blend the pictures seen through a stereoscope.

Operative treatment of muscular anomalies consists in advancement, tenotomy or partial tenotomy. Either advancement or tenotomy may be performed alone, or advancement of one muscle may be combined with tenotomy of its opponent.

Advancement.—Many operations for advancement have been described but most are unreliable. I will describe the operations of Worth and Verhoeff, as my best results have been obtained from these two methods.

Worth's Operation.—Local anæsthesia is usually sufficient for adults and the older children, but general anæsthesia may be necessary for younger children. Care should be taken that the hands of the surgeon and the assistant are sterilized. The instruments should be boiled for at least ten minutes just before using. The patient's face should be carefully cleaned, and the conjunctival sac should be thoroughly irrigated with boracic acid or normal salt solution. The speculum (Fig. 55) is inserted to separate the lids, and the conjunctiva is grasped with toothed forceps (Fig. 56), while with scissors (Fig. 57) a vertical cut about a half inch long is made in it close to the margin of the cornea. A similar incision is made in Tenon's capsule and the tendon exposed. The muscle is then held up from the

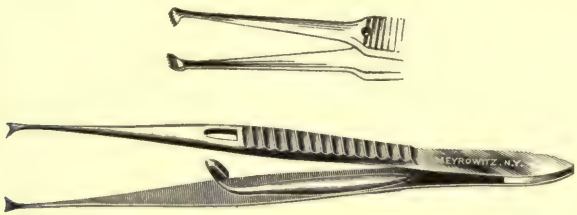


Fig. 56.—Toothed forceps.

sclera by a tenotomy hook (Fig. 58), and the smooth blade of Prince's advancement forceps (Fig. 59) inserted beneath the muscle and the forceps closed, so that tendon, Tenon's capsule, and conjunctiva are all clamped together. The tendon is then cut from its scleral attachment with scissors. One needle (Fig. 60) is then passed inwards at *A* (Fig. 61) through conjunctiva, capsule, and muscle, and brought out at the under side of the muscle. It is again passed through muscle, capsule, and conjunctiva and brought out at *B* (Fig. 61). The bight of the thread thus encloses the lower fourth of the width of the muscle, together with tendinous expansions, capsule, and conjunctiva. The second needle is similarly entered at *A'* (Fig. 61) and brought out at *B'* (Fig. 61). Both sutures are placed before proceeding farther in order that they may be symmetrically placed. The

ends of the thread at *A'* and *B'* are then knotted tightly at *C*. The end bearing the needle is then entered at *D* and passed through conjunctiva, capsule, and muscle, then carried beneath the blade of Prince's forceps nearly to the corneal margin. The needle is then passed into the tough circumcorneal fibrous tissue and brought out at *G'*. The two ends of the thread are tied loosely at *H*. The other suture is then similarly completed. The free end of the muscle, capsule, and conjunctiva are then cut with scissors near the Prince forceps. The muscle is then drawn toward the cornea, and the gap closed by tightening the sutures at *H H*, so that the eyeball is rotated to its proper position. After operation the eye is irrigated with a mild solution. Atropine may or may not be instilled; the edges of the lids

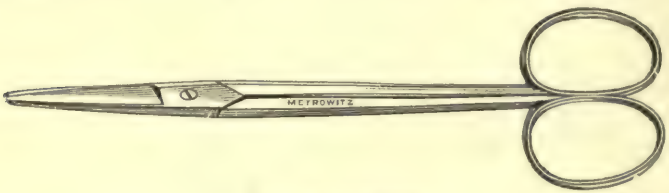


Fig. 57.—Scissors.

are smeared with a bland ointment and a double bandage applied.

The eye is irrigated and dressed daily. The bandage may be removed on the fifth day and the sutures on the seventh or eighth day. After removal of the bandage the glasses correcting the refractive error should be worn constantly.

Verhoeff's Operation.—A vertical incision is made in the conjunctiva about 3.5 mm. from the cornea, and the conjunctiva undermined as far as the limbus. After freeing the muscle from its attachments to the capsule and surrounding tissue, the smooth blade of Prince's forceps is inserted beneath the tendon and the forceps clamped. The anterior conjunctival flap is then retracted and one of the needles of a double-armed, silk suture is inserted into the sclera, or, better, the tough, fibrous, circumcorneal tissue, on

a level with the lower border of the tendon to be advanced, and then passed upward through the upper layers of the sclera as far as the upper border of the tendon (Fig. 62^1). The needle is then reinserted in the hole of exit and passed through superficial scleral tissue about 3 mm. in the direction of the upper border of the tendon. The other needle is then passed in a similar manner below (Fig. 62^2). The tendon is then cut from its scleral attachment with scissors, anterior to the forceps, and the muscle is lifted away from the globe to permit the passage of the two needles through muscle, capsule, and conjunctiva far enough back to get the desired effect (Fig. 62^3). The muscle is then advanced toward the cornea by means of the Prince forceps, and at the same time the globe is rotated to such a position that the needle holes in the sclera and muscle are in apposition, when the suture is tied (Fig. 62^4). The advancement

Fig. 58.—Tenotomy hook.

forceps is removed and the extra tendon and capsule cut away with scissors. Care must be taken to leave enough tendon and muscle anterior to the suture to prevent tearing out. The free end of the tendon is then tucked under the conjunctiva and this membrane sutured (Fig. 62^5). Fig. 62^6 shows the same operation, with an additional suture. This, however, is not necessary.

The dressing and after-care is the same as described under Worth's operation.

Tenotomy is performed by making a small vertical conjunctival incision about over the insertion of the muscle. A similar incision is made in Tenon's capsule, when the muscle can be easily picked up with a tenotomy hook and severed close to its scleral attachment. It is best to reunite the conjunctiva with a single suture. A bandage may or may not be applied. Usually after irrigation of the conjunctival sac the eye is allowed to go uncovered. The conjunctival stitch may be removed in three or four days.

Partial Tenotomy.—In this operation the muscle to be lengthened is exposed in a way similar to the preliminary steps of an advancement operation. Small portions of the muscular fibers are cut either at the sides of the muscle or in the middle, care being taken not to entirely cut the muscle in two. This operation has very little value, but is occasionally used in comparatively low degrees of functional muscular anomalies.

Paralytic Strabismus is the result of a paralysis of the motor nerves which supply the ocular muscles, or from injury which severs a nerve or muscle.

Symptoms.—Limitation of motion on the side of the affected muscle. Motion is lost in complete paralysis, and much lessened in paresis. An easy way of determining this is to have the patient hold his head in one position, and

Fig. 59.—Prince's advancement forceps.

with his eyes follow the finger of the examiner as it is moved about the patient's field of vision. *Diplopia* is marked in the field of vision governed by the affected muscle. For example, should the right external rectus be paralyzed the diplopia would be most marked when the patient looked to the right. It may be slight when the patient looks straight ahead, and is absent when looking to the left.

The Paralytic Squint is only marked when the eyes are turned in the field of the involved muscle. There is no squint when the eyes are turned in the opposite direction. The deviation of the squinting eye when the patient fixes with the sound eye is called the *primary deviation.* The deviation of the sound eye when the patient fixes with the affected eye is called *secondary deviation.* In paralytic cases the secondary is much greater than the primary deviation, and this sign serves as an additional diagnostic point

in distinguishing paralytic from simple strabismus, for in ordinary strabismus the primary and secondary deviations are the same.

Complete paralysis of the *oculomotor* (third cranial) nerve causes ptosis by paralysis of the levator palpebræ and external strabismus through the unopposed action of the external rectus. The eye is also turned slightly down as well as out by the unopposed action of the superior oblique. There is dilation of the pupil, because of paralysis of the sphincter of the iris and absence of accommodation because of paralysis of the ciliary muscle. There is inability to turn the eye inward, upward, or downward (except slightly down and out by superior oblique). Diplopia is present when the upper lid is raised, but absent when ptosis is present because the lid covers the pupil.

Fig. 60.—Needle holder.

Fourth nerve paralysis is rare alone; when present it causes diplopia when the patient looks down and out on the affected side.

Sixth nerve paralysis causes a convergent strabismus through the unopposed action of the internal rectus, and homonymous diplopia.

Most forms of paralysis of the ocular muscles are due to syphilis, and respond readily to antisyphilitic treatment. An operation for paralytic strabismus is not indicated until a thorough constitutional treatment has been tried. Cases due to injury, especially when the muscle alone has been severed, should be corrected by operation as soon as possible.

The orbicularis muscle is supplied by the *facial nerve,* and the symptoms arising from its paralysis are seen in facial paralysis. There is an inability to close the eye, the eyeball turning up to avoid the cornea being exposed to the air. There is epiphora caused by improper drainage of tears into the lachrymal canal. Conjunctival inflammation

and corneal ulceration may be of an accompaniment because of exposure.

Nystagmus, or tremulousness of the eyes, is a condition in which there are short jerky movements of the eyes very rapidly repeated, and which occur in the same direction. The movements of the eye as a whole are not affected by it. Different kinds of nystagmus are distinguished according to the direction of the movements.

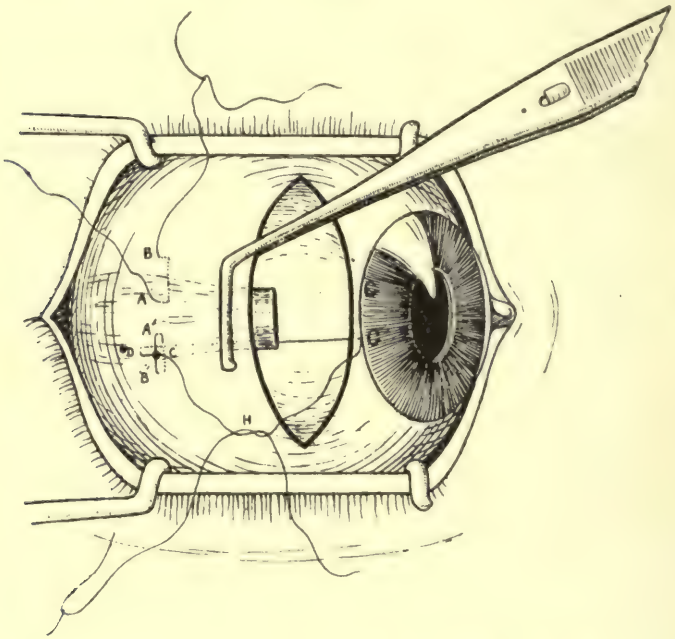


Fig. 61.—Worth's advancement operation. *(Worth.)*

Nystagmus Oscillatorius is present when the eyes are in a state of vibration, in a horizontal or vertical direction.

Nystagmus Rotatorius is when the eyes have rolling movements in the antero-posterior axis. Frequently there is a combination of these movements. Often it is not constantly present, but begins again or becomes more marked when the patient knows that he is observed, or if he attempts to keep the eyes still. Nystagmus usually affects both eyes,

but it may be less in one eye than in the other, or even in rare cases absent in one eye. It is usually associated with squint.

Etiology.—Congenital amblyopia. Ophthalmia neonatorum that has left corneal scars or leucomata, congenital

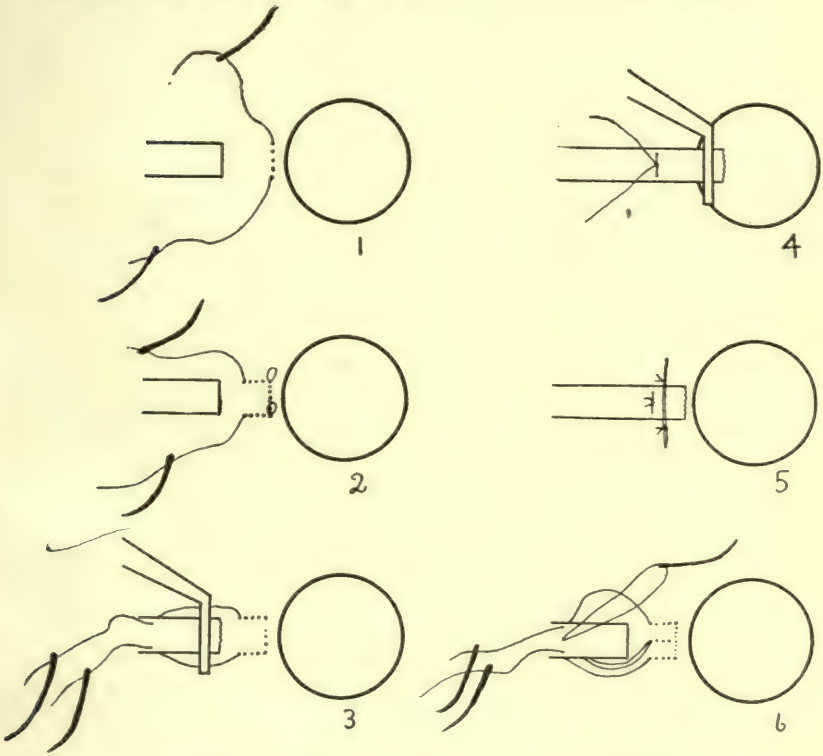


Fig. 62.—Verhoeff's operation for advancement.
(Ophthalmic Record.)

cataract, great refractive errors, albinism, retinitis pigmentosa, etc.

Treatment is of practically no avail. It may be lessened somewhat by the fitting of proper glasses. Patients having nystagmus are not aware of the defect in regard to vision, as the defect is the cause of the nystagmus, not the result of it.

CHAPTER VII.

DISEASES OF THE CONJUNCTIVA.

THE conjunctiva is a mucous membrane, and is principally subject to inflammatory affections; catarrhal, mucopurulent, and purulent. These conditions are more or less infectious according to cause, and present many common characteristics. The true inflammations are usually preceded by a condition of hyphæmia, which is also common to all irritative conditions, such as growths, foreign bodies, eye strain, etc. The *conjunctival injection* (Plate II, Fig. 1) should be differentiated from the ciliary injection. The former is bright red, showing, in most instances, the individual blood-vessels in their engorged condition. It is most marked in the culs-de-sac and fades toward the cornea, about which is seen a zone of transparent conjunctiva. It can be readily bleached by slight pressure of the finger and is movable. *Ciliary injection* (Plate III, Fig. 4) is most marked immediately surrounding the cornea and fades toward the periphery. It is pink-colored and quite uniform, because of its being deeper than the conjunctival injection. It cannot be moved. It accompanies diseases of the iris, ciliary body, and cornea. Severe inflammation of the eye usually shows a combination of these forms of injection.

Œdema of the conjunctiva, known as *chemosis,* accompanies severe inflammation of the conjunctiva, and if marked may cut off the nourishment of the cornea causing it to slough. Most all forms of conjunctival inflammation show the more typical lesions on the conjunctival surface of the upper lid, therefore it is of the greatest importance that the upper lid should be everted in all examinations of inflamed conditions of this membrane.

PLATE II.

Fig. 1. Mild acute catarrhal conjunctivitis, shows typical conjunctival injection.

Fig. 2. Everted upper lid in a case of vernal catarrh. The eyeball in this case showed no signs of inflammation.

Fig. 3. Pterygium. Growth just beginning to involve pupillary area.

Fig. 4. (A) Shows severe trachomatous conjunctivitis with pannus and central ulcer of the cornea. The vascularization below is not usual. (B) Shows the everted upper lid of the same case. Dense granulation tissue well marked.

PLATE II.

Fig. 1.

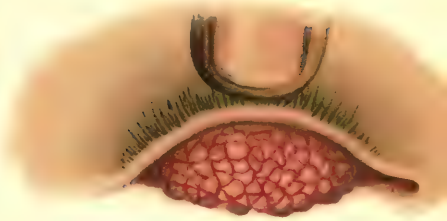


Fig. 2.

Fig. 3.

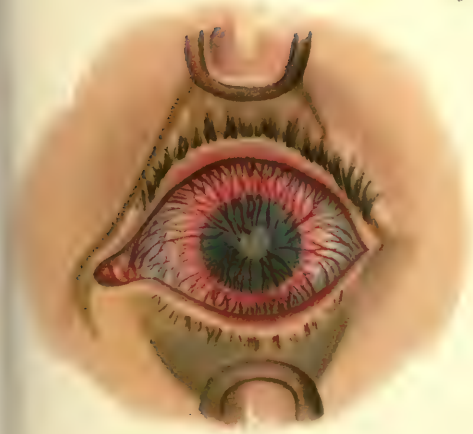


Fig. 4. a

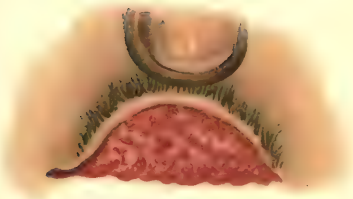


Fig. 4. b

Simple Catarrhal Conjunctivitis is little more than an active hyphæmia of the blood-vessels, principally of the palpebral conjunctiva.

Etiology.—Eye strain from long continued near work, uncorrected refractive errors, local irritants such as dust, wind, tobacco and other smoke, nasal catarrh, etc.

Symptoms.—Slight irritation; possibly a slight photophobia, but usually none; there is most always an itching and smarting sensation, as though sand were in the eyes. The normal secretions are slightly increased.

Treatment consists primarily in removal of the cause, if possible, such as correcting refractive errors, treatment of the nasal conditions, changing of occupation, habits, etc. Cold applications of normal salt solutions or boracic acid solutions, two or three times a day, followed by some mild astringent, are of benefit (see Formula 1). In the more chronic cases, boracic acid powder may be dusted into the eyes twice a day, or the application of a nitrate of silver solution, grains 2 to the ounce, applied with a cotton swab, the excess neutralized with normal salt solution, two or three times a week.

Prognosis.—Usually excellent, cure being effected in a few days or weeks; although some chronic cases, especially those in which the cause has not been removed, resist treatment for many years.

Acute Catarrhal Conjunctivitis (Pink Eye) is an inflammatory condition of the conjunctiva accompanied with quite marked injection and mucoid or muco-purulent discharge. The disease is usually bilateral, occurring in both eyes simultaneously or spreading from one to the other; the second eye involved usually showing milder inflammatory symptoms.

Etiology.—Chief cause is active contagion from the pus cocci or the bacillus of Morax-Axenfelt and the Weeks bacillus. Infection by means of towels, handkerchiefs, and fingers is not an uncommon cause.

Symptoms.—The conjunctiva is much injected, especially in the folds of the culs-de-sac; the conjunctiva of the

globe is injected, showing the typical conjunctival injection (Plate II, Fig. 1). There is a mucoid or muco-purulent discharge, which causes the lids to be stuck together in the morning. This discharge may increase to an active purulent discharge. In certain cases there are seen several areas of subconjunctival hæmorrhage. The conjunctiva is practically never chemosed, but the lids in the severe forms may show some œdema. There is more or less photophobia and lachrymation, occasionally to such marked extent that it becomes necessary for the patient to wear dark glasses or stay in a darkened room.

Diagnosis.—All severe forms which have a purulent discharge should have a bacteriological examination to differentiate them from the specific virulent infections. A quite accurate diagnosis can be made from the history and appearances of the eyes; the acute catarrhal form not running as virulent a course as the more specific infections.

Treatment.—If there is no corneal involvement, and this is an extremely rare complication of this form of conjunctivitis, cold applications can be used two or three times a day, or oftener if the patient is thereby rendered more comfortable. Cold is the best applied in the form of ice poultices, which are applied to the eyes for fifteen minutes two or three times a day. They are made by wrapping finely cracked ice in a thin layer of absorbent cotton. Cold applications lose their effect after 24 or 36 hours. The eyes should be irrigated with a lotion of boracic acid (Formula 2), every hour or two, or oftener if the discharge is marked. In a muco-purulent or purulent case a collyrium of argyrol (Formula 3) or protargol (Formula 4) is used in the eyes from three to six times a day. Combined with this treatment there should be a bland ointment applied to the edges of the lids, to serve the double purpose of keeping them from sticking together and preventing an inflammation of the lids. After the discharge has become much less, and the eye begins to whiten out, the astringent solution (Formula 1) is substituted for the albuminate of silver. The physical condition of the patient should be carefully looked out for, and if in poor health he should be prescribed for accordingly.

Prognosis.—This disease is usually self limited, even if left untreated, but when untreated is much more liable to run into the chronic form. Treated cases respond in from two days to two weeks, depending largely on the severity of the inflammation.

Phlyctenular Conjunctivitis, or eczema of the conjunctiva, is usually accompanied by phlyctenular keratitis, but is frequently seen alone. It is characterized from the beginning by small cone-like elevations of the conjunctiva, known as phlyctenulæ, each surrounded by a zone of injection. These phlyctenulæ soon break down into minute ulcers and heal without leaving any appreciable scar. They occur in numbers varying from one to ten or more, and their favorite site is at the corneal margin (Plate III, Fig. 1). In the severe forms the injection may take the form of a sheath of vessels running from the ulceration toward the culs-de-sac. There are always areas of clear conjunctival tissue.

Etiology.—This disease occurs in children who have a tendency toward the old-fashioned disease, scrofula, and accompanies catarrhal or purulent conditions of the nose and naso-pharynx, also eczema of the face, neck, and scalp, and glandular enlargements. The age at which it usually appears is between one and sixteen, and occurs largely in children living under poor hygienic conditions, and whose diet has largely consisted of pie, cake, pickles, tea, coffee, and cheap candy.

Symptoms.—In the mild form there are very few symptoms other than those described under simple conjunctivitis, but the severer forms show photophobia, lachrymation and slight mucoid discharge. There may be blepharospasm, which renders the examination of the cornea difficult, but this is rarely the case except when the cornea is involved. It must be remembered that it is essential that the cornea is wholly seen in each individual case. If through squeezing together of the lids or squirming you are unable to separate the lids with the fingers, the child should be held across the lap of an attendant in such a manner that the head of the patient will rest, face upward,

between the examiner's knees. With the knees the head is held firmly, and the lids carefully separated by means of two lid elevators (Fig. 63), one for each lid, and in this manner an excellent view of the cornea is obtained (Fig. 64).

Diagnosis is readily made from the isolated ulcers or phlyctenulæ, the age, the history, symptoms, etc.

Treatment.—When the cornea is uninvolved there is no local treatment necessary other than a simple wash of boracic acid three or four times a day. A correct diet for the age should be substituted for the faulty one, a daily bath should be ordered, plenty of fresh air encouraged, and possibly a tonic of cod-liver oil or syrup of the iodide of iron. The bowels should be kept regulated, an excellent drug in this particular case being calomel gr. $^1/_{10}$, as

Fig. 63.—Lid retractor.

needed. The accompanying nasal and skin conditions should have first attention because these conditions are largely causative. Cases that fail to respond to treatment should be taken from their parents or guardians and placed under the care of a nurse or in a hospital, where discipline is enforced and treatment carried out as ordered.

Prognosis in uncomplicated cases is invariably good, provided the nasal and skin conditions are treated and relieved, and the dietary and hygienic rules are followed out.

Ophthalmia Neonatorum is the purulent conjunctivitis of the newborn, caused by the babies' eyes becoming infected during birth from the infectious discharge in the mother's cervix or vagina; the specific cause usually is the gonococcus. It is a disease which has given rise to about 30 per cent. of the blindness in this country, and about 45 per cent. in Europe. According to present methods of prevention and treatment this percentage should fall

to 5 per cent. or under, and does fall in properly conducted obstetric cases, and with intelligent and prompt treatment after the disease has made its appearance.

Symptoms.—In a period varying from a few hours to ten days (the average is three days) the eye shows symptoms of catarrhal conjunctivitis with a muco-purulent discharge, which rapidly develops into a virulent discharge, accompanied with great swelling of the lids and palpebral

Fig. 64.—Method of examining the eyes of infants and children.

conjunctiva. There is occasionally chemosis. The discharge increases rapidly in amount, frequently a dram or more exuding from between the lids when they are separated. From the œdema of the lids it is impossible to see the cornea unless we use lid elevators, as previously described under phlyctenular conjunctivitis. One eye usually becomes involved before the other. This fact is of great importance in the treatment. The cornea, early in the disease, is practically never involved, although in cases

of great virulence of the infection it may become infected and slough away in one night.

Diagnosis is made on the severity of the symptoms, the age, the clinical picture, and the bacterial examination. These cases almost invariably show gonococci in their typical arrangement in the pus cells (Plate I, Fig. 6).

Treatment.—If the infection is in one eye only, wash out carefully the uninvolved eye with sterile boracic acid; place in the inner canthus of the eye about a quarter of a dram of iodoform or aristol powder, and over the eye apply a cotton pad, which should be stuck down with collodion. This dressing should be removed every day for a few days to be certain the eye beneath is not infected. For the inflamed eye, where the cornea is still clear, ice poultices may be used for twenty-four to thirty-six hours to take down the œdema. Separate the lids with the thumb and finger of the left hand and thoroughly irrigate the eye with 3 per cent. boracic acid solution every half or three quarters of an hour. Use as a collyrium 25 per cent. argyrol every two or three hours, after the eye has been first irrigated. Keep constantly applied to the edges of the lids some bland ointment (Formula 5). This will prevent the lids from sticking, which would retain the discharge, and it will also keep the lids and cheek free from inflmmation. The importance of the treatment lies in the proper carrying out of orders. These cases should be cared for by an intelligent nurse, preferably one who has had charge of similar cases and knows the severity of the disease. Should the cornea become involved, to the former treatment is added atropine for dilatation of the pupil and yellow oxide of mercury. They can be nicely combined in a single ointment (Formula 6). In severe cases of ulceration that seem about to perforate a Saemisch operation should be performed, as described under the treatment of keratitis with hypopyon, Chapter VIII. Protargol may be used instead of argyrol, but is not so effective in my hands.

Prophylaxis.—Credé was the first man to suggest prophylaxis, and if his method, or a similar one, was uni-

versally carried out this dreaded disease would be infinitely reduced, if not actually prevented. He advocated that the eyes of the child should be cleansed with boracic acid solution, and then a drop of 2 per cent. silver be freely instilled, immediately after birth. In every case of childbirth the child should be treated by the Credé method, or thoroughly irrigated with boracic acid followed by 20 or 30 per cent. argyrol solution. There should be no excuse to offer for this not being done. It cannot harm the child, and the obstetrician is not an absolute judge of the infectious condition of the vaginal discharge.

Prognosis.—If the child is treated correctly from the onset of the symptoms, by one who realizes the severity of the case, and who insists upon an absolute execution of his orders, the prognosis would be far better than it is now. Unfortunately the cases that come under the observation of most ophthalmologists have either been poorly treated or absolutely overlooked until the cornea has become involved or has perforated. In over 150 cases of ophthalmia neonatorum that came under my observation at the Massachusetts Charitable Eye and Ear Infirmary, in Boston, about 75 cases, or 50 per cent., were admitted with clear corneæ; of these but one later developed corneal complications. We there had a special ward for this class of cases, with nurses who were trained especially for this work, under the supervision of the staff and the resident surgeons. It goes to show how much can be accomplished by careful treatment and nursing.

Gonorrhœal Ophthalmia is the term applied to a gonorrhœal infection of the eyes acquired other than at the time of birth. It occurs mostly in adults, and runs a more virulent course than ophthalmia neonatorum.

Etiology.—In most cases it is a direct infection from a gonorrhœal urethritis, the right eye being more frequently infected than the left. Physicians and nurses caring for gonorrhœal patients sometimes infect their eyes, and for this reason great care should be exercised that the hands of attendants are kept thoroughly clean. When treating a

patient for gonorrhœa the attendants' hands should be kept away from their eyes. Some have advised the use of rubber gloves, but I have found this unnecessary, aside from the fact that the gloves interfere with the careful manipulation of the patient's eyes. Towels used by gonorrhœal patients are another source of infection. These should be thoroughly boiled or steamed after use, and reserved for the patient exclusively.

Symptoms are very much as in ophthalmia neonatorum except that the virulence is greater. It is, however, well recognized that a patient having a chronic gonorrhœal urethritis has a less severe infection than one suffering from an initial attack of acute urethritis, or one who has acquired the disease innocently. Fortunately but one eye is usually involved. The lid œdema is often very great, necessitating an external canthoplasty. The conjunctiva is greatly chemosed, frequently to such an extent that the cornea is completely covered by it. The discharge is thick, purulent, and may be greenish. The cornea rapidly becomes infected, and ulcerates early in the disease, increasing rapidly in extent, and is prone to perforate. This causes great pain momentarily followed by relief and also less progress, or no further progress, in the ulceration. Some cases go on to complete slough of the cornea, which may result in loss of the lens and vitreous.

Treatment.—First protect the good eye, as described under ophthalmia neonatorum. I do not favor a Buller shield, as it does not afford the more perfect protection of the collodion dressing. This dressing has the disadvantage that the patient is unable to see with the good eye while it is on, but the better protection justifies its use. Some patients who have a tendency toward temporary insanity when both eyes are kept closed must be given the Buller shield. Boracic acid irrigation should be given freely and frequently; as often as every twenty minutes or half hour if the discharge is profuse. Argyrol, 50 per cent. solution, instilled into the eyes every two or three hours. When the cornea becomes involved there can be used an ointment of

nosophen powder and atropine (Formula 8), substituted for the bland ointment previously applied to the lids. This ointment should be put inside of the conjunctival cavity. If the ulceration becomes deep nosophen powder may be dusted into the eye, and atropine solution. Because of the fact that many cases show improvement after perforation of an ulceration I have been accustomed to forestall nature several hours by performing a Saemisch operation on the affected cornea. This stops further progress of the disease, especially if the incision is kept open, and saves more clear cornea for the patient. I have never seen a panophthalmitis originating from a Saemisch operation in gonorrhœal ophthalmia.

Prognosis should be guarded, although more eyes are saved to-day than formerly. These cases need the most constant care and watchfulness, the cornea being the guide as to the outcome.

Diphtheritic Conjunctivitis is a rare disease, but one case occurring in 30,000 at the Massachusetts Charitable Eye and Ear Infirmary in 1902. It is almost always found in children, although rarely it is seen in the adult.

Etiology.—Most cases are secondary infections from a nasal or laryngeal diphtheria, nasal being the more common. Direct infection involving the eye alone is quite rare. Several cases are known where the eye of a physician has become infected by a patient suffering from diphtheria coughing in his face and eyes. For this reason it is advisable for physicians attending diphtheritic cases to wear protective glasses during the examination of the throat.

Symptoms.—One eye is most frequently involved, although both may be. The lids are greatly swollen and tense, and appear dark blue or purple from passive congestion. The everted lid shows a dirty gray, tenacious membrane, which leaves bleeding points where it is removed from the conjunctiva. The discharge is muco-purulent in character, and is quite profuse, producing a marked inflammation of the lids and cheek, with which it comes in contact. The lids are with great difficulty everted, and are extremely

painful when handled. The cornea is apt to become infected early in the disease, and tends to break down rapidly.

The diagnosis is made by the great swelling of the lids combined with their great rigidity and blue color, also the appearance and tenaciousness of the membrane of the conjunctiva. The bacterial examination will reveal the Klebs-Löffler bacillus (Plate I, Fig. 2). It must be borne in mind, in examining the discharge from a suspected eye for the diphtheria bacillus, that Xerosis bacillus has the same morphological characteristics as the Klebs-Löffler bacillus.

Treatment.—Since the introduction of antitoxin for the treatment of diphtheria this disease has needed but little local treatment other than cleanliness. A suspected case should have a preliminary injection of 1500 or 2000 units of antitoxin while awaiting the result of the bacterial examination. Locally to the eye may be applied ice poultices for the œdema of the lids, if the cornea is not affected. Irrigation with boracic acid solution and possibly a 10 or 15 per cent. solution of argyrol. To the edges of the lids and cheek can be applied an ointment similar to Formula 5. After the diagnosis is made positive, antitoxin should be given until the physiological effect is produced, that of curling the edges of the membrane. After the antitoxin has been given the symptoms will subside and the discharge become much less in amount, the lid becomes less swollen and tense. The antitoxin injections should be kept up until the membrane has disappeared; after this a simple antiseptic collyrium may be used, such as Formula 7, four or five times a day. Corneal complications are treated as described under Gonorrhœal Ophthalmia.

Prognosis.—If seen early and treated with antitoxin the prognosis is good. Corneal complications lead to permanent scars, when healed, or may result in perforation and loss of the eye. These complications are fortunately rare under the antitoxin treatment.

Membranous Conjunctivitis is a modification of the acute catarrhal conjunctivitis when there is formed upon the tarsal conjunctiva of the infected eye a pseudo-membrane.

Etiology.—Bacteriological examinations made by the author several years ago in cases manifesting the pseudo-membrane showed no different results from the bacterial examinations of the eyes in acute conjunctivitis.

Symptoms.—The same as in acute catarrhal conjunctivitis except for the membrane. This membrane is not dirty like the diphtheritic membrane and is easily detached from its base leaving few if no bleeding points.

Diagnosis by appearance and bacterial examination.

Treatment.—The same as acute catarrhal conjunctivitis.

Prognosis.—Also the same as in acute catarrhal conjunctivitis, except that there is more tendency to corneal involvement.

Vernal Catarrh is a rare affection of the conjunctiva, so called because the symptoms arising from the condition are most annoying in the spring. It is a disease which does not respond to medicinal treatment; it is essentially chronic, lasting for three to eight years, and is unlike any other conjunctival affection. It occurs most frequently in young males, and practically always affects both eyes.

Etiology.—Unknown.

Symptoms.—The disease becomes annoying in the early spring causing excessive itching, quite marked photophobia and moderate watery discharge. The conjunctiva of the upper lid shows the typical lesions of the disease; upon eversion of the upper lid this membrane is seen to be filled with smooth, flat, hard areas, separated from each other by crevices, so that it resembles a very irregular cobble stone pavement (Plate II, Fig. 2). In the spaces stringy mucous collects, a portion of which adheres to the cornea causing temporary blurring of vision. The surfaces of the hard areas are so smooth that the cornea is rarely affected by the contact with them, as one would naturally expect. The bulbar conjunctiva may be only slightly reddened, or there may be a zone of quite dense injection beginning about 1 mm. outside the corneal margin and fading gradually toward the fornix. The intense itching causes the patient to constantly rub his eyes, and this produces increased inflammatory

symptoms from the irritation. The symptoms last as long as the warm weather continues; any subjective sensations immediately disappearing during temporary cold weather, only to become manifest as soon as the weather becomes warm. The conjunctival appearance remains the same during the winter months, but the patient appreciates no discomfort. The disease finally disappears leaving no trace of its existence behind.

Treatment.—Neither local or general medicinal treatment is of any avail in shortening the disease. Mild astringents diminish the discharge and often relieve somewhat the discomfort. Fox recommends a solution of chinosol (Formula 9) for the itching. Protargol in 20 per cent. solution or argyrol in 50 per cent. solution should be tried

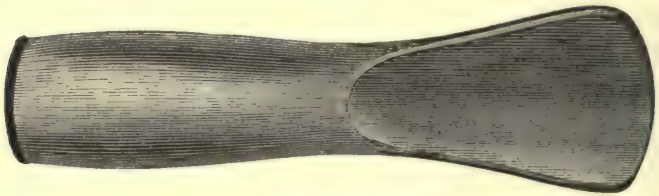


Fig. 65.—Bone spatula.

in all cases, although there is little hope of benefit from its use.

Grattage gives good results in some cases, but not in all. It is performed as follows: Cocainize the eye with a 4 per cent. solution and evert the upper lid, insert between the lid and cornea a bone spatula (Fig. 65), then scarify the area of the exposed conjunctiva with a scalpel, or a three-bladed knife of Weeks (Fig. 66). The tissue is then scrubbed with a tooth brush, which has been dipped in a solution of 1 : 500 corrosive sublimate before being used. Repeat this on all parts of the conjunctiva affected. There is comparatively little danger in the proceeding, and the results are better than with any other treatment. Constitutionally the patient may have a tonic of arsenic (Formula 10), or the syrup of the iodid of iron.

The prognosis is good as to ultimate recovery with good vision, but little can be done other than the grattage operation to abort the attacks.

Follicular Conjunctivitis is characterized by an excessive growth of adenoid-like tissue principally in the retrotarsal folds and culs-de-sac.

Symptoms.—The follicles are small round elevations about ½ to 2 mm. in diameter, and they do not extend, except in very rare cases, to the lid margin, which aids in distinguishing this disease from trachoma. They heal without leaving a scar, and never show any tendency to ulcerate. The bulbar conjunctiva is usually not involved, and appears as in the normal catarrhal conjunctivitis of a mild type.

Diagnosis.—Frequently difficult to distinguish from a mild trachoma. The absence of cicatricial contraction and

Fig. 66.—Weeks's knife for grattage.

corneal involvement, as well as the history and appearance of the lesions, give a good idea of the nature of the disease.

Treatment.—Astringents are used in preference to the silver salts, although some benefit may be derived from painting the lids two or three times a week with 1 per cent. nitrate of silver. Dusting boracic acid powder in the eyes twice a day will cure many cases in a few weeks. Better than any treatment is an ointment of lead acetate (Formula 11), put in the conjunctival cavity three or four times a day. In cases where the follicles are large and resist medicinal treatment the author has been in the habit of *stripping* the lids. This operation is performed by everting the upper lid and squeezing it between the blades of loop forceps (Fig. 67), or rolling out the follicles with the roller forceps (Fig. 68). This method is painful but shortens an attack by many weeks. In operating on the lower lid the conjunctiva is grasped as far back in the fornix as possible and squeezed between the forceps blades.

Trachomatous Conjunctivitis is a contagious inflammatory disease characterized by a thickening of the conjunctiva, which is prone to ulcerate and also has a tendency to form a membrane on the cornea called a pannus. This disease heals by scar contraction.

Etiology.—It is a disease supposed to be caused by an atypical gonococcus, which has as yet never been isolated. It is most common in the countries of Southern Europe, Arabia, and Egypt. In this country it is mostly seen in the foreign quarters of large cities, and among people who live under faulty hygienic conditions. It is nearly always acquired by direct contact with the secretions, although this takes some time. The Russian Jew and the Italian show the disease more frequently than any other races. Some cases appear to arise spontaneously, but an exhaustive search

Fig. 67.—Loop forceps.

would probably reveal the source of infection. Almshouses, asylums, and similar institutions frequently have many inmates showing this disease, probably because, as in crowded communities among the poorer classes, there is carelessness about the use of towels, handkerchiefs, and other articles. The negro appears to be immune to this disease.

Symptoms.—In this country there is rarely seen the true acute form. It is similar to gonorrhœal ophthalmia, except that it is not as quickly destructive. Most cases seen here are of the subacute or chronic forms. The disease is chronic, but if neglected frequently breaks out into acute exacerbations, in which the symptoms increase in severity, and a muco-purulent or purulent discharge appears. The disease is practically always bilateral. The changes in the appearance are gradually progressive, the patient often having the disease for some months before being aware of it.

The conjunctiva of the lids becomes thickened, injected, and granular, the granules extending to the lid margin, although most thickly located in the fornix (Plate II, Fig. 4b). The upper lid is usually first involved. At first the conjunctiva of the globe is normal, and the cornea clear. The lids are somewhat swollen and heavy, and cause a slight ptosis. The granular process is constantly attacking normal conjunctiva, while the involved portions break down into ulcerations and heal by cicatricial contraction, which leaves whitish scars below the level of the inflamed membrane. Finally the conjunctiva of the globe becomes inflamed, but does not show the granular appearance of the tarsal conjunctiva. The cornea is involved by pannus formation, which is really a deposit of new tissue on the true cornea, which is highly vascular, and which easily ulcerates. These ulcerations extend into the deeper layers of the cornea, causing marked

Fig. 68.—Knapp's roller forceps.

interference with vision, and frequently cause secondary iritis (Plate II, Fig. 4a). With the involvement of the cornea the photophobia becomes more intense and the lachrymation much greater. Frequently there is marked blepharospasm. The pannus begins at the corneal margin above and extends downward to about the middle. It rarely reaches below this. This new membrane is practically opaque, and when the pupillary area of the cornea is involved the vision is materially interfered with.

Complications or sequelæ arise from the constant friction of the roughened conjunctiva over the cornea which gives rise to loss of substance and ulceration. The contraction in healing causes a rolling in of the lids, entropion, and there is usually formed a distorted row of lashes, called trichiasis, which brush across the eye causing increased irritation. The lachrymal puncta may be so misplaced that they no longer carry off the lachrymal secretion and thus the

epiphora becomes permanent. Staphylomata, symblepharon, and even xerosis conjunctivæ may occur.

Diagnosis.—The history of the case, the character and location of the granulations, the cicatricial contraction in the conjunctiva of the lid, the formation of a pannus, and the other sequelæ of this disease should make the diagnosis easy. It is unlike any other disease, except follicular conjunctivitis with which it could not be confounded for any length of time.

Treatment.—In the acute case with muco-purulent or purulent discharge the treatment is much the same as in gonorrhœal ophthalmia. For corneal ulceration use Formula 8 in the conjunctival cavity three or four times a day. After the more acute symptoms have subsided, and the corneal ulceration has practically healed, paint the conjunctivæ of the lids with a 1 or 2 per cent. nitrate of silver solution, neutralizing the excess with normal salt solution before allowing the lids to come in contact with the cornea. As the conjunctiva becomes smooth under this treatment it can be changed to advantage by using the sulphate of copper stick instead of the silver solution, and later the alum stick. The granulations can be removed either by the stripping or grattage operations, previously described. Two procedures are possible for the treatment of the pannus, when this fails to disappear after the medicinal treatment or the operative treatment on the lids. *Peritomy* is a favorite operation for this condition after the other means have failed. The operation is performed after the eye is first cocainized and the lids separated by means of the speculum. The conjunctiva at the limbus is grasped with a pair of forceps, and a semicircular cut made with scissors close to the cornea about that portion covered by the pannus. If the whole cornea is covered with the pannus the entire circumference of the conjunctiva is cut at the limbus. Another form of operative treatment for pannus is to inject repeatedly into the subconjunctival tissue immediately around the cornea in the area of the pannus a solution of normal salt or a 1 : 10,000 bichloride of mercury solution. Of late excellent results

have been reported through the use of the X-ray in this disease. Its use is certainly justifiable when the disease fails to respond to other forms of treatment.

Prognosis.—Cure is rarely effected in severe cases, although if treatment is persisted in for a period of several years, good vision may be obtained. Patients who neglect their treatment go from bad to worse, and eventually become practically blind, some cases becoming hopelessly blind.

Sub-conjunctival Hæmorrhage is due to the rupture of a small sub-conjunctival vessel or vessels and produces a very red eye, which almost always alarms the uninitiated.

Etiology.—Acute conjunctivitis, especially of the catarrhal type; coughing or excessive vomiting may cause it, or small penetrating injuries of the conjunctiva.

Symptoms.—The part of the eye involved presents a uniform red appearance. No individual vessels are made out. The color does not bleach on pressure, and has a tendency to settle to the lower parts of the eye. No subjective symptoms are noticed. The blood is gradually absorbed, changing from bright to a dark red, finally a brown color, then through the greenish and yellowish shades until completely absorbed.

Treatment is of no avail. Alternate hot and cold compresses may have a slight effect, and certainly make the patient more comfortable mentally.

Pinguecula is the term given to a small yellowish elevation at the nasal side of the cornea.

Symptoms.—At times it may become inflamed or may cause uneasiness because of its appearance.

Treatment.—It may be excised or treated with mild astringents.

Xerosis is a disease in which the conjunctiva is dry, lusterless, and usually atrophied or shrunken.

Symptoms.—In advanced cases the conjunctival lachrymal glands cease to exude fluid, and a secretion of mucopurulent material takes its place. Spots appear on the con-

junctiva of the lids, which are incapable of being moistened, and give rise to great sense of dryness. The condition may eventually involve the entire conjunctiva. From these areas of dryness the Xerosis bacillus is obtained in pure cultures. When the disease progresses to the cornea, this structure loses its transparency and vision is gradually lost.

Treatment.—Dryness may be slightly overcome by instillations of normal salt solution, olive oil, or albolene, or the use of a camphor solution with sodium biborate (Formula 12).

Pemphigus is a rare conjunctival disease frequently associated with pemphigus of the skin. It causes shrinking of the conjunctiva.

Symptoms.—The conjunctiva is reddened and displays one or two spots of grayish ulceration, which slowly undergo contraction in healing. While this is going on other ulcerations are constantly forming, and the case progresses to slow but inevitable destruction of the eye. The secretions dry up, and cicatricial contraction bands are stretched across from lid to globe. The cornea also ulcerates and becomes cloudy and dry. In bad cases the lid becomes entirely adherent to the eye, forming total symblepharon. No bullæ are formed as in skin pemphigus.

Treatment.—Arsenic is given internally either in the form of Fowler's solution or in pill form (Formula 10). Locally the treatment is the same as in xerosis. In certain cases skin grafting may be tried.

Tuberculosis of the conjunctiva usually appears as ulcerations, for the most part located on the tarsal conjunctiva.

Symptoms.—The lids appear thickened, and when everted there is seen upon the conjunctival surface an ulcer with a yellowish-red base or covered by grayish-red granulations. Near the ulcer may be found small gray nodules (tubercles). The ulceration spreads slowly and may pass to the conjunctiva of the eyeball. The lymphatic gland in front of the ear is swollen. One eye only is usually involved.

Diagnosis.—A small bit of involved tissue is excised and examined for the tubercle bacillus; the tuberculin reaction may be tried.

Treatment.—Local cleanliness and dusting the ulcer with iodoform powder. Good results have been obtained lately by injecting tuberculin.

Pterygium (Plate II, Fig. 3) is a vascular thickening of the conjunctiva, which extends on the cornea. It is triangular in shape with apex, or head, on the cornea, and the base well back in the fornix. The growth practically always occurs on the nasal side.

Etiology.—This condition is most frequently found in males who are exposed to all kinds of weather, or to irritating dust.

Symptoms.—The growth is gradual, and at first is attended by no subjective symptoms. In certain cases the disease remains stationary and does not involve the pupillary area. The growth toward the pupil, in progressive cases, is hardly appreciable except by actual measurement, but may cause visual disturbances before reaching the pupillary area by producing an astigmatism. When the pterygium involves the pupillary area the sight is materially interfered with. Except at the point the growth is rather loosely attached, as is also the part over the sclera.

Treatment.—A small non-progressive pterygium needs no treatment but one which is known to be growing and threatens to involve the pupillary area or has already done so, should be excised or transplanted. The best operation for *excision* was devised by Hobby. In his operation the conjunctiva is excised along the upper border of the pterygium from its corneo-scleral junction to its base. A vertical incision is then made at right angles to the first incision at the margin of the cornea, extending some distance above and below the pterygium. The pterygium is then separated from the cornea either by pulling it away with a tenotomy hook (Fig. 58), or dissecting it with the handle of a scalpel. It is then turned back and excised at its base with a V-shaped cut, the apex of which points

toward the canthus. The loose ends of the conjunctiva are brought together and sewed with two or three interrupted sutures.

Transplantation gives better results than excision, and is best performed as follows: The pterygium is separated from the conjunctiva by an incision above and below, beginning at the corneal margin, and extending inward to near

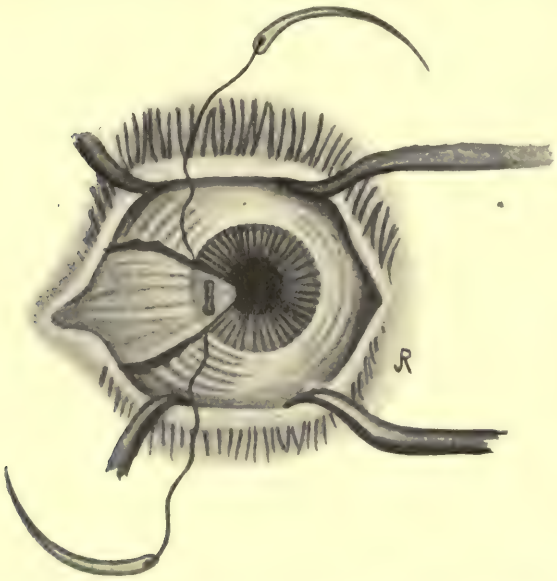


Fig. 69.—First step in transplantation operation for pterygium. (After *Fox.*)

the base. Then two tenotomy hooks are inserted under the pterygium and the point is separated from the cornea by pulling on these hooks. A double needled suture is then fastened to the apex. After the conjunctiva has been separated from the sclera above and below the incisions, the head of the pterygium is swung downward underneath the conjunctiva and drawn over to near the median line. The two needles are then passed through the conjunctiva in this position and the suture tied, thus holding the head well

buried. The free edges of the conjunctiva are then brought together and united by interrupted sutures (Figs. 69, 70, 71). In both these operations the after care is as follows: Thoroughly irrigate the conjunctival sac with boracic acid solution and then put along the lids a mild antiseptic ointment (Formula 13), and apply a sterile pad over the eye, which can be held in position by a roller bandage or adhesive plaster strips (Fig. 72). The case should be dressed daily for a day or two, after which the bandage can be

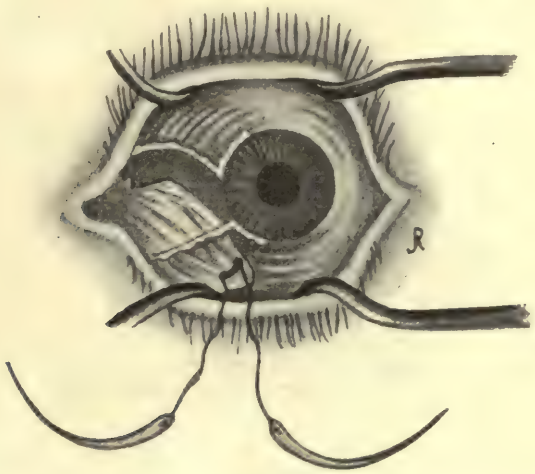


Fig. 70.—Method of burying the head beneath the conjunctiva. (After *Fox.*)

omitted. The stitches are removed on the sixth or seventh day.

Burns of the Conjunctiva are extremely painful, and if extensive are very serious, causing sloughing of symblepharon, which is the attachment of the lid of the globe.

Etiology.—Hot water, hot tar, acids, alkalies, etc.

Symptoms are those of pain, inflammation, and blurring of vision if the cornea is burned.

Treatment.—In alkaline burns use milk, oil, unsalted butter, or Formula 14 when the cornea is involved. In acid

burns use sodium bicarbonate or sulphate of magnesium. Oils give the best general results, or simple vaseline. To prevent adhesions, a form made of thin porcelain or celluloid may be worn for some weeks between the lids and the globe.

Prognosis is always grave. It is best to wait several days before giving an opinion.

Tumors of the conjunctiva are not infrequent in their occurrence. They occur in both forms, benign and malignant.

Dermoid Tumors appear almost always at the cornea-scleral margin and are situated partly in the conjunctiva,

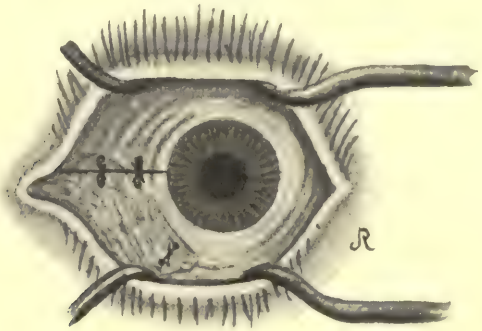


Fig. 71.—Completed operation after suturing the conjunctiva. (After *Fox.*)

and partly in the cornea. The surface is usually smooth, or may be covered by hairs or a soft down. The tumors are always congenital, and are frequently associated with other congenital malformations. Their chief harm lies in the fact that they produce disfigurement, and if large and covered with hair they produce considerable irritation. Microscopic examination reveals a composition similar to the external skin, containing hair follicles, sweat, and sebaceous glands.

Treatment.—The tumors can be easily excised, cutting as little of the underlying structure as possible, and afterwards drawing together the conjunctiva over the denuded area with sutures.

Cysts and Lipomata also occur in or beneath the conjunctiva, causing no harm other than their appearance. Lipomata usually appears in the upper outer angle of the eye between the external and superior rectus, and appear yellowish beneath the conjunctiva. Cysts are small vesicles filled with a limpid fluid, and should be dissected out carefully, removing the entire capsule.

Epitheliomata of the conjunctiva forms a non-pigmented, flat tumor with a broad base. It is usually situated at the cornea-scleral margin and advances on the cornea in

Fig. 72.—Monocular bandage held in place with adhesive plaster strips.

a form resembling a pannus, or they may form at the lid margin. The growth is very slow, and has a tendency toward ulceration.

Diagnosis is made from appearance, location, it being well recognized that primary carcinomatous growths originate at the junction of two membranes, and microscopic examination.

Treatment.—Primary epitheloma which has involved the deeper structures, which readily happens through the anterior ciliary vessels, can only be removed at the sacrifice of the eye. Enucleation is indicated to prevent, if possible,

the formation of metastases. If the tumor is secondary, as, for instance, from the lids, it may be removed sometimes without sacrifice of the eye.

Sarcomata of the limbus are usually pigmented and are more elevated than epitheliomata, and have a small slender base. The growth is mushroom-like and often overlies a portion of the cornea. They may occur in the conjunctiva of the lids.

Diagnosis and Treatment.—The same as in epithelioma.

CHAPTER VIII.

DISEASES OF THE CORNEA.

INFLAMMATION of the cornea, called keratitis, is divided into two distinct forms, non-suppurative and suppurative. In the non-suppurative form there are two stages, infiltration and absorption. In the suppurative form there are three stages; the stage of infiltration, the stage of ulceration, and the stage of cicatrization. The stage of ulceration is still further divided into the progressive period, which is that of the foul ulcer, and the retrogressive period, which is that of the clean ulcer.

Fuchs gives a valuable guide as to the clinical diagnosis of the various forms of keratitis: "If the surface is dull we are dealing with a recent affection, and in that case, if there is no loss of substance, with an infiltrate; but if a loss of substance is present, with a foul ulcer. If the surface is lustrous, the affection is an old one, and, if a loss of substance is present, with a clean ulcer; but if no loss of substance is present, with a cicatrix."

In keratitis there are frequently noticed blood-vessels which grow in from the corneal margin. This occurs mostly where the cornea is undergoing repair. The vessels may be superficial or deep, and their function seems to be constructive. Their presence is a favorable sign, and little further danger is to be expected from the ulceration. After the cornea is healed the vessels gradually disappear, although in larger scars there always remain some trace of them.

The suppurative forms will be first considered.

Ulcer of the Cornea.—In the beginning there is noticed on the cornea a small area of grayish infiltration, which gives a dull reflex. The epithelium over this area soon breaks down and the infiltration enters into the deeper structures

of the cornea, thus producing an ulcer. This is at first surrounded by a gray zone of infiltration; the base and walls are uneven and dirty, giving an eaten-out appearance. This is the stage of progression, or foul ulcer. If the resistance is sufficiently great, the ulceration will not enlarge beyond this stage, but will first become clean and heal by cicatrization. This scar tissue is opaque, and should the ulcer have been in the pupillary area of the cornea, the resulting scar would materially interfere with good vision. If the resistance is not sufficient the ulcer will enlarge in diameter and extend deeper into the true cornea. The grayish appearance may change to the yellowish color of more purulent infection. If the progression is great, perforation of the cornea is to be expected, or larger and larger areas involved until the scars formed in healing will produce great reduction in vision or practical loss of sight. In certain cases the purulent ulcer progresses rapidly on one side while healing on the other; this form being known as serpiginous ulcer, which will be considered under a separate paragraph.

Corneal ulcer is accompanied by symptoms of pain, photophobia, marked lachrymation, and ciliary injection. Secondary iritis is a frequent complication, one might say the usual complication, of corneal ulcer. This is manifested by turbid aqueous, discoloration of the iris, contracted pupil, which is either sluggish or inactive in its reaction to light, and there may be attachments of the iris to the lens (posterior synechiæ). After the stage of ulceration comes the stage of repair. The ulcer ceases to advance; it becomes clean and shallow, finally becoming filled with a gray cicatrix. During this time the symptoms of irritation gradually disappear; the eye becomes less red, the iris regains its normal color, and the pain ceases. During cicatrization the cornea may become vascularized in the area of the ulceration. A fresh cicatrix is always more dense than an old one, and the cicatrix formed after a very superficial ulceration may entirely disappear. This is especially true in children.

Etiology.—Usually injury, but may accompany general diseases, such as small-pox, measles, eczema, or other eruptive diseases.

Treatment.—Atropine should be applied in ½ to 1 per cent. strength, either in the form of a collyrium or in combination with some antiseptic ointment (Formula 6 or 8). The atropine dilates the pupil, thus preventing the formation of posterior synechiæ, or, if they have already formed, breaks them away. It also puts the eye in a condition of rest. The ointment of nosophen or yellow oxide of mercury keeps the drug in contact with the ulcerated surface. Another drug that has proved valuable in certain cases is the red iodide of mercury, applied in ointment form (Formula 15), or the red oxide of mercury (Formula 16). Formula 15 may be ordered without the cocaine if that drug has a detrimental effect on the cornea. It is best to use a cocaine ointment or collyrium very sparingly, and only when under the constant care of a physician. A solution of nitrate of silver recommended by some authors is, in my opinion, faulty treatment, in that it appears to increase the density of the opacity. Argyrol in 50 per cent. solution is a valuable aid in cleaning the ulceration, as this medicine sticks to the ulcerated surface, and its effect is prolonged. In severe ulcerations that are advancing, a bandage over the affected eye is frequently of benefit, after having first dusted the ulcer with nosophen or aristol powder, and instilling 1 per cent. atropine solution. This bandage should be changed twice or three times in twenty-four hours, and the treatment renewed. Hot fomentations to the eye three or four times a day relieve pain, or leeches applied to the temple have an excellent analgesic effect, as well as aiding in the dilatation of the pupil. The patient's eyes should be protected from the light, either by dark glasses or a shade, proportionate to the amount of photophobia. A darkened room, except in very severe cases of photophobia, is neither indicated nor desirable, for the reason that on entering into a more brilliant light the contrast is much greater and causes increased irritation.

Keratitis Serpens, or ulcer with hypopyon (Plate III, Fig. 2), is an acute purulent ulcer, which spreads rapidly over the surface of the cornea, at the same time penetrating deeply into the structure as far as the membrane of Descemet. This membrane is more resistant than the rest of the cornea, and the process may be retarded here, or it may go on to perforation. The ulcer is more yellow at the edge than at the center; one side, called the head or advancing portion, shows a particularly well-marked yellowish area. The ulcer is surrounded by a gray zone of infiltration, and may also show gray striæ, which extend out in all directions into the clear portion of the cornea. The anterior chamber usually contains a yellowish exudate which settles to the bottom. This is called the hypopyon. It varies in height from ¾ mm. to filling the entire anterior chamber. Secondary iritis is always very marked, the infiltration always plastering down the iris to the lens forming large synechiæ, unless the pupil has been previously dilated. There is always marked injection of the ciliary and conjunctival vessels, œdema of the lids, marked photophobia, lachrymation, and intense pain. The ulceration spreads until practically the entire cornea is involved or else perforated. If perforation occurs before the entire cornea becomes infected, the clear portion may not ulcerate, and when the condition is healed it will be found transparent. When perforation occurs there is great momentary pain followed by marked relief in the subjective symptoms. The aqueous flows out carrying with it the exudate or hypopyon; the iris prolapses into the wound, and, if healing now begins, it becomes incarcerated into the scar, causing *anterior synechia.* The suppuration may not end here, but extends into the deeper parts of the eye, causing an infection of the entire contents, known as panophthalmitis. Serpent ulcers heal with a very opaque cicatrix, which is permanent, and which interferes very materially with vision. There are usually found anterior synechiæ.

Diagnosis.—The clinical picture is characteristic, especially in the beginning. The yellow margin, the shallow

ulceration, the rapidity of its advance, and the early formation of hypopyon with marked iritis.

Treatment.—The same local treatment is given as in ulcer of the cornea. Many cases of hypopyon will clear up over night when the conjunctival cavity is filled with aristol or nosophen powder, and the eye bandaged. The ulcer may be rubbed with tincture of iodine, after the eye is cocainized, care being taken that the iodine does not extend beyond the ulcerated area, or the edges of the ulceration may be touched with the actual cautery. It has been observed that the progress of the disease has been checked when the ulcer perforated. This led Saemisch to advocate the operation which bears his name. Should the treatment described above fail to check the progress of the ulceration and the hypopyon increase in size, a Saemisch operation is indicated. It is performed as follows: The eye is cocainized, or the patient is put under the influence of a general anæsthetic, the lids are separated by means of a speculum, and an incision is made through the ulcer with a Graefe cataract knife. The incision should start and end in clear cornea, passing as nearly through the center of the ulcer as possible. The anterior chamber is evacuated, and at the same time the hypopyon comes out through the wound. Atropine is then instilled into the eye, the cornea dusted with nosophen powder, and a bandage applied. The success in this operation depends upon the wound being kept open, which is done once or twice a day with the thin blade of a spatula. Under this treatment the eye generally clears up rapidly, a large portion of the cornea is kept clear, and the danger of panophthalmitis lessened. Some cases heal without the formation of anterior synechiæ, but the majority have an attachment of the iris to the wound. The anterior synechiæ following Saemisch operation are not so large as those found where the ulcer is allowed to perforate.

Etiology.—The serpent ulcer is caused by injury; the bacterial examination made from cultures taken from the ulcer, in the majority of cases, show the pneumococcus in pure culture. Most cases are seen in stone cutters; the

small fragments of stone flying into the eye produce an injury which seems most readily to become infected. The injury is practically always a superficial one, causing little more than the break in the epithelial layer. Another quite common injury is a scratch of the cornea by the finger nail or twig. This form of ulceration is most commonly seen in the laboring class, partly because of their exposure to all forms of injury, and partly because they are prone to neglect an injury until it becomes infected.

Serpent ulcer is a common complication of gonorrhœal ophthalmia and diphtheritic conjunctivitis. A corneal injury in an eye having lachrymal obstructions or lachrymal blennorrhœa is very prone to become infected and become a serpent ulcer.

Prognosis is always grave. This is classed among the most serious of all ocular diseases, and must be checked early that it does not cause blindness through a dense opacity of the cornea (Plate IV, Fig. 2), or panophthalmitis requiring the removal of the contents of the eye.

Perforation of the Cornea.—This may take place when an ulceration has penetrated deeply in the corneal tissue, either spontaneously or by a sudden increase in the intraocular pressure. This increase may be caused by bodily exertion, as stooping and lifting, or coughing, sneezing, and squeezing the lids tightly together. In certain cases it is caused by the examiner in his attempt to see the cornea. It is, therefore, advisable to use the utmost caution in handling an eye, the cornea of which is deeply ulcerated. When the perforation occurs, the aqueous flows out, carrying with it the exudate and the iris, the latter appearing quite black. In large perforations the lens and vitreous may present at the wound or even be expelled. In certain cases there is a prolapse of nearly the entire iris, which in healing gives rise to a condition known as *anterior staphyloma.* This is commonly seen following cases of ophthalmia neonatorum that have been improperly treated, or treated too late to save the cornea. If the perforation is small the iris may attach itself but slightly to the wound, thus form-

ing a small anterior synechia. When healed such an eye will have an elongated and laterally placed pupil due to the iris being pulled to one side. Should the perforation fail to heal entirely it gives rise to a permanent opening called fistula of the cornea. This appears as a small, round, black point in the center of scar tissue, the anterior chamber is absent, and the eye remains soft. In the treatment of prolapsed iris it is important that the surface be kept as even as possible. This is accomplished by putting on a pressure bandage after the eye has become well advanced in the healing process, or the portion of the iris bulging above the cornea may be excised. Naturally excision should not be performed if the prolapse is a large one.

Corneal Fistula may be treated by touching the area with the actual cautery, or a bandage in combination with miotics, and absolute rest in bed may permit of firm closure of the opening.

Cicatrization may be aided by the application of irritants to the eye. Powdered calomel is one which has considerable vogue, but the ointments of the yellow oxide of mercury, 8 to 12 grains to the ounce, or the red oxide, 4 grains to the ounce, put into the eye night and morning and gently massaged through the upper lid have a much better effect.

Phlyctenular Keratitis (Plate III, Fig. 1) is an extension of the phlyctenular conjunctivitis to the cornea.

Etiology has already been described in the previous chapter.

Symptoms are largely an accentuation of those described under Phlyctenular Conjunctivitis. The ciliary injection becomes marked, the photophobia and lachrymation increase to a marked degree, so that we usually find patients with their faces buried in a pillow or in their mothers' arms. This naturally retains all the discharge, increases the local heat, both of which aggravate the condition. Children frequently will not open their eyes because, when they do, the hot tears flow down their cheeks causing great discomfort.

The *diagnosis* is usually very easy to make.

Treatment.—It is essential in order to properly treat a case that the cornea should be thoroughly seen at least once a day, and lid elevators must be used, if no other way is successful. Locally the eye should be treated with frequent irrigations of boracic acid solution, and an ointment of yellow oxide and atropine (Formula 6), three or four times a day. A shade should be worn well down over the eyes, but not in contact with the lids; this is preferable to dark glasses. The patient should not be allowed to bury his face in a pillow or the bed clothes, but should be encouraged to look about the room made not too dark to obscure interesting things. Great care should be taken as to proper diet, and rules of hygiene. As soon as possible the patient should be taken out in the open for a good portion of the day. Internally tonics of iron or cod-liver oil should be given. The syrup of the iodine of iron is one of the best tonics for children. Arsenic and strychnine may also be given.

Prognosis.—Good except for corneal nebulæ—faint scars (Plate III, Fig. 1), which may largely clear up. Cases that occur through the faulty hygienic and dietetic conditions in which they live have a much more guarded prognosis, as have also those cases due to nasal or post nasal obstructions which the parents refuse to have operated upon.

Interstitial Keratitis, or parenchymatous keratitis, is a diffuse chronic inflammation of the entire corneal tissue, and which is constitutional in its origin. It occurs in two forms, one which begins at the center and the other at the margin of the cornea. There is no loss of substance, the inflammation lying almost wholly in the true cornea. Most cases show interstitial vascularization.

Etiology.—The disease is almost invariably the result of inherited syphilis or tuberculosis. These patients usually showing the characteristic notched teeth described by Hutchinson. Some cases of acquired syphilis manifest this form of corneal inflammation. In rare instances there is history of trauma, but that may have been but coincidental. Some cases with a scrofulous or rheumatic history also show this condition.

PLATE III.

Fig. 1. Phlyctenulæ at corneal margin and two on the conjunctiva. The center of the cornea shows old scars of previous attacks. Eczema of the lid well shown. Patient, girl 9 years old, with tubercular history.

Fig. 2. Serpent ulcer of the cornea with hypopyon. (Note the changed color of the iris and blocked irregular pupil.)

Fig. 3. Dendritic ulceration of the cornea stained with fluorescin. (Note mild ciliary injection and irregular outlines of ulcer.)

Fig. 4. Mild iritis, showing irregular dilatation of the pupil; posterior synechia above; green tint of a normally blue iris, and ciliary injection.

PLATE III

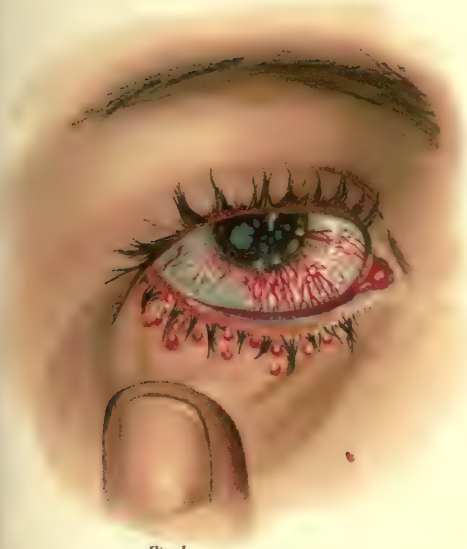


Fig. 1.

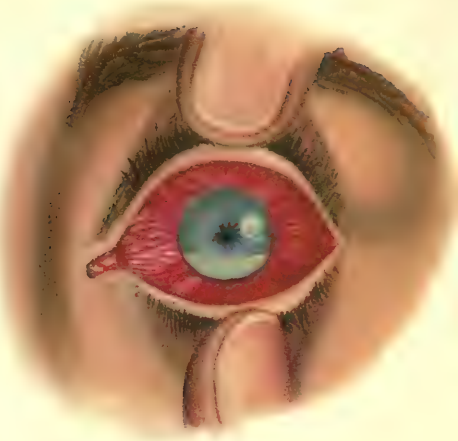


Fig. 2.

Fig. 3.

Fig. 4.

Symptoms.—If the disease invades the center of the cornea first, small gray areas of infiltration are seen lying in the middle or deep layers over which the epithelium appears dull. The areas increase in number gradually advancing toward the corneal margin, but remaining thickest at the center where they may become confluent. The cornea may present the appearance of ground glass, for even between the well defined areas the corneal substance is quite uniformly gray. As the case advances corneal vascularization may take place, the vessels lying in the cornea proper, and are best seen with a + 16 lens in the ophthalmoscope.

In the cases that begin in the corneal margin, small lusterless areas are seen lying deeply in the cornea. These increase in number and advance to the pupillary area when the cornea resembles the other form, except that the opacity is more dense at the periphery. The vascularization when present in this form is seen in two varieties; one, more superficial than the other, forms almost a complete zone around the limbus and extends on the cornea about 1 or 1½ mm.; the deep vessels are very faintly seen running in the corneal substance much as they do in the form of interstitial keratitis beginning at the center.

These two forms give rise to *symptoms* of failing vision, more noticeable at first in the kind which begins at the center. The opacity may become so dense that the patient is unable to see anything except light, and the observer may be unable to see the iris. There is accompanying ciliary injection, photophobia, and lachrymation, although the two latter may be absent to a marked degree, and most cases show a secondary iritis. The stage of repair begins with the decrease in the density of the opacity at the periphery of the cornea, the center remaining opaque longer. The blood-vessels gradually disappear, although in some instances the faintest trace may remain after many years. The cornea gradually clears up entirely leaving but a faint indefinite haze which usually does not interfere with excellent visual acuity. Some cases do not run so severe a course, while others may form such dense opacities that they never

entirely clear up. In some cases the cornea becomes so vascularized that it appears red, while in others the vessels are made out with the greatest difficulty, or not at all. The disease practically always affects both eyes, but may not do so simultaneously.

Diagnosis.—The disease can hardly be mistaken for any other form of corneal inflammation. The situation of the infiltration in the cornea proper without the loss of substance, the chronicity and especially the characteristic appearance of congenital syphilis—Hutchinson teeth, prominent frontal eminences, and the lines or scars about the angles of the mouth.

Treatment should be both local and constitutional. The *local treatment* consists of the instillation of atropine in not more than sufficient amount to keep the pupil dilated and prevent posterior synechiæ. In the stage of regression irritants should be applied to the eye; to promote absorption of the infiltration, the yellow or the red oxide of mercury are remedies which give the best results. They are applied in ointment form twice a day. After placing into the conjunctival cavity a piece about the size of a split pea, the eye is gently massaged through the upper lid. The eyes should be protected from the light by dark glasses or a double shade.

The general treatment is of great importance, and the two remedies of greatest benefit used either singly or together are inunctions of mercury and the syrup of the iodide of iron. In adults potassium iodide is used instead of the iodide of iron. Inunctions of mercury are well borne in cases showing the characteristics of congenital syphilis, or from whom a history of syphilis is obtained. It should be thoroughly rubbed into the skin for from ten to twenty minutes, in quantities of a dram or more each day. A new place is selected for each application to prevent irritation of the skin. The person applying the ointment should protect the hands with rubber gloves. Corrosive sublimate in doses of $^1/_{100}$ of a grain are given with good results to children three times a day, or protiodide in doses of $^1/_{20}$ grain. Four-

nier considers the administration of mercury by the mouth the logical form of administration. Syrup of the iodide of iron is given in 5 to 20 drop doses in water, three times a day. The iodide in adults can be gradually increased from 10 drops to 1 dram three times a day.

Prognosis of this disease is unfavorable as regards duration, for it may drag on for months and even years. The physician should remember that the prognosis as to the ultimate recovery of normal vision is good, and this should be told the patient, or patient's family, that they may be encouraged to keep up the treatment in the hopes of a perfect result.

Dendritic Keratitis (Plate III, Fig. 3) is so named because the ulceration takes the branching form of the dendrites of a nerve cell.

Etiology.—There are two definite constitutional causes for this disease, malaria and influenza. Some cases have no history other than trauma.

Symptoms.—The inflammation is almost always superficial and is not deeply infiltrated, the loss of substance being made out only upon most careful examination. Touching the cornea with a cotton swab saturated with a 2 per cent. solution of fluorescein will stain yellow that portion of the cornea denuded of epithelium. In this manner can be brought out some really beautiful designs, and the entire extent of the ulceration clearly seen. The disease is almost always accompanied with great pain, and marked symptoms of irritation, photophobia, and lachrymation. Secondary iritis is a usual complication. The superficial forms of ulceration leave a very faint scar which may entirely disappear. Many cases are very resistant to treatment, the time elapsing before recovery being out of all proportion to the objective symptoms.

Diagnosis is easily made from the history and the appearance when stained with fluorescein.

Treatment.—Atropine should be instilled to keep the pupil dilated. This form of ulceration responds best to daily rubbing the ulcerated surface with tincture of iodine,

or in some cases touching lightly the ulcerated area with the actual cautery. At the same time an ointment of nosophen powder or aristol may be used, or an ointment of the red iodide of mercury (Formula 16).

Prognosis.—Good in mild cases. Some cases may last some time and leave a large, thin, irregular scar.

Herpes Corneæ is a condition which almost always arises during an attack of herpes zoster of the ophthalmic nerve. At the same time there is usually marked herpes of the supra-orbital nerve, always affecting but one side.

Symptoms.—Some cases appear to have no pain, but most suffer some pain and discomfort both from the skin affection and the corneal ulceration. The ulceration is quite superficial, and is not deeply infiltrated in most cases. More severe cases show deep ulceration branching over the cornea, or in various small spots, which condition is accompanied by secondary iritis and rarely by hypopyon and perforation of the cornea. The upper lid is moderately drooped, giving rise to a slight temporary ptosis. The disease extends over a period of several weeks and may recur several times after it has been apparently healed, each time resulting in the loss of more clear cornea.

Treatment.—Atropine locally and the use of ointments and tincture of iodine as described under Dendritic Keratitis. Constitutionally there should be given tonics of iron and strychnine in order that the general health may be maintained.

Prognosis.—In mild cases there may be very slight scar formation and consequently little interference in vision. More severe cases range in severity from the formation of corneal opacities to perforation of the cornea and loss of sight.

Keratitis Bullosa is a form of corneal inflammation characterized by the formation of quite large vesicles or blebs on the surface. This condition is a rare accompaniment of other ocular diseases. There are marked symptoms of pain, photophobia, and lachrymation especially after the blebs or vesicles rupture. There is great tendency toward

recurrence, each attack being ushered in by a marked increase in all symptoms. The blebs and vesicles after rupture leave abrasions and superficial ulcerations which are very painful. The disease may last off and on for several years.

Treatment.—Other than the administration of tonics is of little avail. The local irritation is somewhat relieved by the use of collyrium of cocaine and pilocarpine (Formula 17).

Keratitis Punctata, or Descemetitis, is not an inflammatory condition of the cornea, but is a deposit of opaque material on Descemet's membrane. This deposit may be white or brown in color, usually the latter, and is always associated with diseases of the iris, ciliary body, choroid, or vitreous. The deposit is arranged in the form of a pyramid with the apex at the pupillary margin and the base at the corneal margin below.

Abscess of the cornea is a suppurative condition in which the purulent process lies deeply in the tissue.

Symptoms are much the same subjectively as in corneal ulceration. Upon examination the cornea appears quite uniformly gray about a dense point of yellowish infiltration. There is little or no loss of substance. This yellowish area may penetrate to the membrane of Descemet and threaten perforation before the surface ulcerates. The usual result is ulceration and the future progress is the same as that described under Ulcer of the Cornea.

Treatment.—The same as that described under Ulcer of the Cornea and Serpent Ulcer. Threatened perforation should be met at once with either a paracentesis of the cornea or the Saemisch operation.

Foreign Bodies lodging in the cornea give rise to symptoms of quite severe irritation. They are usually hot cinders, flying particles from an emery wheel, or bits of metal, wood, stone, or powder grains. If allowed to remain in the cornea for some time they become surrounded by a zone of infiltration and may drop out leaving an ulcerated area behind.

The treatment is removal as early as possible, under

cocaine anæsthesia, with an eye spud (Fig. 73), or it is best to try at first a simple cotton swab which does less damage to the cornea in the hands of the beginner. The subsequent treatment should be the use of a mild antiseptic collyrium or, if ulceration has taken place, an antiseptic ointment.

Conical Cornea has been considered from a refractive standpoint in the chapter on refraction. We will consider the condition here from the standpoint of treatment other than refractive. Local medication is useless, it being impossible to check the advancement of the disease. Various operative measures have been suggested, but only a few will be briefly described. Frequently evacuation of the aqueous by repeated paracentesis of the cornea, followed by the instillation of a miotic and the application of a pressure bandage. This treatment sometimes gives rise to temporary flattening of the cornea, but it is unfortunately not per-

Fig. 73.—Corneal spud.

manent. The removal of the elliptical piece from the apex of the cone followed by the suture of the wound has given rise to flattening of the cornea, but this produces a scar in the pupillary area through which the patient cannot see and necessitates a second operation for an artificial pupil. Another method is cauterization of the apex of the cone with the nitrate of silver stick or the actual cautery. This also produces an opacity over the pupil and prevents seeing unless an artificial pupil is made. The author has devised a preliminary operation which consists in making an incision about 1½mm. from the corneal margin in the axis of the myopic astigmatism which is always found. The incision should be semi-circular, extending nearly to the equator on both sides (Fig. 74), the object being that in contraction of the scar there will be produced an artificial hypermetropic astigmatism which will overcome the myopic astigmatism, and at the same time produce flattening of the cornea. This operation will certainly give temporary relief and will result

in improvement of the vision. Should the conicity again become prominent the excision operation or the cautery operation can be performed followed by iridectomy for an artificial pupil.

Globular Cornea, or buphthalmos, is a general spherical distention of the cornea, and has been called dropsy of the anterior chamber. Visual acuity may be normal, or there may be quite marked myopia. Diagnosis is easy except in differentiating it from infantile glaucoma. Ophthalmoscopic examination will easily render the diagnosis easy, for in globular cornea the fundus is normal.

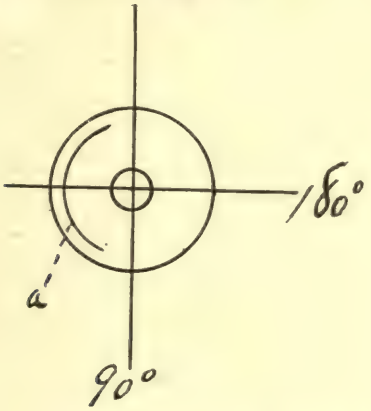


Fig. 74.—Author's operation for conical cornea.

Treatment is of little or no avail, although repeated paracentesis may be tried, or sclerotomy.

Anterior Staphyloma is a protrusion forward of an opaque or partially opaque cornea due to the weakening of its structure. It follows cases of deep ulceration or perforation of the cornea.

Treatment.—The bulging portion may be excised, the edges of the wound being held together by sutures, or the eye may be enucleated. The latter is the best procedure in cases with large staphylomata, as the eye is useless, and an artificial eye is less conspicuous than one which is greatly scarred and sightless.

CHAPTER IX.

DISEASES OF THE IRIS, CILIARY BODY, AND CHOROID.

THE iris, ciliary body, and choroid form the middle coat of the eye, and are called the uveal tract. They are very closely connected and all participate to a greater or less extent in the inflammatory diseases of the others. Inflammation is the most common diseased condition which is liable to affect them, causing great engorgement of the blood-vessels with which they are so abundantly supplied. During inflammatory conditions the function of the iris is suspended and the color changes. The inflammation causes the exudation of plastic material and this attaches the iris to the anterior capsule of the lens producing posterior synechiæ, also a contraction in the size of the pupil. The exudate may block the pupillary area, become organized into a false membrane and cause permanent impairment of vision.

IRIS.

Iritis is an inflammatory condition of the iris which is preceded by a condition of hyperæmia. Hyperæmia almost always accompanies inflammatory diseases of the cornea, or sclera, which in turn almost always becomes a well defined iritis.

Etiology.—Iritis is caused by a number of constitutional conditions, principally syphilis and rheumatism, and, much more rarely, gout, diabetes and tuberculosis. It also frequently results from the extension of inflammation from neighboring ocular structures. It is also due to trauma, possibly to exposure to cold or wet, and during certain febrile diseases, especially influenza. There is a distinct form which is undoubtedly gonorrhœal in origin. Some cases arise without definite cause, and are called idiopathic.

Symptoms.—In the early stages there are practically no symptoms noticed other than a feeling of irritation, and a slight photophobia. Objectively the iris does not seem to be discolored, and the pupil reacts to light although this reaction may be slightly sluggish. The injection may hardly be called ciliary and yet is slightly more than a mild conjunctival injection. It is at this stage that beginning iritis may be mistaken for simple irritation, and if uncertain as to diagnosis, the pupil may be dilated with 1 per cent. homatropine, or the patient told to report for further observation in twelve or twenty-four hours. Later the disease becomes defined; the color of the iris changes, blue irides become greenish (Plate III, Fig. 4), and the brown irides become a muddy color; the striæ are made out with difficulty, the pupil is contracted and does not respond to light, ciliary injection is marked, and there is considerable photophobia and pain. The aqueous is more or less turbid and, in severe cases, there are brownish deposits on the membrane of Descemet. The vision is diminished in proportion to the turbidity of the aqueous and the amount of exudate in the pupil. Tension is usually normal, but there may be an increase in tension if the pupil is thoroughly tied down to the lens. Palpation through the lid causes marked pain in the eye. In some form there is poured out by the iris a large amount of exudate which fills the pupillary area. This form is called plastic iritis and is largely of syphilitic origin. Another form is characterized by a swollen nodular appearance. These nodules are yellowish-red and are found chiefly in or near the pupillary margin. They have been called gummata of the iris, but as they occur in the second stage of syphilis, they should not be so called.

Diagnosis.—Iritis may be mistaken for conjunctivitis, keratitis, or glaucoma. In considering the differential diagnosis of these conditions all parts of the eye must be carefully examined. The type and character of the injection should be carefully observed. The size of the pupil and its reaction to light and accommodation. The condition of the media, cornea, aqueous, lens, and vitreous. The color and

DIFFERENTIAL DIAGNOSIS OF IRITIS, CONJUNCTIVITIS, KERATITIS, AND GLAUCOMA.

	Iritis.	*Conjunctivitis.*	*Keratitis*	*Glaucoma.*
Injection.	Ciliary.	Conjunctival.	Ciliary.	Ciliary and conjunctival (passive).
Cornea.	Clear, hypersensitive. May be punctate deposits on Descemet's membrane.	Normal.	Shows ulceration or infiltration.	Clouded in acute cases and anæsthetic.
Tension.	Normal or subnormal.	Normal.	Normal or very soft following operation or perforation.	Increased + 1, + 2, + 3.
Iris.	Discolored, may be swollen or in normal plane. Posterior synechiæ.	Normal.	As in iritis, in severe cases.	Bulged forward.
Pupil.	Contracted and unreacting.	Normal.	As in iritis, in severe cases	Dilated and unreacting.
Accommodation.	Diminished or absent.	Normal.	Diminished or absent in severe cases.	Absent in acute attack.
Vision.	Reduced according to exudate and blocking of pupil.	Normal.	Much reduced in severe cases.	Practically absent in acute cases. Field limited in chronic cases.
Optic nerve.	Normal.	Normal.	Normal.	Cupped.
Pain.	Severe and nocturnal.	Irritation only.	May be very severe.	Severe in acute cases, not necessarily nocturnal.
Anterior chamber	Normal.	Normal.	Normal.	Shallow.
Hypopyon.	Rarely.	None.	Frequently.	None.
Media.	Turbid.	Clear.	Turbid.	Clear, except cornea in acute cases.
Discharge.	Watery.	Muco-purulent and purulent.	May be slight muco-purulent.	None.

position of the iris, the depth of the anterior chamber. The cornea, whether ulcerated, infiltrated, or shows a punctate deposit on Descemet's membrane, also whether anæsthetic or not. Tension should be taken, and the condition of the optic nerve noted. In typical cases the differential diagnosis is as follows:—

Treatment is both general and local. *Local* treatment consists in the instillation of atropine to dilate the pupil so that posterior synechiæ may not form, or, if they have already formed, to break them away. One per cent. solution is sufficient in the early stages to dilate the pupil, at least irregularly (Plate III, Fig. 4). Stronger solutions, 2 per cent. or 4 per cent., may be used by the physician, but should not be given to the patient. In using strong solutions of atropine pressure should be made over the inner canthus for a few minutes in order that the atropine will not run into the nose and become absorbed, and give rise to atropine poisoning. Leeches applied to the temple will relieve pain and aid in the dilatation of the pupil. Dionine in 5 per cent. solution instilled into the eye, or a few crystals placed in the conjunctival cavity, will frequently relieve pain and aid in the mydriatic effect of the atropine. If atropine causes irritation and toxic effects, scopolamine (Formula 18), or hyoscine (Formula 19), may be used in its place. Hot fomentations applied to the eye for ten or fifteen minutes three or four times a day will do much toward relieving the pain and diminishing the inflammation. They are best applied by holding absorbent cotton, which has been soaked in hot boracic acid or normal salt solution, over the eye with the lids gently closed. The cotton pads should be frequently changed in order that heat may be constantly applied for about fifteen minutes. Adrenalin 1 : 2000 combined with atropine is often of benefit.

General Treatment.—It is important to keep the bowels open, and a saline cathartic should be given as soon as possible after the disease becomes manifest. In cases having a syphilitic history, mercury should be given up to the physiological limit, either by the mouth or in the form of

inunctions; it must be stated here that mercury has a decidedly beneficial effect in those cases where no syphilitic history is obtained. The bichloride is given internally in doses of $^1/_{30}$ grain three times a day and gradually increased in strength up to $^1/_{10}$ of a grain. The protiodide in doses of $\frac{1}{8}$ grain, which may be increased to $\frac{1}{2}$ grain three times a day. Inunctions are usually applied once a day, beginning with about a quarter of a dram of the ointment and gradually increased to a dram or more. Potassium iodide may be given, and in some cases gives good results. Ten-drop doses of the saturated solution three times a day may be increased to dram doses if the drug is well borne. In rheumatic cases sodium salicylate may be given up to forty grains a day in cases that are closely watched, or asperin, thirty grains a day, is often better in that it is not likely to cause digestive disturbances, but in certain cases it cannot be used on account of causing a troublesome urticaria. In diabetic cases much can be accomplished by instituting a suitable diet.

In all cases the eyes should be protected from the light by the use of dark glasses or a double shade. Severe cases must be confined to a darkened room in proportion to the photophobia. I should like to state here my disapproval of the single eye shade. It is usually worn close to the eye and causes more damage than it can possibly do good. It also does not obviate the reflex tendency toward the pupillary contractions when light is thrown on the sound eye. In cases when the pupil fails to dilate and there is a tendency toward secondary glaucoma, an iridectomy should be performed, even in the height of the disease. It must be performed under a general anæsthetic, as cocaine has little influence upon an inflamed eye.

Sequelæ.—Posterior synechiæ are most frequently found. These are attachments of the iris to the lens, and they may persist as traction bands giving rise to a constant source of irritation, so that it may become necessary to divide them. They may even cause secondary glaucoma.

Pupillary Membrane (occluded pupil) is caused by

the deposit of exudate in the pupil becoming organized into a membrane which is more or less permanent. The vision is of course lessened, depending upon the thickness of the membrane.

Seclusion or Exclusion of the Pupil is caused when the pupillary margin of the iris becomes attached to the lens, closing the passage between the posterior and anterior chambers. The pressure of the fluid in the posterior chamber causes the iris to bulge forward causing a condition known as *iris bombe*. Continued irritation follows this condition causing subacute attacks of iritis or secondary glaucoma, both of which conditions require an iridectomy for their relief. For technique of iridectomy see chapter on "Glaucoma."

Total Posterior Synechia is a condition in which the whole of the posterior surface of the iris is attached to the lens. This condition is incurable by local medication or operation and leads to atrophy of the eye-ball with, of course, absolute loss of light perception.

Opacity of the Lens may result in consequence of disturbed nutrition. It is noticed in cases where secluded pupil has existed for some time or where the lens has been surrounded by exudate. It cannot be operated upon with much chance for success.

Prognosis.—A mild attack of iritis will clear up entirely leaving no trace behind other than possibly a few pigment spots on the lens capsule which do not interfere with vision. This form will run its course in from ten days to a month. In very serious cases manifesting any of the sequelæ mentioned above or with serious involvement of the ciliary body and choroid, the prognosis should be guarded, normal vision rarely if ever being attained.

Among *congenital anomalies* of the iris a few deserve mentioning, that they may not be mistaken for diseased conditions.

Persistent Pupillary Membrane is rarely seen, and is most always unilateral. It is seen best by focal illumination and is manifested by small opaque bands which stretch

across the pupillary area, or as tags hanging from the pupillary margin of the iris.

Coloboma of the Iris (Plate IV, Fig. 1) is more common and appears as a cleft or fissure in the iris which on ophthalmoscopic examination may be found to extend well back into the choroid. This condition is about equally divided in its occurrence as a binocular or monocular anomaly. It has the appearance of an iridectomy and always occurs downward in the median line. It may or may not influence vision, but is usually associated with other congenital anomalies such as cataract, nystagmus, etc., and is frequently seen in several members of the same family.

Pigment Changes are not at all uncommon varying from one eye being blue and the other brown to a blue area in a brown iris or *vice versâ*. Small spots of pigment are frequently seen which may be mistaken by the uninitiated for a foreign body in the iris or the cornea. The irides are devoid of pigment in albinos, and appear pink, due to the reflex or the fundus showing through.

Absence of the Iris, or anaridia, is a very rare congenital condition, and is almost invariably accompanied by poor vision and nystagmus.

Cysts and Nævi may occur, but congenital growths are very uncommon.

Iridodonesis, or tremulous iris, is usually seen after the lens has been extracted, or after luxation of the lens. It may, however, occur rarely as a congenital condition. The tremulousness is noticed when the eye is moved.

Tumors of the Iris.— Tuberculosis and syphilis give rise to iritic growths which are most commonly seen. In syphilis they appear as small tumors at or near the ciliary margin, and in tuberculosis the tubercles are seen in the substance of the iris. Both conditions are treated by the local treatment for the iritis, with which they are associated, and the constitutional cause of the inflammation.

Cysts other than congenital occasionally form, probably in most instances due to trauma. Their contents are liquid or semi-solid in character, and they vary in size from

very small bodies to enlargements which may fill the anterior chamber and cause glaucoma, irido-cyclitis, or sympathetic ophthalmia from pressure. Cysts are malignant, their only danger being due to pressure. If found growing they should be removed in such a manner as one would perform an iridectomy, the growth being dissected from the iris.

Melanotic Sarcomata may be found in the iris as a primary growth. It should be excised if small, or if large and the diagnosis is certain the eye should be removed in order that metastasis, which is common, may not take place. Most growths of the iris are associated with the ciliary body and are dangerous to life if malignant, and to the involved eye or even the good eye through sympathetic ophthalmia by the pressure they occasion.

Wounds of the Iris (non-penetrating).

Traumatic Mydriasis is a dilation of the pupil which may remain permanently. It results from paralysis of the sphincter. Pilocarpine, 1 per cent., solution should be used twice a day for some time to see if the condition can be overcome.

Rupture of the Iris is a tear of the pupillary margin which usually includes the sphincter of the iris. The pupil is dilated. The use of pilocarpine for some time may overcome the mydriasis.

Iridodialysis is a condition in which the iris has been severed from its attachment to the ciliary body, causing it to spring away, thus forming an artificial pupil. In certain locations this new pupil may permit of the formation of two images on one retina, giving rise to monocular diplopia. A detached iris is liable to displacement, one form in which the iris is folded back on the ciliary body (retroflexion); another, in which it is twisted or curled forward upon itself showing the pigment surface (antroflexion); and a third form in which the detachment is so large that it settles to the bottom of the anterior chamber.

Non-penetrating wounds of the eye are especially liable to cause hæmorrhage in the anterior chamber, a condition

known as *hyphæma*. This blood gradually absorbs and usually leaves no trace behind, but if in great amount the iris may be stained a slightly yellowish color. Treatment consists in the use of atropine and alternate hot and cold applications. Large detachments of the iris are incurable.

Penetrating Wounds of the Iris are considered under a special chapter devoted to injuries of the eye.

OPERATIONS.

Iridectomy is described in chapter on "Glaucoma." *Iridotomy* is an operation frequently performed in cases where it is necessary to break up adhesions of the iris to the lens, but it is dangerous in cases where the lens is transparent because of the possibility of producing traumatic cataract. In aphakia, where adhesions are simply attached to the capsule the operation is frequently performed for artificial pupil. When the lens is present and transparent, and posterior synechiæ are to be broken away, an incision is made in the cornea with a Graefe knife or a keratome and a small portion of the iris is drawn out and cut. Through this incision a spatula or a spud is inserted and the adhesions broken away. Atropine is instilled, an antiseptic ointment is used, and a sterile dressing applied.

Iridectomy for *artificial pupil* (Plate IV, Fig. 2) should be performed directly behind the clear portion of the cornea, in such a position, if possible, that it will give the patient the best vision.

CILIARY BODY.

As previously stated it is doubtful if a case of iritis ever occurs without involvement of the ciliary body, and the converse of this is true in that an inflammation of the ciliary body will involve the iris. In very severe cases of iritis there is great tenderness on palpation over the ciliary region, a punctate deposit on the membrane of Descemet, and vitreous opacities. The condition is called iridocyclitis. When the disease originates in the ciliary body it is either due to trauma of sympathetic ophthalmia. The term

iridocyclitis should be retained, but simple cyclitis does not exist as a clinical entity.

Iridocyclitis is a condition of great severity and practically always leads to impaired vision, or may result in absolute destruction of the eye.

Etiology same as iritis, but also includes penetrating injuries of the ciliary region, which become infected, and sympathetic disease extending from the other eye. It frequently follows cataract extraction which has become infected.

Symptoms are similar to iritis except that they are very much more severe. The pain is usually intense and may be constant. The photophobia is very marked. The anterior chamber and vitreous become cloudy with exudate, which reduces the vision to the perception of large shadows or light. This condition leads, in many cases, to detachment of the retina, blindness and atrophy of the eyeball.

Diagnosis is easily made from the severity of the clinical manifestations and subjective symptoms.

Treatment is the same as in iritis except, as advised by Gifford, these cases should be given sodium salicylate up to the physiological limit. Atrophy of the globe following this condition, which continues to be a source of irritation, requires enucleation, that there may not be caused a sympathetic inflammation in the other eye. Severe pain has been temporarily allayed or permanently relieved in cases of severe iridocyclitis by the use of the violet-ray for six or eight minutes once or twice a day. This treatment for pain is as yet in the experimental stage, but it is certain that pain has been relieved in cases having had persistent pain for weeks.

The treatment of cases caused by injury and sympathetic diseases is considered in a special chapter.

Prognosis is always grave. Good vision is practically never restored and the disease may lead to blindness or sympathetic ophthalmia.

Purulent Iridocyclitis, or panophthalmitis, is described in the chapter on injuries.

CHOROID.

The choroid is involved to a certain extent in severe forms of iritis and in iridocyclitis, but there are definite inflammatory conditions that are primary in this membrane, the changes caused being recognized by the ophthalmoscope.

Choroiditis is a condition which is, as in iritis, characterized at first by a hyperæmia which later becomes inflammatory.

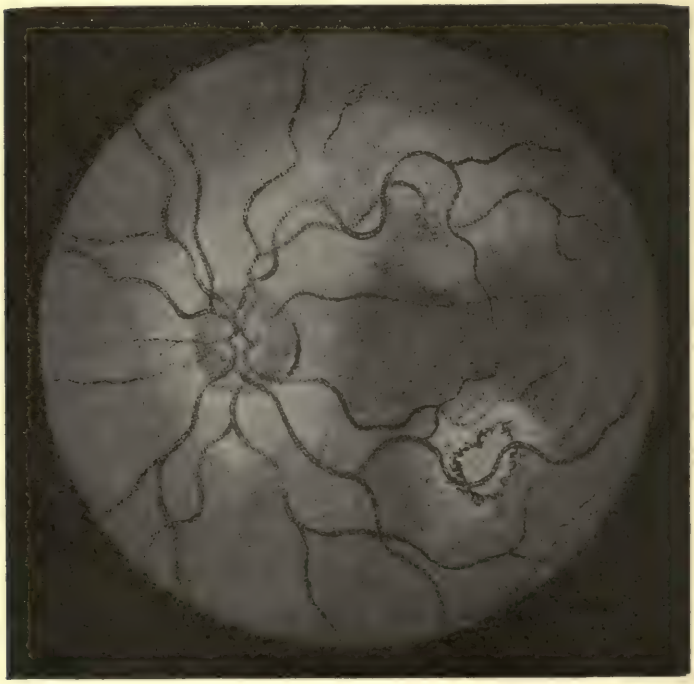


Fig. 75.—Syphilitic choroiditis. (*Ball.*)

Etiology.—Inherited or acquired syphilis is the most common cause of choroiditis, although certain cases are seen in patients who have a tubercular diathesis or no definite constitutional cause. Many cases are associated with myopia, and apparently have no other cause than the refractive condition. In myopic cases that have worn glasses

since youth this condition is rarely seen. The most acute forms are due to iridocyclitis, scleritis, or penetrating wounds of the eye.

Symptoms.—In most cases there are no subjective symptoms other than a diminution of vision, which is proportionate to the destruction of the eye-ground. The ophthalmoscope will reveal an exudate and hæmorrhages into the choroid, which will be seen through the retina. The exudate is absorbed and the diseased areas are replaced by connective tissues which appear as white spots, usually surrounded by a pigment areola (Fig. 75).

Diagnosis is made by the alternations in color, pigment changes, hæmorrhages, exudate, etc.

Treatment.—Myopic cases should have full correction of the refractive error if possible. The glasses should be worn constantly. The syphilitic cases need mercury and potassium iodide, given in the way described under treatment of iritis. The eyes should be put at rest by the instillation of atropine for a time, and the use of dark glasses. Most all cases respond quite well to large doses of potassium iodide.

Prognosis depends upon the destruction to the eye-ground and the readiness with which the disease responds to antisyphilitic treatment.

Suppurative Choroiditis, or, as it is most frequently called, metastatic choroiditis, is a secondary inflammation of the choroid.

Etiology.—In most cases it is secondary to infection by means of penetrating injuries or through the blood from other parts of the body. It may arise from iritis or iridocyclitis.

Symptoms.—The eye shows signs of general infection of its whole structure, yet not of the acute purulent character found in panophthalmitis. Very early in the disease it may be possible to locate the areas of infection by means of the ophthalmoscope, but this is uncommon. Soon the vitreous becomes dense and cloudy and the pupil appears yellow. The lens is surrounded by an exudate. There is usually pain, headache, malaise, and a pyæmic temperature. In

many cases there are found other purulent foci. The inflammation extends forward and involves the ciliary body, iris and cornea. The anterior chamber is usually shallow, and the pupil dilated. Chemosis and muco-purulent discharge are not uncommon. There may be increased tension at the height of the disease, but the eye rapidly becomes soft and degenerates into phthisis bulbi. The condition may extend into a true panophthalmitis requiring evisceration.

Diagnosis.—Early in the disease the diagnosis may be made by the ophthalmoscopic picture, and the presence in other parts of the body of purulent inflammation.

Treatment.—If the disease is due to local inflammation the cause should be removed as soon as possible. If a secondary inflammation through the blood, there is little to be done other than allay pain and control, if possible, the inflammation. Enucleation had best be performed as soon as all the tissues of the eye become involved and before the cellular tissue of the orbit becomes infected. If the latter has become infected evisceration may be done. The patient should be kept in bed in a moderately darkened room, and hot fomentations applied for pain. A cathartic of calomel followed by a saline is indicated early in the disease. The operations of enucleation and evisceration are described in the chapter on injuries.

Prognosis is always grave. Vision is always lost. Should the eye shrink and remain irritable there is a chance of its producing sympathetic inflammation in the other eye.

Plastic Choroiditis (Fig. 76), or disseminated choroiditis, a form which is mostly binocular, is characterized by the formation of plastic material recognized by means of the ophthalmoscope.

Symptoms.—Early in its development it can with difficulty be recognized with the ophthalmoscope, and is frequently overlooked. Later the small grayish-white areas become more defined, the retina lying over them may become involved, and give rise to areas of cloudy vision (scotomata). The lens and vitreous may become opaque. The usual rule, however, is that the retina shows little or no change and the

vision remains very good. Typical lesions appear late in the disease, and are easily recognized with the ophthalmoscope. The areas of exudation are absorbed and atrophic changes take place, resulting in white areas surrounded by a pigment areola. The disease extends from the periphery to the posterior pole of the eye, and may leave but a small area

Fig. 76.—Disseminated choroiditis. (*Ball.*)

about the macula free from change. There is a form known as *choroiditis areolaris,* which is confined to the posterior pole of the eye in the macular region surrounding the fovea and separated from it by healthy choroid. The spots are large, oval or circular, white or yellow in color, and surrounded by a pigment ring. In the syphilitic form the vitreous is usually filled with fine dust-like opacities.

Diagnosis.—It is quite typical and can hardly be mistaken for any other disease. In several instances I have seen it mistaken by students for retinitis pigmentosa, but a careful ophthalmoscopic study will enable one to differentiate between these conditions.

Treatment.—If there is any history of syphilis or syphilis is even suspected a thorough mercurial treatment is indicated, combined with large doses of potassium iodide or the syrup of hydriodic acid in dram or two-dram doses before meals. In all cases the eyes should be put at rest with atropine and dark glasses. The refraction should be carefully tested and the proper correction constantly worn. A careful examination of the refractive error should be frequently made in order to correct changes which rapidly occur in this condition. Increase of tension should be carefully watched for, and atropine stopped immediately, and eserine or pilocarpine used should it occur. It may be necessary to perform an iridectomy.

Prognosis of choroiditis is grave, although not so bad in the plastic form as in the suppurative. In chorio-retinitis the vision is seriously disturbed.

Chorio-retinitis is an extension of the inflammation to the retina. It is usually syphilitic in origin, and gives rise to disturbance of vision.

Treatment as in choroiditis.

Bony Choroid.— It is not uncommon to find calcareous deposits in the one eye which is atrophied. The bony formation is usually found in the inner layers of the choroid. Owing to the fact that such eyes frequently cause irritation, they should be enucleated.

Tumors of the Choroid.

Carcinoma.—This is an exceedingly rare disease, De Schweinitz having collected but twenty-seven cases in the literature. When present it is usually secondary to carcinoma of the breast.

Diagnosis is made by microscopic examination only, and on account of the rapid metastasis the lymph glands are involved early.

Treatment consists in early enucleation as soon as intra-ocular tumor is diagnosed.

Sarcoma is a more common disease, one case occurring in 28,000 in Massachusetts Charitable Eye and Ear Infirmary, in 1902, and the same in 1903. The tumor is usually pigmented (melano-sarcoma). The growth is malignant, being rather slow in onset but later spreads rapidly, and forms metastatic growths in the viscera. The growth is always primary in the choroid and attacks but one eye.

Symptoms.—In the beginning it is quite impossible to state the exact conditions within the eye. The growth usually occurs near the posterior pole of the eye, but may arise laterally. It does not appear unlike a detachment of the retina. There are usually visual disturbances. As the growth increases in size, the symptoms become glaucomatous in character; the tension is increased, there is much pain, and the cornea may become cloudy and anæsthetic, preventing an examination of the fundus. A further increase in size causes rupture of the sclera and an extension of the disease to the orbit, which may extend along the optic nerve and involve the brain. Perforation causes a decrease in tension and in the pain. The perforation is usually anterior to the equator, but may penetrate posteriorly, causing exophthalmos. The last stage is that of metastasis; the organ most frequently involved is the liver.

Diagnosis.—Occurs in middle life, none occurring in early childhood, which will differentiate it from glioma of the retina. There may be some difficulty in a differential diagnosis from retinal separation, but the latter is more whitish, has a wavy motion, and does not show choroidal vessels behind it. It is differentiated from primary glaucoma by the symptoms, history, and appearance.

Treatment.—Complete removal of the eye is indicated as soon as diagnosis of intra-ocular tumor is made. The optic nerve should be cut as far away from the globe as possible. Should the orbit be found infected the orbital con-

tents should be completely exenterated, or as much as possible removed and the part left treated with the X-ray.

Prognosis.—Always grave even if the eye is removed early. In the later stages metastasis is sure to have taken place, but pain will be relieved by enucleation and exenteration.

Miliary Tuberculosis of the Choroid is a disease which occurs very rarely, or at least rarely comes under the observation of the oculist. The tubercles occur in the late stages of miliary tuberculosis, and appear as small, round, yellowish spots, which grow rapidly, showing no pigment changes.

Treatment is the same as for miliary tuberculosis in other parts of the body.

Choroidal Hæmorrhage usually follows trauma, but may occur in an eye which has disturbed intra-ocular circulation such as glaucoma, sclero-choroiditis, and arterio-sclerosis. It may follow incision for cataract extraction in people having arterio-sclerosis from the sudden diminution in intra-ocular pressure. The blood may be confined to a small area between the choroid and retina; it may be of sufficient amount to cause retinal separation; or may flow into the vitreous and out a wound. It is frequently difficult to differentiate between choroidal and retinal hæmorrhage; the fact that a retinal vessel may be seen running over a hæmorrhagic spot would prove choroidal hæmorrhage.

CHAPTER X.

DISEASES OF THE SCLERA.

INFLAMMATION of the sclera is always confined to that portion of the eye lying between the equator and the cornea. It is recognized in two forms: that of the superficial layers, episcleritis, and that of the deep layers, scleritis. The superficial form may recover, leaving behind no trace of its presence, or may extend into a true scleritis. The deep form is dangerous to sight in that it extends to other portions of the eye. The importance of discrimination between the two forms of the disease can readily be seen.

Episcleritis.—In 90,000 cases at the Massachusetts Charitable Eye and Ear Infirmary this disease was seen in 193 patients, or about 1 in 470, which is a greater proportion than usually given by American authors.

Etiology.—Text-books are unanimous in attributing the cause to a rheumatic or gouty diathesis, due, as Verhoeff suggests, to a tendency to assign this cause to any obscure disease. Some cases give a definite rheumatic history, and are relieved somewhat by anti-rheumatic remedies. Verhoeff, in a recent article,[1] has pointed out that in thirteen unselected cases under his care all gave a general reaction to tuberculosis and nine gave a local reaction in the eye. Ambler, in a recent article,[2] made the statement that, "A clearly defined reaction must be accepted as diagnostic proof of the existence of tuberculosis." It is true that some or all of these cases may have had other tubercular foci, and some did give such evidence, but Figs. 77 and 78, showing

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1 "Tuberculous Scleritis," Boston Medical and Surgical Journal, March, 1907.

2 "Tuberculin Test," Journal of the American Medical Association, May 18, 1907.

the microscopic appearance in two nodules of episcleral tissue, give proof of the local tubercular process. Some cases are syphilitic in origin and respond to anti-syphilitic treatment. It is a disease which occurs more frequently in women and is prone to show exacerbations during the menstrual periods.

Symptoms.—The condition is that of a localized inflammation, which bulges out in the form of a nodule. It is traversed by deep vessels (episcleral) and this gives the

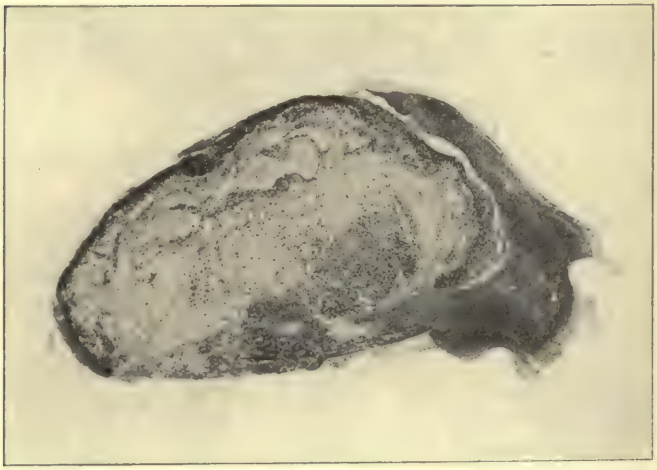

Fig. 77.—Nodule of episcleral tissue showing focus of epithelioid cells. × 37. *(Verhoeff.)*

nodule a more or less purplish color, although some may show no such color in the beginning. The nodule is in the superficial scleral layers and is immovable, while the conjunctiva above it can be moved. The area is quite tender to pressure, sometimes exquisitely so.

Other than at site of the nodule or nodules the eye may be free from inflammation. There may be but few subjective symptoms, such as pain, photophobia, and lachrymation, although some cases complain of severe pain, which may even cause loss of sleep. The nodules never break

down into ulcers, but disappear by absorption. The ordinary case will last from six weeks to two months, although some cases disappear in less time and others last much longer without involving the deep sclera or other parts of the eye. Most cases heal without leaving any trace behind, while the most severe cases leave a purplish scar at the site of the lesion. Vision is practically never affected. There is a distinct tendency toward recurrence, as is seen in all tubercular conditions of the eye.

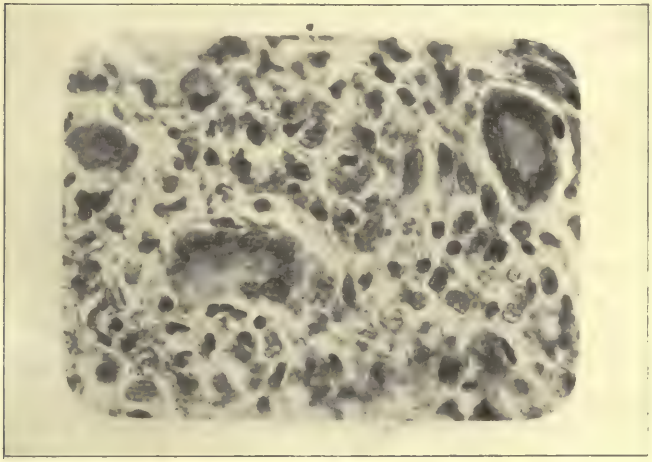

Fig. 78.—Nodule of episcleral tissue showing giant cells among epithelioid cells. × 500. *(Verhoeff.)*

Diagnosis is made from the sensitive, deeply situated nodules which show no tendency toward ulceration. The condition might at first be mistaken for phlyctenular conjunctivitis, but in this disease the phlyctenulæ soon ulcerate at the tip, when the diagnosis becomes easy.

Treatment.—Hygienic treatment is perhaps best of all. The patients should lead restful, out-of-door lives, have plenty of wholesome food, and sleep either out of doors or in a room which is very well ventilated. The eyes should be rested by relief from any near work, and a shade or dark

glasses worn if the photophobia is annoying. A tonic of the syrup of the iodide of iron in children should be given, or formula 10. Fox recommends a formula used by Shadford Walker, which has proved an excellent tonic in adults (Formula 20). Cases showing a tubercular reaction may be given injections of Koch's old tuberculin twice a week, beginning with smaller doses than caused the tuberculin reaction. These can be gradually increased in strength so long as the eye does not show any reaction or there is not caused a rise in temperature. The tuberculin treatment is the one carried out by Verhoeff, who also had his patients keep a record of their weight. The weight will usually increase with the improvement of the physical condition. The cases can be best treated in their homes, or if the home is unhygienic they can be treated in some country place or sanitarium. The ocular condition should be carefully noted twice a week, or oftener if necessary. Locally a mild ointment of the yellow iodide of mercury may be used once a day and gently massaged through the lid into the nodular area. If pain is severe hot fomentations to the eye or leeches are of benefit.

In rheumatic cases asperin and sodium salicylate tend to take down the inflammation, or reduce pain. Syphilitic cases need mercury in the form of inunctions, or protiodide by the mouth, grain $^1/_6$ to grain $^1/_4$ three times a day. Also the iodide of potassium may be given in increasing doses.

Prognosis as to vision is good. These cases practically never affect the sight, but the duration covers a period of nearly two months or more and may relapse.

Scleritis is an inflammation of the deeper layers of the sclera which involves also the conjunctival and episcleral tissues. The disease is particularly liable to extend to adjacent parts, one form in which the cornea is involved being known as kerato-scleritis.

Occurrence.—The disease is found entirely in adults, and is more rarely seen than episcleritis. In 90,000 cases at the Massachusetts Charitable Eye and Ear Infirmary the disease was seen in 61 patients, or 1 in about 1500 cases.

Etiology.—Same as episcleritis.

Symptoms.—The nodules show a more definite bluish-red coloration than in episcleritis. The nodules appear in the circumcorneal or ciliary region, and may form a complete circle about the cornea. They are most frequently seen above. Later the sclera in this region takes on a pale violet color, usually likened to fine porcelain. Owing to the fact that the sclera is more extensively involved the intra-ocular pressure causes a bulging in this position giving rise to a condition known as *staphyloma of the sclera,* and in severe cases the eye may become pear-shaped, being elongated in its anterior-posterior diameter.

Complications extending to other parts of the eye are common, the usual structures involved being the cornea and the uveal tract. In the cornea are seen areas of deep infiltration resembling interstitial keratitis, which are most marked in the origin near the scleral lesion. These areas show a slight tendency toward vascularization. This corneal condition, and the irregularity of the globe caused by the bulging of the anterior segment, gives rise to a marked irregular astigmatism with its resultant poor vision. The opacities in the cornea clear up very little after the disease has quieted down. These are usually signs of iritis; the iris is usually found attached to the capsule of the lens, giving rise to posterior synechiæ. The secondary inflammation of the choroid usually is confined to the anterior portion and gives rise to additional visual injury through the accompanying opacities of the vitreous. Scleritis almost always affects both eyes, but there may be an interval of several years before the second eye becomes involved.

Diagnosis.—From the character of the disease and the resulting complications the condition can hardly be mistaken for any other.

Treatment.—Cases reacting to tuberculin should have the same general treatment described under Episcleritis. In addition to the hygienic and general treatment, there should be instilled into the eyes atropine to prevent or break up the posterior synechiæ and put the eye at rest. Dark glasses or a

shade should be worn constantly and, if possible, the refractive error corrected by means of glasses. All use of the eyes should be given up and the patient should be prepared to live an idle out-of-door life. Subsequently iridectomy may be performed for visual purposes, but this should not be done until all inflammatory symptoms have subsided. For pain asperin may be given in five-grain doses three or four times a day, and locally hot fomentations to the eye and leeches to the temple aid greatly in relieving pain, especially if there is an accompanying iritis. Syphilitic and rheumatic cases should receive appropriate general treatment.

Prognosis is rather grave, there usually being some permanent visual defects remaining. Tuberculin combined with proper hygienic treatment have caused cases to become free from inflammation sooner than any other treatment heretofore advocated.

Staphyloma of the Sclera.—One form of staphyloma has been described under complications of scleritis. There is a form of staphyloma which is called *equatorial staphyloma,* and is usually due to disease of the uveal tract. Iridectomy may prevent the condition from progressing, although it may be necessary to enucleate if the staphyloma becomes very large and sight is lost. Posterior staphyloma is usually associated with myopia and choroiditis. It is seen with the ophthalmoscope, and is treated with proper correction of the refractive error and care in the use of the eyes that they may not be subject to eye strain.

OPERATIONS ON THE SCLERA.

Sclerotomy (*anterior*).—De Wecker's method is as follows: A Graefe knife is entered 1 mm. outside the margin of the cornea and brought out again at an equal distance on the opposite side. The points of entrance and exit are therefore symmetrically situated, and are selected as though the intention was to form a flap 2 mm. high out of the cornea. In fact a sawing motion is made with the knife but the knife is withdrawn before the incision is completed, thus leaving a bridge to prevent gaping of the wound.

Eserine is instilled to prevent prolapse of the iris. The operation is substituted for iridectomy in glaucoma. It may be of benefit in checking the increase in size of an equatorial staphyloma.

Sclerotomy (*posterior*).—In this operation the sclera is opened from behind forward in the direction of the fibers, thus preventing gaping. The position of the incision should be so chosen that it will not include any of the extra-ocular muscles, or the ciliary body. The operation is performed for detached retina, glaucoma, and the intra-ocular foreign bodies.

Injuries are discussed in a special chapter.

THE CALMETTE AND THE VON PIRQUET TESTS FOR TUBERCULOSIS.

Tuberculosis as a causative factor in many ocular lesions is now well established, and the importance of recognizing this type of cases is evident. Recent investigations have shown that certain ocular lesions heretofore thought to be idiopathic or due to other organic diseases are now known to be tubercular.

As a result of this now well established fact the newer methods for the diagnosis of tuberculosis are of importance, and it is the purpose in this sub-chapter to enumerate the present attitude (November, 1908) of the profession in regard to them.

The subcutaneous injection of tuberculin for diagnostic purposes has been used some years, although not extensively as a diagnostic aid in ocular diseases, but as simpler tests have come into prominence these will be more fully described, namely: the Calmette ocular reaction, and the von Pirquet cutaneous reaction.

The Calmette Ocular Reaction.—This test consists in the instillation of 1 drop of a ½ or 1 per cent. aqueous solution of the alcoholic precipitate of tuberculin into the conjunctival sac of a sound eye. If tuberculosis is present in the individual to whom the test is applied the reaction is described by Calmette as follows: "From the third hour

onward the eye in which an aqueous solution of tuberculin has been applied became reddened, and in the course of several hours showed all the appearances of a more or less pronounced attack of muco-purulent inflammation of the conjunctiva. The maximum was seen within six or seven hours after the instillation of the tuberculin. All traces of inflammation had disappeared in two or three days. The plan is free from danger and causes the patient scarcely any discomfort." That this happens in many cases is undoubtedly true, but unfortunately there are many exceptions to and variations from the above statement.

Reactions are obtained in individuals manifesting no tubercular lesion and having no tubercular history either family or individual. It is also true that many tubercular individuals fail to respond to this test, even when tubercle bacilli are found in the sputum. As a diagnostic method, therefore, the Calmette reaction must at best be considered as suggestive, and not too great reliance placed upon a reaction in the absence of other signs, nor should a case be called non-tubercular because no reaction was obtained.

That the reaction may be delayed even three or four days is well known to those who have used the test extensively, and the reaction lasts in some cases weeks and even months. The reaction in several cases under my observation has persisted over seven weeks.

It must also be denied that the test is free from danger. Many observers have sounded a note of warning against the promiscuous and unskillful use of the test, and even when skillfully and correctly applied the test is not free from danger. Arnold Knapp has reported a case of interstitial keratitis following the instillation of Calmette solution. De Lapersonne reported 6 cases of ulcero-vascular keratitis following the use of tuberculin in the eye. Severe reactions and complications have been noted by Netter, Eisen, Feer, Weins and Gunther, Baldwin, Smithies, Derby, Parker, and many others. It is the concensus of opinion that the test should not be applied to an eye having an active or healed lesion of any character, and if it becomes necessary

to apply a second test this should be applied to the previously unused eye if possible. In cases where the test is used for the diagnosis of ocular disease this is, of course, impossible.

A uniformity in the tests is essential, and they should be made with great care by one familiar with the technique. In such instances it can be fairly stated that in the Calmette reaction we have a valuable aid in the diagnosis of tubercular disease both ocular and general.

The von Pirquet Cutaneous Reaction.—It was at first thought that the vaccination test was unreliable in tubercular patients over two years of age, von Pirquet himself having originally made a report to this effect. It has since been demonstrated, however, that the test is of marked diagnostic value at all ages.

While it is too early to make a comparison of the value of these tests it seems fairly certain that the cutaneous reaction is equally sensitive to the conjunctival reaction. Mainini, Derby, and others report better results with the cutaneous test.

It is true that the cutaneous reaction is as sensitive as the conjunctival, and there is plenty of evidence that the cutaneous should be the test of choice, as there are, so far as I can find, no untoward effects following the application of the test. For the diagnosis of ocular diseases especially, the cutaneous test should be preferred to the conjunctival, because of the danger of applying the latter to diseased eyes, and in a few instances to apparently normal eyes.

The physician should not look upon these tests as a short cut to the diagnosis of tuberculosis. The tests must be looked upon simply as valuable aids in the diagnosis of ocular disease of tubercular origin.[3]

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[3] Since writing the above it has become more evident than ever that the cutaneous test is preferable to the ophthalmic. The Morro cutaneous reaction is more frequently used than the vaccination test of von Pirquet.

CHAPTER XI.

DISEASES OF THE OPTIC NERVE.

INFLAMMATION of the optic nerve may occur anywhere along its course, but the only part that the physician is able to see is that within the eye. These cases are called intra-ocular neuritis or papillitis, and are to be distinguished from the inflammation located behind the eye, called retro-bulbar neuritis. As this form of inflammation cannot be seen its presence is inferred from other symptoms.

Optic Neuritis or Papillitis.

Etiology.—This condition is rarely a local lesion, but it usually originates in some deep-seated affection, and for this reason is usually bilateral.

Brain diseases are by far the most common cause of optic neuritis leading to inflammation either through pressure or extension of the inflammation. Pressure symptoms most commonly arise in brain tumors and hydrocephalus. The fluids are squeezed out of the cranial cavity and go along the spinal cord and optic nerve. The spaces between the nerve fibers are filled with fluid and give rise, not to a true inflammation, but to a condition of engorgement called *choked disc.* This term is used synonymously with optic neuritis or papillitis. This condition constitutes an important diagnostic symptom of cerebral pressure. Direct transmission takes place from diseased conditions of the brain or meninges, especially at the base, such as tuberculous meningitis. Syphilis is a common cause of optic neuritis, which may attack the nerve primarily, or result from extension. Acute infections and febrile diseases also give rise to papillitis, as do chronic disturbances of nutrition, such as Bright's disease and poisoning, especially lead.

Symptoms.—Externally there are no signs other than dilatation of the pupil corresponding to the diminution in

sight. The ophthalmoscope shows the characteristic picture (Fig. 79). The color of the disc is alternated and is either white, gray, or reddish, and may show several hæmorrhagic spots. The outline of the disc is indistinct due to the inflammation extending on the retina. This disc is swollen and can be refracted several diopters with the ophthalmoscope. The blood-vessels show marked change; the veins are dilated and tortuous, and the arteries contracted;

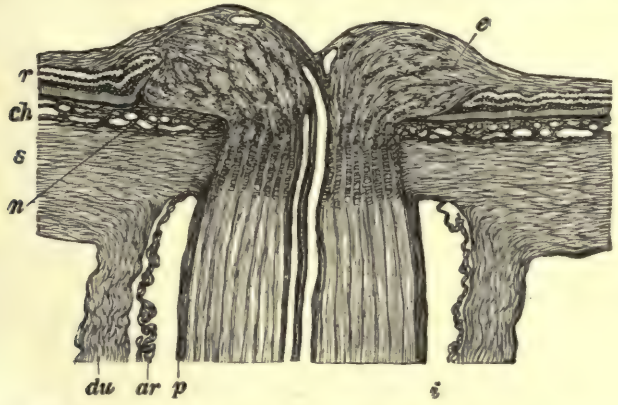

Fig. 79.—Longitudinal section through the head of the optic nerve in papillitis (choked disc). Magnified 14 × 2.

This is greatly swollen, so as to project above the level of the adjacent retina and form at the base an annular tumefaction, the neuritic swelling, *n*. There is a cellular infiltration, particularly along the minuter blood-vessels, *e*, for which reason the latter appear specially prominent. The retina, *r*, is thrown into folds about the circumference of the papilla, in consequence of the swelling of the latter; the choroid, *ch*, and the sclera, *s*, are normal, as is the optic nerve posterior to the lamina cribrosa. Here there is present simply a dilatation of the intervaginal space, *i*, through accumulation of fluid, by virtue of which the greatly folded arachnoid sheath, *ar*, becomes especially prominent; *du*, dural sheath; *p*, pial sheath.

these conditions being due to pressure. The subjective symptoms are visual; although marked cases occur in which the vision is normal, the majority show marked diminution in visual acuity and even blindness. The field of vision is usually contracted and may take the form of hemianopia.

Treatment depends upon getting at the cause of the

condition and treating that. Syphilitic cases need anti-syphilitic remedies, and those arising from other causes occasionally do well under the use of mercury and potassium iodide. Cases of anæmia do well under tonics of iron, and certain cases have responded very well to large doses of sodium salicylate.

Prognosis.—The disease extends, as a rule, over long periods, taking months for the inflammation to subside, and then may become an optic atrophy. When this occurs the disc becomes paler, the edges distinct, and the blood-vessels in the nerve and retina narrowed. The degree of atrophy depends largely on the degree of neuritis, and the resultant vision will also depend upon this. Cases frequently get a much higher visual acuity just after the subsidence of the acute symptoms than after a greater length of time. The prognosis is always grave.

Retro-bulbar Neuritis is located in the orbital portion of the optic nerve and hence the signs seen with the ophthalmoscope are either normal or unimportant. Later, however, after the neuritis has subsided signs of the optic atrophy may be seen with the ophthalmoscope. This takes place when the nerve fibers are destroyed in the area of the inflammation, giving rise to a condition called descending atrophy. It occurs in acute and chronic forms.

Acute Retro-bulbar Neuritis.

Etiology.—Syphilis, malaria, diphtheria, alcoholic intoxication, rheumatism and extension from adjacent parts are given as cause of this condition.

Symptoms.—The most important symptom is sudden impairment of sight which may occur within a few days and in some cases causes complete blindness. Externally the eye appears normal, or the pupil may be slightly dilated. The ophthalmoscope shows no characteristic changes. There is usually violent headache, and dull pain in the orbit, which may be increased when the patient moves his eyes. The disease is frequently unilateral.

Treatment.—Free purgation should be instituted as soon as the case is seen. Mercury, iodide of potash, strych-

nine, pilocarpine, and sodium salicylate are indicated in the disease. The removal of the cause is essential if possible.

Prognosis.—This disease usually disappears partially or wholly. In certain cases a central scotoma may become permanent, or more rarely blindness may remain.

Chronic Retro-bulbar Neuritis (Alcoholic and tobacco amblyopia).

Etiology.—Usually the excessive use of alcohol or tobacco or both. The same condition may arise from the continued absorption of poisons such as wood alcohol, quinine, chloral, and other drugs. Auto-intoxication from the intestinal tract may cause this condition.

Symptoms.—The vision becomes gradually impaired; at first medium sized print can be read, but reading soon becomes impossible. The condition is binocular, both eyes being affected about equally. The vision is usually best on a dark day or in the evening. Patients frequently say they see at night as well as ever. The color sense is usually defective especially for red or green. Ophthalmoscopic examination usually shows no changes except later in the disease, when pallor of the disc on the temporal side is fairly well marked. The vision is quite reduced, usually below $^1/_{10}$ centrally, but the field of peripheral vision is about normal (Fig. 80).

Treatment.—Removal of the cause absolutely, when due to alcohol, tobacco, or drugs. Strychnine gr. $^1/_{30}$ three times a day, potassium iodide, and pilocarpine are of benefit. Dark glasses should be worn, and the eyes given a rest as far as possible.

Prognosis.—Usually good if the cause is removed. Vision returning to normal or nearly so in most cases.

Optic Atrophy is either primary or secondary to an inflammatory condition. There are two forms which will be considered, simple atrophy and secondary atrophy.

Simple Atrophy (non-inflammatory) (Fig. 81) is manifested by the disc becoming paler, which finally appears white or bluish-white; the edge is sharply defined, the dots in the lamina cribrosa may be plainly seen, and there

may be slight cupping of the disc (atrophic excavation). The blood-vessels are very slightly altered in this form of atrophy. As the atrophy progresses the sight is reduced until complete blindness may result.

Etiology.—Spinal cord disease, usually tabes dorsalis, the atrophy usually appearing before the ataxic symptoms become manifest. Brain affections such as disseminated sclerosis and paresis, also tumors and focal affections may produce atrophy by direct pressure on the nerve itself.

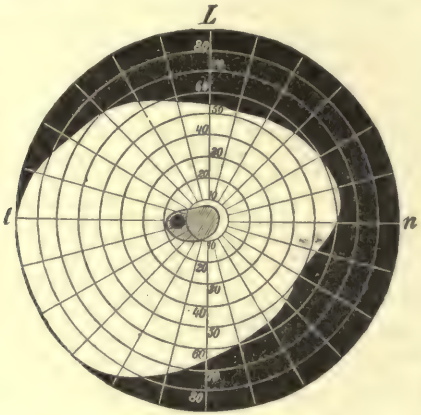

Fig. 80.—Field of vision of the left eye of a man suffering from tobacco amblyopia. *(Fuchs.)*

The visual field when tested with a white object (shown by the portion left white in the figure) is normal. When, however, the examination is made with a red object, a central scotoma is found having an extent represented by the shaded area which forms an irregular oval. The small black circle comprised in this area represents Mariotte's blind spot.

Injuries to the nerve or fracture of the orbit or base of skull may cause atrophy.

Secondary Atrophy occurs as an end result of neuritis or retinitis. The ophthalmoscopic picture is different from the picture seen in simple atrophy. The disc is traversed by connective tissue formed by the organization of the exudate; at first the margin of the disc is slightly hazy, the veins are somewhat distended and tortuous, and the color grayish-

white. Later the disc becomes pure white or blue-white, is sharply defined and may be smaller than normal. The arteries and veins are both narrowed.

Treatment consists in management of the cause, very little result however being expected. Strychnine subcutaneously gradually increased to heroic doses frequently has

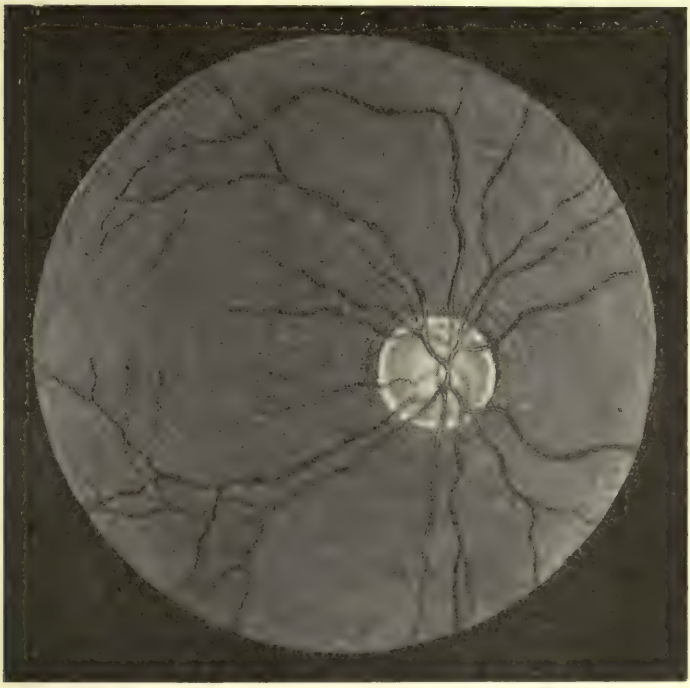

Fig. 81.—Simple atrophy of optic nerve. (*Ball.*)

some effect. Mercury, potassium iodide and nitroglycerin should be tried, but they are very unsatisfactory.

Prognosis.—In secondary atrophy blindness is proportionate to the amount of primary inflammation. Simple atrophy leads to blindness.

Hemiopia.—The semi-discission of the fibers in the optic nerve affords an explanation of the various forms

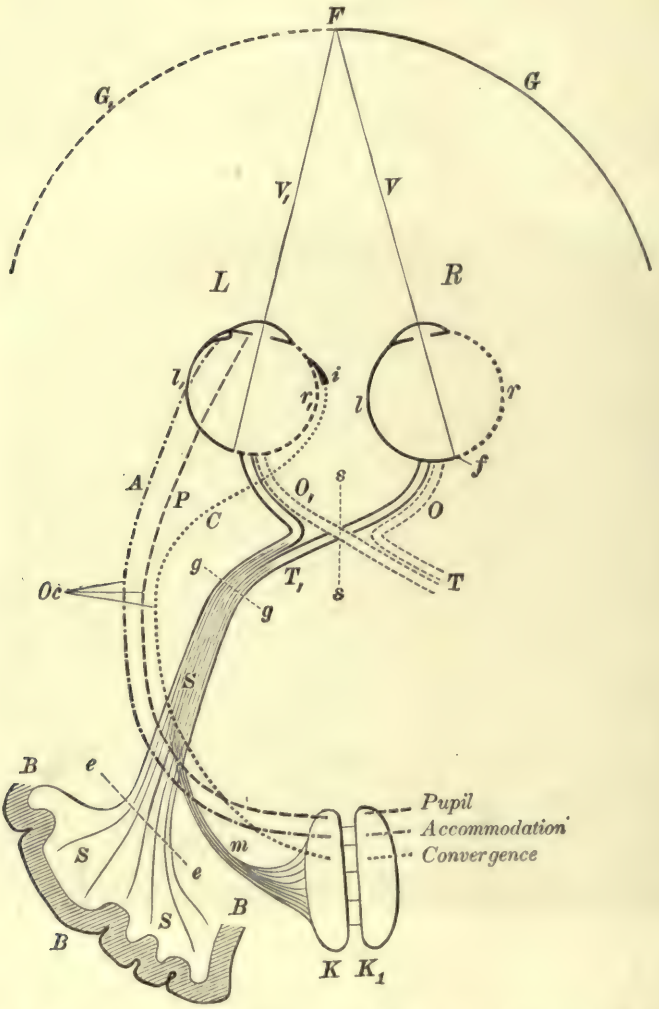

Fig. 82.—Schematic representation of the optic tracts. *(Fuchs.)*

The field of vision common to the two eyes is composed of a right half, G, and a left half, G_1. The former corresponds to the left halves, l and l_1, of the two retinæ, the latter to the right halves, r and r_1. The boundary between the two halves of the retina is formed by the vertical meridian. This passes through the fovea centralis, f, in which the visual line drawn from the point of fixation, F, impinges upon the retina. The optic nerve-fibers arising from the right halves, r and r_1, of the two retinæ (indicated by the dotted line) all pass into the right

optic tract, *T*, while the fibers belonging to the left halves, *l* and l_1, of the two retinæ pass into the left optic tract, T_1. The fibers of each optic tract for the most part pass to the cortex of the occipital lobe, *B*, forming Gratiolet's optic radiation, *S*: the smaller portion of them, *m*, goes to the oculomotor nucleus, *K*. This consists of a series of partial nuclei, the most anterior of which sends fibers, *P*, to the pupil (sphincter iridis); the next one sends fibers, *A*, to the muscle of accommodation; and the third sends fibers, *C*, to the converging muscle (internal rectus, *i*). All three bundles of fibers run to the eye in the trunk of the oculomotor nerve, *Oc*. Division of the optic tract at *g g* or at *e e* produces right hemiopia; and in the former case there would be no reaction to light on illuminating the left half of either retina. Division of the chiasm at *s s* produces temporal hemiopia. Division of the fibers, *m*, abolishes the reaction of the pupil to light, but leaves the sight and also the associated contraction of the pupil in accommodation and convergence unaffected.

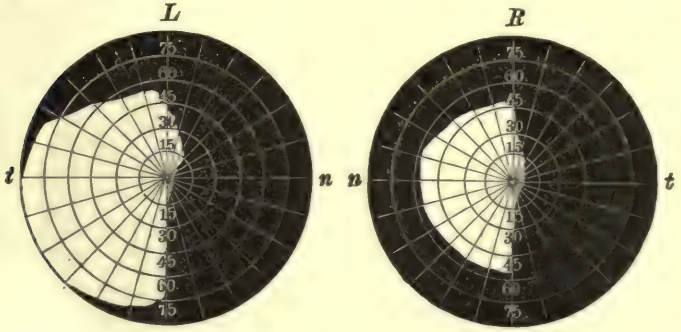

Fig. 83.—Homonymous hemiopia. (After *Schweigger.*) (*Fuchs.*)

The areas which have been left white correspond to the left halves of the visual fields, *R* and *L*, of the right eye and left eye, which are still intact; *t*, temporal; *n*, nasal side.

of this condition and aids in localization of the lesion causing it. If the left optic tract is interrupted at *g g* (Fig. 82), the left halves of both retinæ would be cut off from the cortex and would be blind. The result of this defective field of vision would show on a perimeter chart the right halves wanting (Fig. 83), and the result would be that only the left half of all fixed objects would be seen. Hemiopia of this kind is called homonymous. *Homonymous hemiopia* therefore indicates a lesion lying centrally to optic chiasm on the same side as the blind half of the retina. If the chiasm were divided into a right and left half (*s s* Fig. 82), the decussating fibers would be severed. The decus-

sating fibers supply the nasal half of the retina, so that these portions would be rendered blind. The outer halves of the fields of vision would be wanting (Fig. 84) giving rise to a condition known as *temporal hemiopia.* A tumor of the chiasm situated in the median line would give rise to this condition.

DISTURBANCES OF VISION WITHOUT APPARENT CAUSE.

Congenital Amblyopia.—This condition can be assumed when we get the history from the patient that weak-

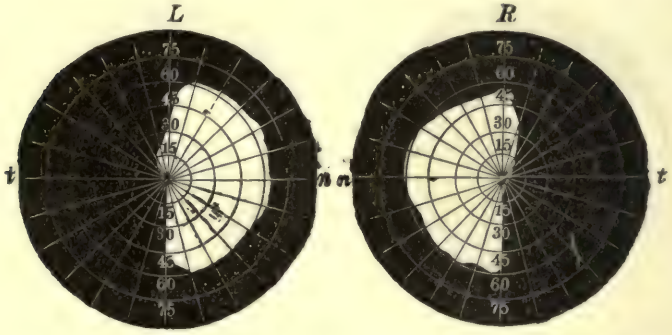

Fig. 84.—Temporal hemiopia. (After *Schweigger.*) (*Fuchs.*)
The areas left white correspond to the nasal halves of the visual fields, *R* and *L*, of the right and left eye, which are still intact: *t*, temporal; *n*, nasal side.

ness of sight has existed since very early childhood, especially if the eye shows other congenital anomalies such as extreme degree of astigmatism, or hypermetropia, coloboma of iris, etc. The condition is usually unilateral and the eye may or may not be in a state of squint. This condition must not be confounded with *amblyopia ex anopsia,* which is the condition mentioned in the chapter on the muscles, and is not congenital but arises from disuse. It is seen in those cases of squint which have existed for some time, in congenital cataract, corneal scars, etc. The ophthalmoscopic picture is that of a normal eye.

Treatment.—Congenital amblyopia does not respond to treatment. In amblyopia ex anopsia the treatment consists in removing the cause if possible. If due to a squint, a correction of this may cause a return of function, but if the squint has existed for some time this will not be successful. Cases due to congenital cataract will recover function after the removal of the lens. Exercise of the amblyopic eye, by covering the good eye, may result in some return of function.

Amblyopia and Amaurosis of Central Origin may arise without any noticeable ophthalmoscopic change being noticed. Disturbance of vision of this sort may be transient, even where the patient is for a while absolutely blind; uræmic poisoning may produce such a condition. Disturbances of vision of central origin may cause a hemiopia either homonymous or temporal. Permanent brain lesions give rise to a descending atrophy.

Scintillating Scotoma is a curious form of temporary impairment of vision of central origin. Both eyes are equally affected. The patient has a feeling of vertigo, and a sparkling light or a wavy heat motion is seen before the eyes, which increases until vision is very indistinct or nearly lost. This condition usually starts from a point not far from the center of vision and within this area external objects are not seen. The visual field is usually contracted irregularly. The attack passes off within thirty minutes and is followed by a severe headache of the migraine type. The condition frequently appears in the form of a homonymous hemiopia.

Treatment.—The condition is probably circulatory and can be relieved by amyl-nitrite or nitroglycerin.

Prognosis.—The disease has no special significance, and causes no impairment in the retinal function.

Hysterical Amblyopia is a condition characterized by a concentric contraction of both visual fields. In many cases the contraction gets smaller and smaller the longer the perimeter is used. This Förster characterizes as the reaction of exhaustion typical of hysterical people. The contraction of

the visual fields is usually of different degree in each eye. The relation of the color field is apt to be reversed, or at any rate different from the normal. This aids in making the *diagnosis* as does the fact that these people walk about freely avoiding objects that, judging from their visual fields, could not be seen. There are usually other signs of hysteria such as disturbances of sensibility, tested for in two ways. Touch the eyeball with finger in examining the eye without making a definite move to do so, and the patient will not wink. In examining the throat push the tongue depressor well back into the pharynx and it will frequently be found that this portion of the throat is not sensitive. There may also be photophobia, blepharospasm, and ptosis. Fundus examination reveals no change.

Treatment.—Excellent results are obtained from giving strychnine subcutaneously or by the mouth in watery solution. Another excellent remedy is application of the constant current or the use of static electricity. The results obtained from the treatment are due to the mental effect of various agents used rather than any other. It is essential to get the confidence of these patients and describe in detail the benefit derived from the use of medicine or electricity. One case under my care recovered in two weeks under the following prescription: Quinine sulph., gr. 2; Aquæ dest., ounce 1; teaspoonful three times a day before meals. Another case recovered within a month under the same treatment combined with the use of plane glass spectacles.

Prognosis.—Invariably good, although the condition may extend over a period of years.

Tests for Malingering depend upon the fact that most people pretending to have ocular trouble complain of but one eye being blind. A good test is to place before the good eye a prism base up or down after the supposedly blind eye has been covered with a black disc. Remove the disc before the blind eye quickly and the answers to questions will be confusing, and thus give the patient away; the prism having produced a diplopia when both eyes are uncovered. Another test is to place before the good eye a strong convex glass,

and hold a paper before the patient asking him to read; gradually withdraw the paper to beyond the focal length of the convex glass. If the patient still reads the "blind" eye has good vision. Other tests are easily invented to suit the individual case.

Nyctalopia, or day blindness, is a condition in which vision is best at dusk or in a dull light. It is a symptom of toxic amblyopia. It is especially noticeable in cases with incipient cataract, especially if of the nuclear variety.

Hemeralopia, or night blindness, is a condition in which vision at night is practically lost. It is a symptom of retinitis pigmentosa.

CHAPTER XII.

DISEASES OF THE RETINA.

ASIDE from inflammatory conditions the retina is frequently the seat of circulatory disturbances, such as anæmia, hyperæmia, and hæmorrhage. Also such extreme circulatory disturbances as embolism of the central artery and thrombosis of the central vein.

Retinitis is a condition which is characterized by a diffuse cloudiness of the membrane with circumscribed areas of exudate, which are white and sharply defined. The blood-vessels are enlarged and tortuous, and there may be localized hæmorrhage. The cloudiness is greatest as a rule in the region of the disc. The disc edges are blurred and the retinal vessels are hazy. The exudate may extend into the vitreous, giving rise to vitreous opacities. The vision is impaired in proportion to the severity of the inflammatory condition. In very mild cases the visual acuity may be normal, other than for the fact that there appears to be a thin cloud before the eyes. Severe cases cause a marked reduction in vision due to loss of retinal function and vitreous opacities. Large areas of exudate cause scotomata in the visual fields.

Etiology.—Retinitis is caused mostly by constitutional diseases and for this reason is usually bilateral. Primary retinitis may be caused by brilliant light, such as snow blindness. General causes are Bright's disease, diabetes, syphilis, leukæmia, and diseases of the circulatory system.

Albuminuric Retinitis is one of the most characteristic inflammatory conditions. Aside from the signs of retinitis described above, the area of the disc and the macular region show pure white patches, often silvery in appearance due to fatty degeneration in these areas. In the macular region

the white areas are arranged in radiating lines, like spokes in a wheel, with the fovea in the center (Fig. 85). Around the disc there may be a zone of white spots or a more diffuse area of degeneration. This is the typical form, but there may occur in albuminuric retinitis areas of exudation which have no characteristic arrangement, and frequently neuro-retinitis is seen or even a typical choked disc.

Fig. 85.—Retinitis, albuminurica. *(Fuchs.)*

The clouding of the retina is most pronounced in the region of the papilla, where it exhibits a fine radial striation, and completely veils the margin of the nerve. Furthermore, even at a considerable distance from the papilla, the retinal clouding covers isolated portions of the vessels and especially the distended veins, with a delicate haze, so that the vessels in these places look lighter. Surrounding the papilla are found rounded, brilliantly white spots of exudation and numerous dark-red, radially striate hemorrhages. The latter lie mainly in the neighborhood of the larger retinal vessels, and in part cover them. From this fact and from their striate appearance, it can be inferred that they belong to the most anterior layer of the retina—the nerve-fiber layer. In the region of the macula lutea is seen a group of small white specks, which combine to form the stellate figure characteristic of retinitis albuminurica. In the present case this is not very regularly formed, and above it is a somewhat larger spot, produced by the coalescence of several small dots.

From this it can be readily understood that an examination of the urine should be made in all cases of retinitis.

Prognosis.—As a rule the appearance of albuminuric retinitis has grave significance as to life. The patients manifesting this condition usually die within a year. There are some cases, however, chiefly those of albuminuria of pregnancy, which do not have such a grave prognosis. The same is true of the cases developing in acute Bright's disease.

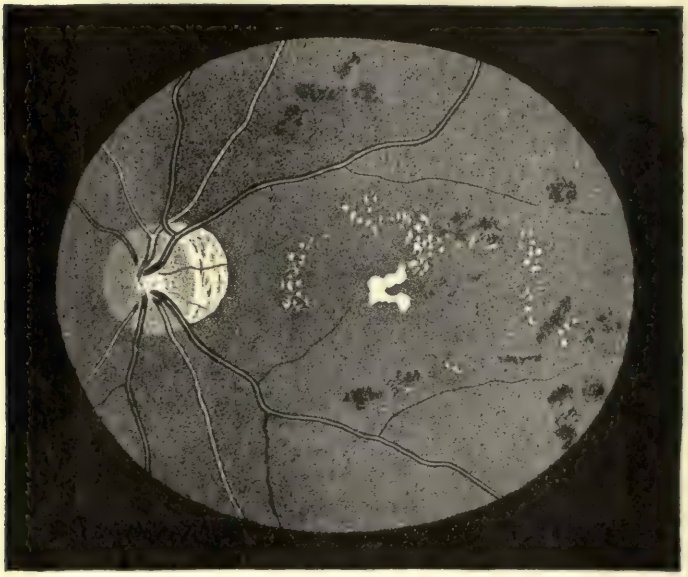

Fig. 86.—Diabetic retinitis in a man sixty-nine years of age. *(Fuchs.)*

When the diabetes was discovered eleven years previous 6 per cent. of sugar was present, while for some years past, under the influence of suitable treatment, the sugar has almost disappeared. The disturbance of sight has lasted for nine months, and is caused mainly by a central scotoma for blue—a scotoma which corresponds to the exudate in the macula. In keeping with the myopia of the eye there is an atrophic crescent, about half the width of the papilla, adjoining the optic nerve. In its posterior section the retina shows numerous punctate hemorrhages, which are generally disposed in groups, and frequently coalesce to form rather large patches. In addition, small brilliantly white dots are present of irregular shape and sharp outline. These are disposed quite irregularly in a large circle surrounding the macula. In the macula itself is found quite a large exudate having a structure like that of the small dots.

Diabetic Retinitis.—In this form the white areas are small and occupy chiefly the region of macula (Fig. 86). Occasionally the small dots will coalesce, as in the center of Fig. 86, but show from the outline that they are made up of smaller areas. In this form small hæmorrhagic spots are seen which lie in the region of the areas of exudate. Diabetic retinitis may appear under most any form, but the usual one is that described above.

Leukæmic Retinitis shows, in addition to the usual signs, a light color of retinal blood-vessels; in fact, the whole retina is of lighter color than the normal for the individual. There may be white patches surrounded by a red line, but this is rarely seen.

Hæmorrhagic Retinitis is usually due to disease of the retinal vessels and is also termed *thrombosis of the central vein.* Although there are some cases where thrombosis does not occur, the condition being called hæmorrhagic retinitis because the hæmorrhages overshadow all other signs. In these cases the retina is œdematous and cloudy, there are numerous areas of extravasation of blood and the disc is swollen and red, the retinal vessels are dilated and tortuous.

Syphilitic Retinitis.—Syphilis gives rise to many cases of retinitis, which are usually associated with diseases of the uveal tract, especially the choroid, giving rise to a condition known as *chorio-retinitis.* The retinal inflammation is of two kinds, diffuse and circumscribed. The diffuse form shows a general grayish cloudiness with a few denser gray areas, largely in the macular region. Later in the disease the cloudiness becomes less, and pigmentary changes take place, not unlike disseminated choroiditis or retinitis pigmentosa. In the circumscribed form the dense exudate is found in the macular region or along the course of the large blood-vessels.

Retinitis Proliferans is an affection in which dense masses of connective tissue extend into the vitreous from the retina. New blood-vessels are seen running into the

mass from the retina. It is probably a condition brought on by the organization of preceding hæmorrhages.

Retinitis Due to Dazzling is most frequently produced from looking at the sun. There are pigment changes in the macula, and a central scotoma is produced which is liable to be permanent.

Albumosuric Retinitis is an uncommon affection in which the fundus changes are similar to those found in

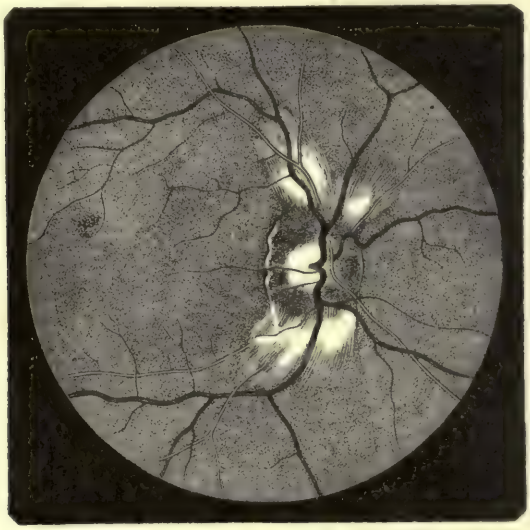

Fig. 87.—Medullated nerve fibers. (After *Jäger.*) (*Fuchs.*)

The papilla shows in its center a whitish coloration, representing the physiological excavation. The temporal border of the papilla is surrounded by an irregular choroidal ring, while the upper and lower borders are concealed by the white fibrous masses that arise from them. These in places cover the retinal vessels, and especially the two arteries running outward and downward. At their peripheral borders the white masses break up into fibers.

albuminuric retinitis. Fox reports four cases in which the fundus gave evidence of arterio-sclerosis. In three cases the fundus reflex was yellow, and colloid dots were seen above and below the optic disc.

Treatment of retinitis should be both general and local. Retinitis due to syphilis responds best to general treatment,

excellent results frequently being obtained from anti-syphilitic treatment. Other constitutional causes are treated as indicated in each instance. All cases, however, respond in some degree to the use of iodide of potassium, a saline and calomel purge and diaphoretics. Locally the eye is protected from the use of too bright light by means of dark glasses or in severe cases in a darkened room. All use of the eyes should be temporarily abandoned.

Prognosis.—Best in syphilitic cases, although the sight is probably always somewhat impaired. In diabetic retinitis the disease is usually near its end, but prognosis as to life depends upon the degree in which the causative condition can be controlled.

Medullated Nerve Fibers appear occasionally in the eye, and are a congenital anomaly which may be considered pathological by one not conversant with the condition. The normal retina is transparent because the nerve fibers lose their medullary sheath before passing through the lamina cribrosa, but when occasionally this does not happen the retina about the optic disc looks opaque (brilliant white). The area about the disc looks like a flame (Fig. 87). The vision in such eyes may be reduced, but it is usually a condition unnoticed by the patient, and discovered by the oculist in a routine examination of the fundus.

Anæmia of the Retina may be of gradual or sudden onset. Sudden onset may result from the occlusion or compression of the blood-vessels. Quinine may cause spasm of the retinal vessels, producing anæmia. In marked cases the retinal vessels may entirely disappear.

Hyperæmia of the Retina is a pathological condition which is manifested by dilated vessels which become more or less tortuous. The disc is reddened and the edges may be somewhat blurred. Venous hyperæmia is most marked in heart disease, thrombosis of the central vein, and in mediastinal tumors. The diagnosis, except in marked cases, is difficult, owing to the wide variations of normal limits. The chief guide is the condition of the optic nerve.

Œdema of the Retina accompanies inflammatory con-

ditions, and is most marked in the albuminuric form. It may also follow a blow on the eye, especially if there be no perforating injury. Vision is but temporarily affected when the condition results from a blow.

Embolism of the Central Artery causes a marked retinal anæmia, especially in the macular region and that portion surrounding it, which usually includes the disc. The fovea shows bright red, which is in marked contrast to

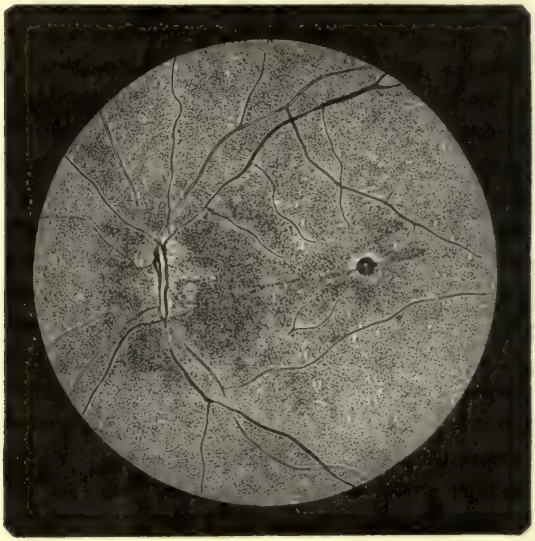

Fig. 88.—Embolism of the central artery, developing eight days previous to the date of observation in a woman affected with aortic aneurism. *(Fuchs.)*

The whitish haze over the retina obscures the outlines of the papilla and the initial portions of the vessels arising from it. The arteries are already better filled than they were, although they still are below the normal in this respect. The veins have a very uneven caliber, the latter in general increasing toward the periphery. In the large veins, running upward and outward and downward and outward, the blood-column is seen to be broken up into short separate sections. The vicinity of the fovea centralis is covered with a dense whitish haze, upon which the finest ramifications of the vessels stand out distinctly, although the connection between them and the main vessels is in places concealed by the haze. The midpoint of the fovea centralis is occupied by a spot which is dark red with a light center, and which represents the chorioid showing through the haze.

the bleached area immediately surrounding it. This is due to the choroid showing through at this point where the retina is very thin. The symptoms are those of sudden and complete blindness in one eye due to the occlusion of the central artery by the embolus. The ophthalmoscopic picture is that described above in the few hours following the blocking of the artery; later the retina becomes opaque, the edges of the disc blurred, and the finer retinal vessels, usually not seen, come into view in the macular region (Fig. 88). The retinal vessels fill up again, but in some cases the blood is seen in them in broken columns. Later still the retina becomes atrophic, the disc white, and the retinal vessels mere outlines. In very rare cases an embolus may involve but a branch of the main artery, causing anæmia in the portion supplied by it, and a localized scotoma in the visual field. If the embolus is septic, as occurs in pyæmia, the eye may assume the appearance of metastatic choroiditis, but the usual result is atrophy.

Treatment.—Absolute rest should be insisted upon, and an effort made to dislodge the embolus by gentle massage of the eyeball, together with the administration of amyl-nitrite or nitro-glycerin.

Prognosis, however, is unfavorable; if vision is not restored in a few weeks there is no hope.

Thrombosis of Central Vein gives rise to a picture of marked hæmorrhagic retinitis, owing to the fact that the blood escapes from the blocked veins. The veins are greatly dilated and tortuous, while the arteries may be fine and thread-like. Rarely a tributary of the main vein may become thrombosed. The condition is seen in people who have cardiac lesions of atheromatous vessels. Other cases arise from local infections.

Treatment.—Rest in bed and the administration of a saline purge are often of some value, but there is little avail in treatment.

Subhyaloid Hæmorrhage, or periretinal hæmorrhage (Fig. 89), occasionally occurs between the retina and the hyaloid membrane of the vitreous. These hæmorrhages

are localized and do not destroy the retinal substance, so that after their absorption the retina regains its function. They appear upon ophthalmoscopic examination as uniform red areas, usually having a clear cut border.

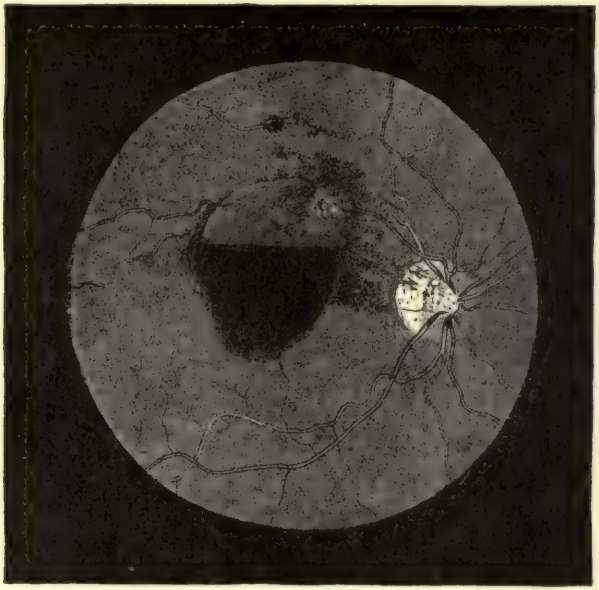

Fig. 89.—Subhyaloid hæmorrhage. (*Fuchs.*)

This represents the right eye of an elderly woman. The eye, in consonance with its myopia, shows a broad white crescent at the temporal border of its papilla; and the latter also has a pretty large physiological excavation. The retinal arteries are very tortuous, the veins normal. The middle of the fundus is occupied by a large hæmorrhage, covering the region of the macula lutea, and extending upward as far as the superior temporal vessels, which are partially concealed by it. The lower part of the hæmorrhage is dark red, and is separated by a sharp horizontal line from the upper, pale-read portion. This division into two parts is caused by the settling of the blood-corpuscles to the bottom of the still fluid blood. In the vicinity of the large hæmorrhage, especially at its upper and inner borders, lie numerous small spots of blood. These extend up to and upon the white crescent adjoining the optic nerve and up to the superior temporal vessels. From these vessels is derived the extravasated blood, which, after breaking through the limitans interna of the retina, gets between the latter and the vitreous, and sinks down to the region of the macula lutea, where even in the normal eye the connection between the retina and the vitreous is the least.

Aneurism of the retinal vessels may occur, but the condition is rarely seen. There is no treatment.

Atrophy of the Retina may appear as the end result of a number of conditions, such as protracted inflammation, embolus, and thrombosis. It is characterized by narrowing or obliteration of the retinal vessels, while the retina may appear unchanged or show scars of previous disease. The disc has the typical appearance of secondary atrophy.

Retinitis Pigmentosa is a degenerative condition of the retina which is characterized by pigmentary changes and atrophy. The condition is pathological, although devoid of inflammation.

Etiology.—These cases are usually congenital. Cases are frequently seen in several generations of the same family. It is seen in cases where there is consanguinity of parentage.

Symptoms.—Vision usually becomes impaired about the age of puberty and gradually becomes worse until the patient is just able to see objects placed directly in front of the eye. One of the most marked symptoms is night blindness or the inability to see in a feeble light. The visual field gradually contracts with the progression of the disease until but a small central portion remains clear. The patient has no lateral projection at this stage and sees as though looking through a tube. The patient may be able to read but will have to be lead about. The end result is complete blindness. With the ophthalmoscope the retina is seen to be filled with stellate patches of pigment throughout the entire periphery (Fig. 90). The pigment is seen to be in the retina, as the vessels are inclosed in it very frequently. The pigment loss from the retina allows the choroidal vessels to be seen through the retina; in the later stages atrophy of the retina takes place, with the accompanying narrowing of the retinal vessels. The condition may be easily differentiated from disseminated choroiditis by the absence of atrophic spots in the former.

Treatment is of little avail. Anti-syphilitic remedies should be thoroughly tried and also strychnine in increasing

doses. Correction of refractive errors will give the patient somewhat better vision.

Prognosis.—Treatment may aid somewhat, but the usual result is complete blindness at about forty years of age.

Detachment of the Retina is a condition in which the retina is detached from the choroid. Normally the retina is attached to the choroid in but two places, posteriorly at the optic nerve entrance and anteriorly at the ora serrata, it being held in contact with choroid lying between these attachments by the pressure of the vitreous. Detachment is

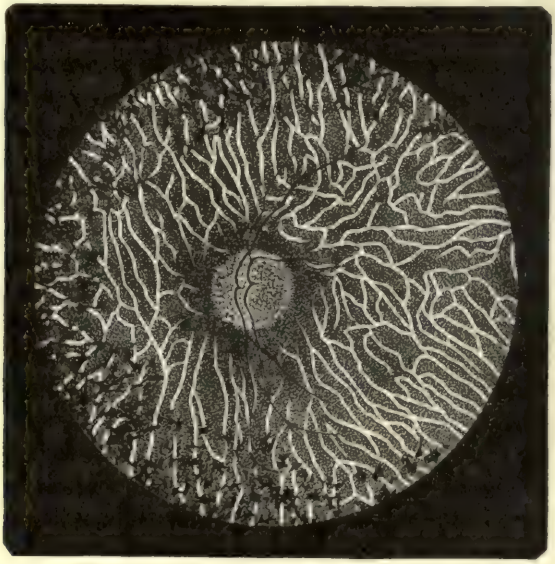

Fig. 90.—Retinitis pigmentosa. (In part after *Jäger.*) (*Fuchs.*)

Owing to the disappearance of the pigment epithelium, the stroma of the choroid is exposed, so that the bright-red choroidal vessel with the darkly pigmented intervascular spaces are everywhere visible. For the same reason numerous branched, interconnected pigment spots are found in the periphery of the retina. This pigmented zone extends in a circle, although it comes closer to the papilla on the nasal than on the temporal side, where, in fact, it lies so far to the periphery that it is not represented in the drawing at all. The papilla is of a dirty grayish-yellow color and ill defined. Of the retina vessels, only the main trunks are visible, and these, especially the arteries, are greatly contracted.

caused therefore only when there is greater pressure behind than is exercised by the vitreous, or diminished pressure or actual traction in the vitreous chamber.

Etiology.—The condition may precede intra-ocular tumor; may be due to trauma, high myopia, traction due to a

Fig. 91.—Separation of the retina. (*Ball.*)

shrinking vitreous, effusion of blood between the retina and choroid, and may arise without apparent cause. It occurs usually in but one eye and is most frequently found in elderly men.

Symptoms.—There is loss of vision corresponding to the area of detachment. Involvement of the macular region causes complete blindness except at the periphery of visual

field. There is no pain, but patients frequently speak of light flashes and a cloud before the eyes. With the ophthalmoscope the separation is usually made out below. The red reflex of the fundus will be broken; a portion will have a white or gray appearance. The area will appear nearer the eye and, on closer examination, will be found to have a wavy motion on movement of the eye. The retinal vessels are plainly seen on a white background, which is irregularly thrown into folds (Fig. 91). In cases that are plainly made out the amount of elevation may be determined by refracting the summit of the detachment in comparison with the attached portion of the retina. In early flat detachments the appearance is little altered from the normal and can be made out by the elevation at point of detachment. Externally the eye appears normal. The tension is normal or slightly decreased in retinal separation not caused by intra-ocular tumor.

Diagnosis is frequently difficult from intra-ocular tumor, but the increased tension accompanying the later condition, also the absence of motion in the detachment, serve to aid in the differential diagnosis.

Treatment.—There have been many methods advocated for the treatment of this condition, and all have been at least temporarily curative in certain cases. The patient should be put to bed and given pilocarpine subcutaneously, also a hot pack. A sclerotomy may be performed directly over the area of detachment and the sub-retinal fluid withdrawn. Following this procedure it is possible that the retina may return to its normal position and become attached to the wound. Sub-conjunctival injections of salt solution, about 10 per cent., have caused depletion by osmosis. Potassium iodide is usually given internally.

Prognosis is unfavorable. Sometimes the retina will return to its normal position under treatment, but usually there is a recurrence of the detachment. Spontaneous cure of the condition has been occasionally observed.

Glioma of the Retina is a malignant growth of the retina, which occurs always in early childhood, and which

PLATE IV.

Fig. 1. Congenital coloboma of the iris. This case had perfectly normal vision in both eyes. No involvement of ciliary body.

Fig. 2. Optical iridectomy upon iris. Below, in center, is cicatrix of old perforated corneal ulcer. Less dense scar toward inner side. Optical iridectomy in this case was necessary because of posterior capsular cataract (central), which could not be shown in picture.

Fig. 3. Glioma of the retina. The eye was enucleated at this stage and showed no extension into orbit.

Fig. 4. Senile cataract.

PLATE IV.

Fig. 1.

Fig. 2.

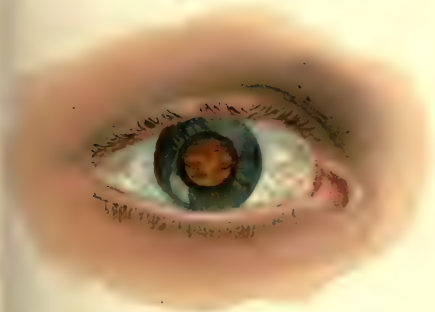

Fig. 3.

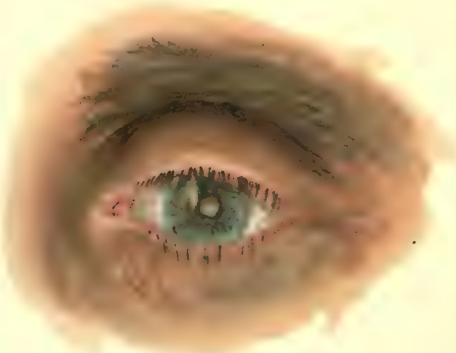

Fig. 4.

may be congenital. In the cases that have come under my observation the disease was mostly bilateral, although the disease was much farther advanced in one eye than in the other.

Symptoms.—Blindness is one of the earliest symptoms, or the mother of the patient notices one pupil looks white or yellow. This has given the name *amaurotic cat's eye* to the disease. This condition is caused by the degenerated retina being seen immediately behind the lens. On the surface of the retina the blood-vessels are plainly seen (Plate IV, Fig. 3). This stage is not accompanied by pain or inflammatory symptoms. The next stage is that of pain and increased tension. The pain may be severe and the eye appears as that of acute glaucoma. The third stage is that of perforation, probably first along the course of the optic nerve, and later there is rupture forward through the cornea. The protruding mass has a distinct tendency toward ulceration; it bleeds easily and is very sensitive. The last stage is extension to other organs of the body. The organs most frequently involved are the brain and liver. It is finally fatal.

Treatment consists of the earliest possible removal of the eye. The cases extend early, usually some time before perforation. In enucleating, the optic nerve should be cut as far back as possible. If the disease has extended to the orbit there is little chance of saving life, but all should be done possible by complete exenteration of the orbital contents. After anterior perforation removal is indicated for the relief of pain and other disagreeable symptoms.

Prognosis is only favorable in the very earliest removal of the eye, but even in some of these cases there is a subsequent loss of life from metastasis.

CHAPTER XIII.

DISEASES OF THE VITREOUS.

INFLAMMATORY diseases of the inner membrane of the eye always produce some vitreous change. The usual diseases producing such change are iritis, irido-cyclitis, choroiditis, and retinitis. The most frequent change noticed is due to opacities.

Opacities of the Vitreous (non-purulent) vary greatly in size, from that of fine dust-like opacities to large webs or exudates. They are seen by the patient as black specks or objects of various shapes. The visual acuity is proportionately diminished. Fine opacities caused by fœtal remains are without pathological significance and are called *muscæ volitantes.*

Etiology.—Muscæ volitantes become especially noticeable when the patient is tired or suffering from eye strain. Pathological opacities are due to disease of the retina, uveal tract, or hæmorrhages into the substance of the vitreous.

Symptoms.—Vision is diminished. With the ophthalmoscope the opacities are seen floating about. To bring these out clearly it is necessary that the patient should move his eyes quickly about in all directions. This will bring into view opacities that have settled to the bottom of the vitreous cavity. Frequently the vitreous is so cloudy that the details of the fundus cannot be seen. To study the opacities closely a + 7 lens should be rotated behind the opening in the ophthalmoscope and the instrument brought near the patient's eye.

Treatment consists in the use of remedies which promote absorption, among which are iodide of potassium, mercury, pilocarpine, saline purge, and sodium salycilate or asperin. Subjunctival injections of a 5 per cent. to 10 per

cent. solution of normal salt, or a $^1/_{2000}$ bichloride solution are frequently of benefit.

Prognosis depends upon the size and duration of the opacities. Recent opacities respond quite readily to treatment and may entirely clear up. Small extravasations of blood may also entirely disappear. Old opacities and those of large extravasations of blood never entirely disappear.

Hyalitis is an inflammation of the vitreous usually caused by the introduction of pus organisms. The condition frequently follows the introduction of foreign bodies into the eye, and is frequently seen in the course of scarlet fever, influenza, typhoid fever, erysipelas, and meningitis. In the latter instances the infection is spread through the blood. Primary hyalitis probably does not occur.

Symptoms depend upon the severity of the infection. Severe cases may run into an irido-cyclitis or a panophthalmitis. In milder cases the pupil may show a yellowish reflex and vision be reduced to light perception. The opacity may be diffused, as described in the previous paragraph, or localized. In certain cases the whole vitreous cavity appears filled with pus. If there is much vitreous change the tension of the eyeball is usually soft, and the function of the retina destroyed, causing faulty projection of light or absence of light perception. Accompanying irido-cyclitis is easily made out by the signs and symptoms of that disease. In children circumscribed collections of purulent material may be mistaken for a glioma, and for this reason are called *pseudo-glioma*. The ocular tension, history, and occurrence of irido-cyclitis serve to differentiate the two conditions.

Treatment.—If caused by a penetrating wound which threatens to become a panophthalmitis or becomes a bad irido-cyclitis, enucleation should be performed at once. If secondary to a constitutional condition mercury, iodide of potassium, and a saline purge may be of considerable benefit.

Prognosis is very grave. The end result usually is phthisis bulbi.

Hæmorrhages into the Vitreous arise from the retina

or uveal tract, and are usually caused by injury which may or may not be penetrating. Spontaneous hæmorrhage is occasionally seen and occurs in elderly people having diseased blood-vessels. It may follow cataract extraction caused by the sudden decrease in intra-ocular pressure. In some cases the vitreous may be entirely filled with blood, obscuring the fundus reflex, but which shows bright red by focal light behind the transparent lens. A great deal of blood can be absorbed, but there is usually left behind a pigment stain.

Fluid Vitreous.—In many cases of vitreous opacities they are seen to float about freely in the fluid. This shows a destruction of the normal frame work of the vitreous and it has become a perfect liquid. In severe cases the vitreous itself shrinks in volume and may cause a detached retina, or bring about a tremulous lens. The iris is also tremulous in these cases and is easily seen when the patient moves his eyes.

Foreign Bodies in the Vitreous usually cause violent inflammation frequently leading to severe irido-cyclitis, which may in turn cause sympathetic ophthalmia. Very rarely a foreign body may become encapsulated without causing inflammation or any future danger.

Treatment.—If a foreign body is known to be in the eye and the eye is inflamed the indication is for immediate enucleation, unless the foreign body is of steel or iron, when it can be removed by the electro-magnet. The technique of this operation is described in the chapter on injuries. A luxated lens usually acts as a foreign body and should be removed. See chapter on Cataract.

Persistent Hyaloid Artery.—This artery usually disappears toward the end of fœtal life. In very rare instances the remains of this artery are made out and its course traced by means of the ophthalmoscope. The thread-like remnant may extend completely across the vitreous chamber, from the posterior capsule of the lens to the center of the optic disc, or it may be seen as a thread with the free end extending into the vitreous, either from the posterior capsule or the

optic disc. In certain cases a transparent hyaloid canal has been traced from the lens to the disc.

Parasites of the Vitreous are rarely seen. They can be frequently seen to move when under observation with ophthalmoscope. The indication is for removal if possible, or enucleation should the eye become much infected.

CHAPTER XIV.

DISEASES OF THE LENS.

Cataract.—When the lens or its capsule loses all or a part of its transparency the condition is termed a cataract. The consistency of the lens is altered with increasing age, and as a consequence a cataract in youthful subjects is softer than in old age. Normally in young people the pupillary reflex is black, but in age this changes to a slight gray and in some instances this may be mistaken for a cataract until the lens is examined by transmitted light and found to be transparent. This grayish appearance does not interfere with vision, which is usually as acute as in early life.

Etiology.—Cataract is mostly seen in old age, and the name *senile cataract* has been given to this condition. The opacity is undoubtedly brought about by faulty nutrition, but in what manner is not clear. Heredity as a causative factor is perhaps little more than coincidental, except in congenital cataract, which is so frequently seen in families showing other congenital anomalies. The senile form is seen in people having diabetes, rheumatism, arterial diseases, syphilis, Bright's disease, and other constitutional diseases, but more frequently there is no condition which may be given as a cause. Trauma is, of course, a cause in many instances. Secondary cataract may be brought about by numerous ocular diseases, such as iritis, uveitis, choroiditis, glaucoma, keratitis, etc.

Senile Cataract (Plate IV, Fig. 4), or hard cataract, is usually seen after the age of fifty years. A cataract appearing between forty and fifty years of age is usually termed *presenile.*

Symptoms.—The most noticeable symptom is gradual

failure of vision. The development is gradual, and takes from two to four years to reach maturity. Failing vision will depend upon the position of the incipient opacity. Usually the lens becomes opaque in the cortical substance first. The opacities take the form of striæ which radiate in from the periphery to the center (Fig. 92). By focal illumination with a dilated pupil these striæ appear gray or grayish-white; by transmitted light the striæ appear black in a red background. This form is known as a *cortical cataract,* and does not materially interfere with vision in the early stages. Another way in which the cataract may start is in the center, when the condition is known as *nuclear cataract.* The opacity being in the center of the pupillary area the visual acuity is lost much sooner than in the corti-

Fig. 92.—Opaque striæ in incipient senile cataract seen by transmitted light.

cal form. Both forms advance by increased opacity until the lens becomes completely opaque.

Symptoms of the Incipient Stage.—Should the opacity be cortical the condition will appear as described above (Fig. 92). If the opacity is more nuclear the center of the lens will appear gray and the pupil clear on focal illumination. By transmitted light the center will appear black surrounded by a red zone (Fig. 93). The cataract should be carefully examined with the pupil widely dilated with homatropine. An early symptom of cataract, before much opacity is made out, is the production of myopia. This is caused by increased refraction of the nucleus and enables the patient to read for several weeks or months without reading glasses. This is called by the laity *second sight.* It does not last long, for after its appearance the lens begins

to show opacities. The usual history is that of gradual blindness free from all inflammatory symptoms. Should inflammation occur it is to be attributed to other causes than cataract. The lens frequently swells at this period giving rise to a narrow anterior chamber. There are occasionally symptoms of monocular diplopia caused by the irregular refraction of the semi-opaque lens. The pupil appears grayish and by focal illumination the iris casts a deep shadow (Fig. 94). This sign shows the lenticular substance lying immediately behind the anterior capsule is transparent. The condition will be spoken of later in reference to mature cataract. The vision is gradually reduced to light perception only.

Mature Cataract.—A cataract is said to be mature when the patient is no longer able to count fingers held a

Fig. 93.—Nuclear incipient cataract, or lamellar cataract seen by transmitted light.

short distance from the eye. With the ophthalmoscope (dilated pupil) the lens appears quite uniformly opaque and no red reflex is seen. The iris no longer casts a shadow by focal illumination; the iris is in its normal plane, and the vision is simply the projection of light. It is at this stage that the cataract offers the best chance of operative success. Later the capsule becomes more adherent to the lens, and operation does not give the good visual results obtained earlier. A still later stage is that of hypermaturity. The lens may become shrunken and even calcareous, or the cortical substance may undergo liquefaction by fatty degeneration. This causes the nucleus to settle to the bottom of the capsule, and the condition is known as *morgagnian cataract.*

Diagnosis.—The condition can hardly be mistaken for any other, so that a differential diagnosis is unnecessary.

Treatment.—In the incipient stage we can often add to the pleasure of the patient by providing a suitable hand glass to aid in reading, or if the opacity is largely nuclear the use of just enough atropine to keep the pupil dilated will enable the patient to see better during the progression of the disease, but in using atropine the case should be carefully watched. Should, however, the opacity be in but one eye these procedures are unnecessary. Many people dread to be told that they have a cataract, and I am in favor, in the early incipient stage, of telling the condition to another member of the family, stating the appearance and the usual result, but being especially careful to say that the opacity

Fig. 94.—Iris shadow obtained before cataract is quite mature.

may not increase further, or in the rarest instances may even disappear. If the lens is still transparent enough to admit of a careful examination of the fundus, this should be done, and a careful note made of the condition for further reference. If the cataract is mature, or "ripe," several tests must be made before advising operation for extraction of the opaque lens. A perfect case for operation should show a completely opaque lens through which no fundus reflex can be seen; the vision should be light perception only, with a quick accurate projection of light. The tension should be normal, the pupil should be round and central and should react quickly to light; the iris should be of good color, should be in a normal plane, and should dilate readily with a mydriatic. There should be no diseased condition of the lachrymal sac, or conjunctiva, as

these conditions are liable to cause infection of the wound with perhaps subsequent loss of the eye. To test the *projection* the patient should be placed in a darkened room as though for ophthalmoscopic examination. The light should be placed behind the patient slightly to one side. The examiner will then throw light into the patient's eye with the mirror of the ophthalmoscope, the other eye being covered. The patient should look in one direction only during the test, while the light is reflected into the eye from various points in the normal visual field. If the source of the light in each instance is accurately stated by the patient it shows the retina to be in good condition, and all else being normal, an operation should give a good visual result.

Many methods have been suggested to hasten the ripening of a cataract. The one which has remained in use the longest is to perform a preliminary iridectomy, combined with, in some instances, a gently massage of the lens, either directly by means of a spatula, or through the cornea. Puncture of the lens seems to be unjustifiable, because of possible serious complications such as iritis or glaucoma.

One is frequently asked his opinion in regard to operating on a cataract which is present but in one eye. If the patient is told that the operation will not enable him to use both eyes together, but that it will give a wider field of vision, and that the operated eye will be of excellent use when the lens in the good eye becomes opaque, as in most cases it will, I think the operation is justifiable. Aside from these reasons the appearance of the patient will be improved and the eye run less danger of becoming amblyopic. The reason for not operating upon a cataract before maturity is that the transparent cortical substance will be overlooked and at the first dressing subsequent to the operation this cortical will be found opaque, giving rise to iritis in many cases and a dense capsule needing secondary operation. Should there be much cortical left behind it might excite a secondary glaucoma.

Prognosis.—Under modern technique and asepsis, with consistent after care, the percentage of good visual

results following operation is very high. Certainly in the uncomplicated cases the loss is but little over 1 per cent.

Conner[1] makes the statement that, "Fifty-one observers report a total of one hundred and forty-seven cases in which the opacity in incipient cataract has regained transparency in whole, or in part." From this it can readily be seen that lenticular opacities disappear, but this is rare.

Capsular Cataract, or secondary cataract, is an opacity of either the anterior or posterior capsule, or both, which is present at the time of the extraction of the lens, or develops subsequent to extraction.

Symptoms.—The vision, with correcting lens, is much below what should be expected. The patient complains of a dense cloud before the eye, and with focal light an

Fig. 95.—Cross-section of a lens showing lamellar form of congenital cataract.

opacity is seen in the pupillary area. By transmitted light this opacity can be readily seen and allows but little fundus reflex to shine through. In milder cases it is seen to be but a thin wrinkled membrane, which cuts down the vision partially by its opacity and partially by its wrinkled condition. This thickening may be due to two causes, or a combination of both; either the cortical left in the eye after extraction of the lens becomes opaque, which in a large part is later absorbed, or it organizes on the capsule and produces an opaque membrane. If no cortical is left, or it becomes absorbed completely, the capsule of itself thickens by proliferation of cells on its surface and in this manner becomes opaque. From 60 to 80 per cent. of cataract ex-

[1] Journal of the American Medical Association, July 6, 1907.

tractions require a secondary operation on the opaque capsule. This is not required in the extraction of the lens in capsule which will be spoken of later.

The secondary operation, or capsulotomy, should not be performed until all signs of inflammation have subsided, unless the capsule forms traction bands which keep up a source of irritation with the possibility of severe iritis or secondary glaucoma.

Congenital Cataract.—The most frequent form seen is the zonular or lamellar cataract (Fig. 95). Upon dilation of the pupil focal examination shows a gray area in the center of the lens surrounded by a clear transparent area (Fig. 93). This opaque area varies in diameter and in denseness; the greater the denseness the less vision the patient has, which varies from normal to a very much reduced vision. By transmitted light this area is black surrounded by a red zone. The densest portion of the opacity is around its periphery, which serves to distinguish it from the nuclear cataract which is most dense in the center. Nystagmus is a frequent symptom. The cataract is almost always bilateral but in very rare instances is seen in but one eye. The opacity lies between the nucleus and cortical, leaving these structures transparent.

Etiology.—Heredity, rickets, syphilis, and there is usually found a history of convulsions.

Treatment is unnecessary unless the vision is considerably reduced. If the vision is reduced one of two operations may be resorted to. In the first the transparent portion of the lens is taken advantage of by making artificial pupil over this area. The position of this pupil should be down and in. The other method is by removal of the lens. In children this is accomplished by needling or discission; in older people, where the nucleus has hardened, by extraction. Iridectomy for artificial pupil has the advantage over the extraction in that it does not require the wearing of glasses following the operation unless there is a refractive error, and also does not require an additional pair for near use, but it is objectionable on the ground that

it produces a deformity, and may cause diplopia. It also usually causes dazzling. It is possible that it may be of temporary benefit only, for some cases of lamellar cataract eventually become more opaque. At the present time there is less danger in discission than formerly, so that in cases of quite marked reduction of vision I am much in favor of this procedure. It requires numerous operations, but the chance of infection is very slight, and the cosmetic result is much better, also the vision is more satisfactory even though two pairs of glasses are needed, one for distance and one for near.

Posterior Polar Cataract is usually congenital, and is a fœtal remnant of the hyaloid artery which normally exists in early fœtal life. The condition is made out on ophthalmoscopic examination only, and is known to be on the posterior capsule by its deep location and the fact that it moves in the opposite direction when the eye is moved. Interference of vision is usually slight and as a consequence there is no treatment.

Posterior Capsular Cataract is an irregular opacity of the posterior capsule which is frequently coincident with choroiditis and retinitis pigmentosa. This form frequently progresses to complete cataract after a considerable length of time. There is no treatment until the lens becomes opaque, and not then unless the retina functionates well.

Anterior Polar Cataract is a small central opacity lying beneath or on the anterior capsule. The condition is almost always congenital, and if so is usually bilateral. If acquired, it is secondary to ulcer of the cornea which had perforated, and only occurs in children. The congenital anterior cataract may be little more than a white dot which does not interfere to any extent with vision, but the acquired form does materially interfere with vision. Part of the interference with vision in the latter form is due also to the scar on the cornea.

Treatment.—The congenital form rarely requires treatment, because of little or no interference with vision. The acquired form may be so large as to demand operative

interference. The operation of choice is practically always an optical iridectomy. The periphery of the lens is clear, and because of the fact that the center of the cornea is usually opaque as well as the center of the lens an iridectomy is a much more logical surgical procedure than removal of the lens.

Aside from the forms of cataract mentioned above there are numerous other forms which are seen mostly in congenital cases, and frequently accompanied with other congenital malformations. Some of the less rare forms are *cataract punctata,* in which the lens contains numerous small dots throughout its substance; *central cataract,* in which the opacity lies in the center of the lens; and *fusiform cataract,* in which the opacity extends from the anterior to the posterior pole, and which shows a small spindle-shaped enlargement at the center of the lens. There is usually no treatment for these various forms.

Black Cataract is an advanced senile condition in which the lens has become sclerosed and formed into a hard mass. The pupil appears quite black and it is only on careful examination that we are able to make out the brown color of the lens. This form of cataract is very difficult of extraction and requires an unusually large incision.

Traumatic Cataract is secondary to a perforating injury of the lens or lens capsule. There are cases in which a cataract forms following a non-penetrating wound of the eye. In the latter instance there is probably a rupture of the capsule or zonula admitting entrance of the aqueous into the lens substance or interfering with its proper nourishment. After penetration of the capsule, the lens, or a portion of it, rapidly becomes opaque, but I have seen several cases where this did not occur. The lips of the wound apparently closed at once, and after a few days nothing could be made out on ophthalmoscopic examination except a faint scar in the capsule. If the case is seen early the pupil should be widely dilated and a thorough examination of the fundus made, in order to determine the presence or absence of an intra-ocular foreign body. The tension

should be carefully noted, for frequently the lens substance swells so rapidly as to induce a secondary glaucoma.

Treatment.—Should the lens swell so rapidly as to threaten secondary glaucoma or cause pain, the cortical should be withdrawn from the eye by suction or paracentesis of the cornea, when the soft lens substance will flow out with the aqueous or may be teased out by gentle massage. Intra-ocular foreign body should be removed or, if this is impossible, enucleation of the eye. The pupil should be kept constantly dilated with atropine, and if iritis occurs it is treated in the usual way. Occasionally these eyes become markedly inflamed and threaten sympathetic ophthalmia, in which case they should be removed.

OPERATIONS FOR CATARACT.

Senile Cataract.—Before operating the eye should be carefully examined and the ideal cataract for operation should present the following points: The conjunctiva and the tear passage should be free from inflammation or disease. The ocular tension should be normal; the pupil should be round, central, and re-acting well to light; the iris should be of good color, should lie in a normal plane, and should dilate well with a mydriatic; the lens should be uniformly opaque, through which no fundus reflex can be seen, and through which the patient cannot see well enough to distinguish form; the projection of light should be accurate and quick. Owing to the danger of infection, and also to the fact that an eye cannot be made surgically clean, it is my custom to have the patient use a collyrium of 10 per cent. argyrol three or four times a day for a week preceding the operation. The evening before the operation the eye should be thoroughly irrigated with a solution of boracic acid. The area about the eye should be carefully scrubbed with castile soap and later with 60 per cent. alcohol, and in the conjunctival cavity and along the edges of the lids should be placed White's ointment (Formula 13). Over this region a weak corrosive dressing may be held in place

by a light bandage. This dressing is left in place until just previous to the operation. Of late I have instilled a drop of 1 per cent. atropine into the eye the evening before the operation and again just previous to the operation. It does not add to the danger of prolapse and admits of easier extraction. Just previous to the operation the eye is again irrigated with boracic acid solution and a 4 per cent. solution of cocaine instilled about three times for the purpose of anæsthesia.

Besides the local preparation of the eye the patient should receive a saline purge the night before and an enema the morning of the operation. This will keep the bowels at rest for a day or two following the extraction, which is much to be desired. If the conjunctiva or lachrymal apparatus show signs of inflammation these should receive appropriate treatment before the eye is operated upon, because of the chance of infection from these sources. It is also most important that the nose be thoroughly examined and it also should be thoroughly treated before operation if diseased, as many cases of infection are secondary to a purulent condition in the nose which extends upward through the tear passage to the eye.

Old age is by no means a contra-indication to operation, but senility is. Diabetic cases should receive appropriate dietary treatment until the sugar in the urine is much reduced or disappears entirely. Cases of Bright's disease do not, as a rule, do well, but if the patient is in fairly good condition the operation is justifiable. A routine examination of the urine should be made previous to each operation.

Operation by Extraction.—This method is practically the only one at present used in patients over thirty years of age. There are four operations at present in use, and these will be briefly described.

Modified Graefe Operation is one in which an iridectomy is performed preliminary to the extraction of the lens. After the eye is thoroughly cocainized a speculum (Fig. 96, *a*) is introduced to hold the lids apart, and an incision is made in the cornea close to the scleral junction with a Graefe

cataract knife (Fig. 96, *b*). The point of the knife should be held at right angles to the cornea in making the puncture, in order that the knife will not run between the layers of the cornea for some distance before it penetrates into the anterior chamber. After puncture is made the handle of the knife is depressed and the blade carried straight across the anterior chamber, to a point corresponding to the primary

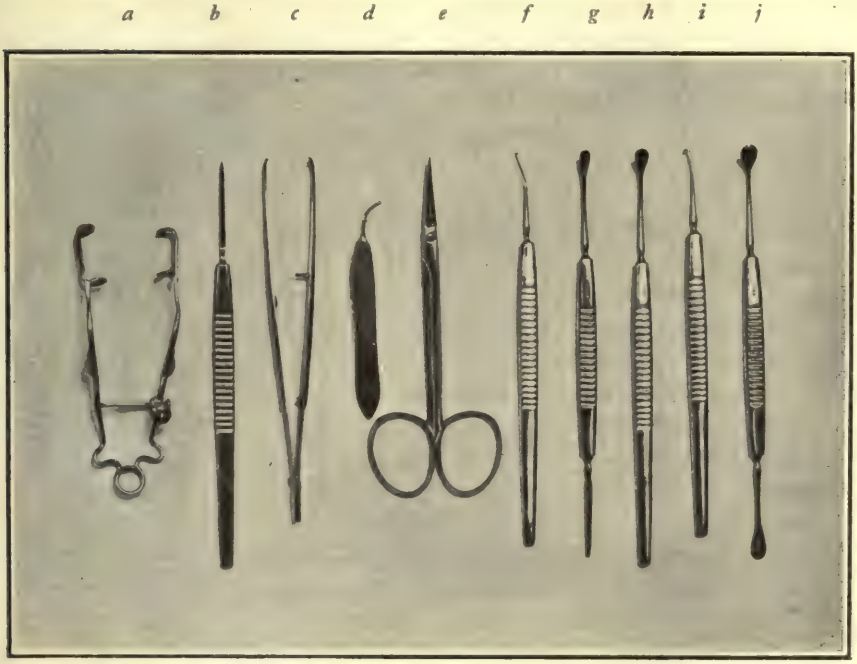

Fig. 96.—Instruments necessary for cataract operation.

puncture, and a counter puncture made at that point. The cut is then completed upward near the cornea-scleral junction until the knife emerges at top, making a flap which embraces slightly less than one-half the corneal circumference. The incision may be ended by including a portion of the conjunctiva (conjunctival flap). The incision should be completed slowly in order that the iris may not prolapse with the sudden rush of aqueous. Before starting to make

the incision the conjunctiva should be seized down and in with a pair of fixation forceps (Fig. 96, *c*), in order that there may be some resistance in making the puncture, and the eye can be held in position in completing the incision.

To perform the iridectomy the iris forceps (Fig. 96, *d*), held in the left hand, are passed into the anterior chamber and a small portion of the iris near the ciliary margin is grasped and slowly withdrawn through the incision. The iris scissors (Fig. 96, *e*), points up, are then used to cut the iris close to the cornea. The iris will then retract in position and the result will be a small, clear cut iridectomy. The capsule is now ruptured by means of a flexible cystitome (Fig. 96, *f*), which can be bent to suit the individual case. This instrument is inserted heel first into the anterior chamber and, when opposite the lower border of the lens, turned with point toward the capsule and a T-shaped cut made. The instrument is again turned with heel toward the iris and carefully withdrawn from the eye. The patient is then instructed to look down and pressure is made with a spoon (Fig. 96, *h*) at the lower margin of the cornea in the median line, and counter pressure with a spatula (Fig. 96, *g*) above the wound. This causes the edges of the incision to separate and the lens is slowly forced out. When the lens engages in the wound pressure must be steady but gentle and as the lens escape it can be caught by the spatula and tossed aside. The pressure below with the spoon should be kept up until all the soft cortical following the lens is pushed out of the wound. It is important to remove all the cortical possible, but this must be done without entering the eye with too many instruments, and thus increasing the chance of infection. The iris is now gently replaced by the spatula, especial care being taken that a portion of it is not caught in the angles of the wound. The speculum is now gently removed, the patient being instructed to keep his eyes open. The conjunctival cavity is then irrigated with boracic acid, a drop of atropine instilled, a last look taken to be certain that all

is in good condition. White's ointment is applied to the lids and a double bandage is applied.

Simple Extraction.—The incision is made as for the Modified Graefe, and the technique of the operation exactly the same except that there is no iridectomy performed. This operation has the advantage over the Modified Graefe in that there is left a round, central pupil in successful cases, and as a consequence the cosmetic result is perfect. It has the disadvantage, however, of a marked tendency toward prolapse of the iris, which is frequently serious, or if not so causes a more marked disfigurement than an iridectomy. If the case seems eminently favorable for simple extraction and this is successfully performed the operator should request the patient to look straight down while the upper lid is held back in order to observe the wound. If the edges separate an iridectomy should be performed before bandaging the eye. If the edges of the wound remain in good apposition when the patient looks straight down, the chance for prolapse is slight.

Simple Extraction with Buttonhole of Iris is an operation devised by Chandler in which the technique is the same as in simple extraction, except that after the extraction is completed and the iris replaced in its normal position the iris forceps are inserted through the wound and a small portion of the iris grasped near the ciliary margin. Gentle traction is made until a small bit is withdrawn from the wound, when it is cut with the iris scissors. Upon replacing the iris a small buttonhole will be seen in it near the ciliary margin and almost beneath the wound. Care must be taken or too large a buttonhole will be made, when, from a cosmetic standpoint, the operation would have no advantage over the Modified Graefe. This operation has all the advantages of a simple extraction, and to a large extent overcomes the danger of prolapse.

Extraction in Capsule was called prominently to the attention of the medical fraternity by the publication of articles on this subject by Major Smith of the British Army

Medical Service in India.[1] Since his report the operation has been frequently performed in this country, but has not been received with much enthusiasm. The technique is much the same as that previously described. An iridectomy may or may not be performed. After the iridectomy, or after the incision if an iridectomy is not done, pressure is made over the lower third of the cornea neither away from or toward the wound with a strabismus hook. Counter pressure is made above the incision with a spoon. The pressure with a strabismus hook is constant and takes from one to three minutes hard pressure to bring out the lens. When the lens is nearly out the position of the strabismus hook is shifted forward and the lens tilted by getting it in the hollow of the hook, pressure being kept up constantly with the hook and spoon. In 2,616 cases reported by Major Smith 2,494 were delivered without rupture of the capsule, and the vitreous was lost in but 6.8 per cent. It is hardly possible that such a high percentage of excellent results would be obtained by any one man in this country. This operation has the advantage of leaving a clean, black pupil in which no capsular or secondary cataract can form, and if it were less heroic would be the operation of choice in selected cases.

The Modified Graefe gives the most satisfactory results, taking every thing in consideration. In selected cases the simple extraction with buttonhole of iris is the operation that will give excellent cosmetic results combined with a high degree of security. The simple extraction is becoming less advocated each year, and the extraction in capsule, while it may be an excellent procedure in India where tens of thousands are operated upon yearly, will never come into general use in this country.

The after care of cataract operations is of great importance. The cotton pad over the operated eye should be stuck down at its edges with collodion, in order that the

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[1]British Medical Journal, September 26, 1903; and Archives of Ophthalmology, 1905.

patient may not insert his fingers beneath the pad, which is a common source of infection. The wound should be dressed daily under strict antiseptic precautions. The patient may be allowed to get up on the second day following the operation, if the eye heals well, the anterior chamber re-establishes, and there are no complications. The bandages may be omitted on the fifth or sixth day. At each dressing a drop of atropine should be instilled into the eye in order that the pupil may be kept widely dilated.

Complications.—The complication most to be dreaded is infection. There are numerous causes for this, and the most common cause is not sufficient care in the sterilization of the instruments and the hands. The operation should be performed under rigid aseptic and antiseptic precautions. The preparation of the patient has been given. The instruments, except the knives, should be boiled for ten or twenty minutes before use. The knives should be dipped in boiling water for about thirty seconds and then placed in a solution of 60 per cent. alcohol. The hands and arms of the operator should be rendered surgically clean, and he and his assistants should wear sterile gowns. The upper part of the patient should be covered with a sterile sheet, tucked well in about the neck and his head encircled with a sterile towel, held in place by a clamp.

Another common cause of infection is from the patient's fingers. There seems to be an irresistible desire on the part of some patients to rub the eye or put the hand under the bandage after operation. This is obviated by sticking the dressing down with collodion or using a protective mask.

Lachrymal obstruction and blennorrhœa, also conjunctival inflammation have been spoken of and should be treated before operation. It is true, that some cases of infection do arise in spite of every precaution, and when signs appear, they should be met with energetic combative measures. If the patient complains of severe pain following operation, the bandage should be removed at once and the eye carefully inspected to ascertain the cause. Should the iris be

discolored and contracted, atropine should be pushed and leeches applied to the temple. Hot fomentations are also of value; constitutional treatment is advisable, preferably mercury. If the wound looks gray and the anterior chamber has been re-established, the bandage should be removed and the eye irrigated every three hours with 25 per cent. argyrol. There should be frequent irrigation with boracic acid solution. Atropine is indicated to keep the pupil dilated. Into the conjunctival cavity should be placed an antiseptic ointment, or the wound may be dusted three or four times a day with an antiseptic powder. This treatment will be successful in checking the inflammatory condition, except in very severe cases which go on to phthisis bulbi or panophthalmitis.

During operation hæmorrhage may occur from the iris and completely fill the anterior chamber, or there may be a choroidal hæmorrhage causing a loss of the contents of the eye and requiring enucleation. Hæmorrhage into the anterior chamber will usually be entirely absorbed and will cause no harm.

An incision made too small will frequently prevent the extraction of a lens. In this case an assistant may rotate the lens with a hook (Fig. 96, *i*), which frequently admits of quite easy extraction; or the incision may be enlarged by means of scissors or a keratome.

Loss of vitreous is not an uncommon accident. It may be due to too great pressure either in extraction or intraocular pressure itself. The vitreous is frequently lost in cases where there is a fluid condition of that portion of the eye. This accident is always to be dreaded because of the increased danger of infection and if much is lost detachment of the retina may occur or vitreous opacities may form.

The anterior chamber may not re-establish within a week, or even longer. If there is any mechanical reason for its closing such as lens substance, capsule, etc., it should be removed. Usually there is no mechanical cause, in which case the bandage should be applied to the operated eye only, when the wound will unite within a few days. When the

wound is open the patient should be cautioned against stooping or straining or any sudden effort which would cause increased intra-ocular pressure with possible prolapse of the iris. An iritis may arise following operation independent of suppuration of the wound, in which case the eye should receive treatment described under that disease.

Capsulotomy, or Secondary Operation, is best performed with Knapp's knife needle (Fig. 97, *b*). The eye is cocainized and the same antiseptic precautions used as described under Extraction. The speculum is introduced and the eye steadied with a pair of fixation forceps. The needle is entered, in much the same way as the cataract knife, near the edge of the cornea in such a position that a clean sweep of the blade will open the capsule in the center of the pupillary area. A large enough hole should be made that there

Fig. 97.—Knapp's knife needle.

will be no danger of its closing together within a few days. A few days after capsulotomy the eye may be tested for glasses, and a record of the vision and refraction made. At the end of six or seven weeks a permanent glass may be given, which in the large majority of instances should permit of good vision from distance. A stronger glass is given for near vision.

Discission.—This is the operation resorted to in cases of congenital cataract or in persons under thirty years of age. Before thirty the lens is soft and does not permit of extraction. The operation is very similar to that of capsulotomy. The needle enters the lens substance several times in order to allow entrance of the aqueous and cause absorption. This may be done with one needle or two.

Sometimes after needling the lens swells so rapidly as to threaten secondary glaucoma. In this case a paracentesis

should be performed near the corneal margin. This is usually done with a bent broad needle (Fig. 98). The aqueous will then flow out carrying with it much soft cortical. If much cortical substance remains behind, and cannot be teased out by gentle massage, the tip of the suction instrument must be introduced into the anterior chamber and the cortical sucked out. Discission for congenital cataract has to be performed several times before the lens substance will become sufficiently absorbed to permit of good vision. As in cases of extraction, the eye has to be fitted to proper glasses before good vision for distance or near is obtained.

Congenital Dislocation of the Lens is a condition in which the lens is displaced from its normal position. The position in which it is seen varies. I have seen it about an equal number of times up and out, and directly downward.

Fig. 98.—Bent broad needle.

Etiology.—The condition is largely hereditary, it being frequently seen in two generations of the same family.

Symptoms.—Diplopia is frequently complained of and faulty vision. The condition is usually binocular. With the ophthalmoscope the edge of the lens is plainly seen and the retina appears in two planes.

Treatment.—If there is not marked interference in vision, operation is not indicated. If the lens is cataractous or is displaced well back on the ciliary body it should be removed with a scoop (Fig. 96, *j*).

Acquired Dislocation of the Lens is usually caused by injury. The dislocated lens may be seen in the vitreous, in the anterior chamber or even subjunctival, the lens passing through a rent in the sclera.

Symptoms.—The displacement can be easily made out by focal or ophthalmoscopic examination. The lens can easily be seen to move on motion of the eye. The iris is tremulous, unless the lens is dislocated into the anterior

chamber, in which case the iris seems bent back into the eye and the anterior chamber is deepened.

Treatment.—A backward dislocation in which the eye is quiet may need no treatment other than glasses. If the dislocation is forward in the anterior chamber, the pupil should be contracted with eserine and the lens quickly scooped out through a corneal incision similar to that made for cataract extraction.

CHAPTER XV.

GLAUCOMA.

Glaucoma depends upon the increase in the intra-ocular pressure. It is due either to a pathological increase of tension for a normal eye, or a normal tension for an eye which is pathological in so far as it is not resistant to this tension. Von Graefe was the first to call attention to the chain of signs which the disease presents, as he was also the first ophthalmologist to perform iridectomy for its relief. Up to that time the disease had been pronounced incurable. The disease is manifested in five distinct forms, congenital, acute or primary, secondary, chronic, and simple.

Etiology.—As the cause of the disease has always been in doubt there have been advocated many theories, most of which need no consideration. Two which have been retained in the absence of more definite knowledge are hypersecretion and retention of intra-ocular fluids. Hypersecretion is said to be due to irritation of the nerves governing the secretion, but the manner in which the secretion is retained is not readily explained. It is demonstrable that fluids pass out of the globe through the canal of Schlemm and the ligamentum pectinatum; also that fluids pass from the vitreous forward in the circumlental space, called the canal of Petit, to the canal of Schlemm. In glaucomatous eyes the iris at its periphery is pushed forward against the cornea, thus blocking the canal of Schlemm (Fig. 99), the explanation of which is only attempted in the theory of Priestly Smith. He claimed that the narrowing or obliteration of the canal of Petit, which is the space lying between the ciliary processes and the border of the lens, prevented the passage of fluid from

the vitreous forward and therefore the increased pressure from behind pushed the lens and iris forward, thus blocking the canal of Schlemm. This theory explains acute, secondary, and chronic glaucoma, but does not explain the simple glaucoma in which the tension is usually normal, the iris in a normal plane with absence of all inflammatory symptoms.

Hydrophthalmos (buphthalmos) is a disease of childhood, usually congenital, which is manifested by a large protruding eye, the sclera of which appears bluish and the cornea large and prominent (Keratoglobus). The cornea

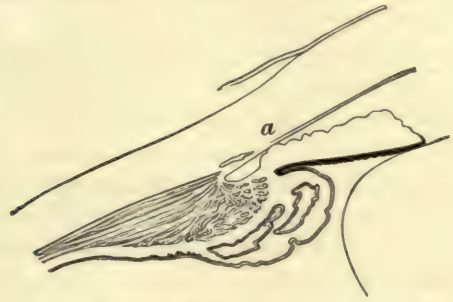

Fig. 99.—Iris and ciliary body in a very hypermetropic eye in dilatation of the pupil. Magnified 9 × 1. *(Fuchs.)*

The iris is contracted and thickened, so that at *a* it comes into contact with the posterior surface of the cornea and cuts off the sinus from the rest of the anterior chamber. The ciliary body is unusually large; the circumlental space narrow.

is usually clear and brilliant, but it may be cloudy. The anterior chamber is deepened and the iris is somewhat tremulous. Tension is usually increased and the optic disc is markedly cupped. Vision is proportionately diminished, and the eye usually becomes blind.

Etiology.—It has been demonstrated in some instances to be due to congenital malformation or absence of the canals for the passage of ocular fluids. It is also due in certain instances to prenatal iritis or iritis of infancy, which blocks the excretory canals with exudate, or by means of adhesions.

Treatment.—The most rational procedures seem to be the continued use of miotics (preferably pilocarpine), and frequent paracentesis of the cornea. More radical operations, such as iridectomy or sclerotomy, have not such good curative effects as in the other forms of glaucoma. Should the eye become blind and greatly enlarged, enucleation is strongly indicated.

Acute Primary Glaucoma arises without apparent cause, although there are certain predisposing factors, such, for instance, as old age, when perhaps swelling of the lens may be causative; hereditary tendency has some etiological significance; race is also considered, the disease being most frequently seen in negroes and Jews. Refraction is very important in that most cases occur in hypermetropes. I have never seen a myopic eye in a condition of primary glaucoma. Hypermetropia may be causative in that the enlargement of the ciliary muscle reduces the circumlental space and imperfect passage of fluids thus bring about glaucoma. The size of the cornea is also of importance. An eye having a cornea less than 11 mm. in diameter is liable to this disease.

Symptoms.—There are definite prodromal symptoms which are frequently described by patients. In this stage there are attacks of transitory blurring or obscuring of vision. During the attack the vision is poor and if a light is looked at it seems to be surrounded by a halo of colors. The eye feels full and pulsating, and there is usually headache. If the eye is seen in such an attack, the cornea appears slightly cloudy and may be anæsthetic. The cloudiness and anæsthesia are more marked centrally. The anterior chamber is narrowed and the pupil somewhat dilated and sluggish in its reaction to light. Tension is increased and there may be some slight ciliary injection. The duration of the attack varies, but at first is usually for a short time and at long intervals. Gradually the attacks last for a longer period of time and finally become of the acute inflammatory type, which is exceedingly painful and for which relief is usually sought. Between the prodromal

attacks the eye becomes normal in all its functions and in appearance. The prodromal attacks can be usually attributed to some definite cause such as errors in diet, late hours, absence of sleep, excitement and shock. In this respect it is kindred to migraine, and I have been led to believe that both are perhaps vasomotor in origin. Many attacks occur without apparent cause, and eventually there may be a certain periodicity in their appearance. Here again the similarity is noticed between the disease and migraine. The cloudiness may be most marked in the morning or *vice versâ,* but frequently attacks occur during sleep. If the attack appears in the daytime sleep may cause it to disappear.

The prodromal stage may extend over many years or, as is more usual, may last but a few weeks or months. This period ends in the second stage, which is that of *acute glaucoma.*

The acute attack is attributable to definite cause in many cases, such as digestive disturbances, overuse of the eyes, the use of atropine, emotional excitement, etc., but the usual history is that there is no definite direct cause. The attack is usually sudden in onset, and the patient complains of severe pain in and about the eyes. The pain is of intense character, and causes loss of sleep and appetite. There may be vomiting, but this is rather rare. The vision falls to the mere perception of large objects held near the eye, or to light perception only. If the vision is acute enough to permit of testing the visual field it will be found contracted, mostly on the nasal side. The eye, on inspection, shows signs of severe inflammation, and rarely œdema of the lids and chemosis. The injection of the globe is seen most prominently about the cornea, and is venous in character, in contrast to the arterial injection of the iritis. The cornea has the appearance of ground glass, especially marked in the center, where it is usually anæsthetic. The anterior chamber is shallow because of the iris being pushed forward, and the iris is usually changed in color. The pupil is dilated and unreacting. The tension is increased, usually

to + 3, which means that no indenture can be made in the globe by palpation. In the acute stage ophthalmoscopic examination is impossible because of the condition of the cornea. Untreated the tension would remain elevated for several days or even weeks. At the end of the attack the symptoms subside and the eye regains much of its function

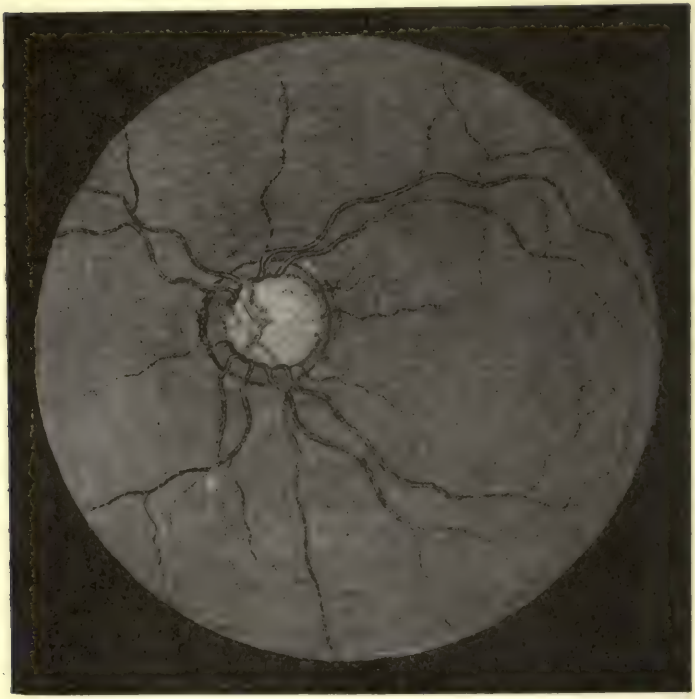

Fig. 100.—Cupping of optic disc in glaucoma. (*Ball.*)

and former visual acuity, but something is lost in each attack that is never regained. The eye may whiten out to a practically normal appearance, but there is usually some dilation of the anterior ciliary veins. The anterior chamber remains somewhat narrowed, and the pupil moderately dilated and the tension is easily determined to be above normal. The optic disc, which can, at this stage, be plainly

seen with the ophthalmoscope, is cupped. Should an eye be examined with an ophthalmoscope following the first acute attack the cupping of the disc would not be marked, but after several attacks the cupping is plainly seen (Fig. 100). The eye may remain quiescent for some time after an acute attack, but as time goes on the attacks become more and more frequent and finally lead to the third and last stage, that of *absolute glaucoma.*

In absolute glaucoma the eye is totally blind, the tension is greatly elevated, usually + 3; the iris is atrophied and discolored; the pupil is dilated extremely; the pupillary area appears grayish yellow; the fundus may be seen but with difficulty, and when seen the optic disc appears deeply cupped. The sclera appears bluish-white and the ciliary veins are enlarged and tortuous. They may form a network of congestion surrounding the cornea. Later the cornea becomes quite opaque and covered with glass-like deposits; the lens frequently becomes cataractous, and the eye is subject to frequent attacks of pain. The patient often speaks of seeing light with the blind eye, but this is a reflex condition and is not due to perception of light. The disease is seen in but one eye at a time, but the vast majority of cases eventually manifest the disease in both eyes. The interval elapsing before involvement of the second eye varies considerably. It may not involve the second eye at all, but such cases are extremely rare. One case under my observation has had no symptoms in the good eye for eleven years following iridectomy in the glaucomatous eye, and another shows no symptoms after seven years.

Treatment is operative and non-operative. The latter has but temporary benefit but is always advisable as soon as the diagnosis is certain, before proceeding to operative measures. It consists locally of the instillation of miotics: those giving the best results are eserine in solution of one-half grain to the ounce or pilocarpine four grains to the ounce. The use of a miotic shortens a prodromal attack and gives relief from pain and tension. In an acute attack the tension is also lessened and the patient made more comfort-

able. The constitutional treatment consists in rest in bed during the attack, and great care in the use of the eyes between the attacks. Morphine for pain has a double effect, it acts constitutionally through its analgesic and hypnotic influence and locally in the contraction of the pupil.

Operative Treatment should be resorted to as soon as the diagnosis is assured. The history of glaucoma untreated by operation should be plainly put before the patient, who frequently will have renewed hope of ultimate cure without operation in the return to nearly the previous condition of the eye which follows the attack. No case of acute glaucoma was ever permanently relieved by non-operative measures. The earlier the operation is performed the better chance the patient has for useful vision. Preliminary to operative measures the eye should be thoroughly treated for twelve or twenty hours with a myotic, to reduce, if possible, the tension. Should the tension remain elevated and the eye remain in an inflamed condition the operation should be performed under general anæsthesia.

The most satisfactory operation is *iridectomy* which was originally performed for the purpose of opening up the filtration angle at the base of the iris, and it was thought necessary to detach the iris from the base. This has been accomplished by making the incision well back in the corneo-scleral junction or in the part of the sclera in front of the attachment of the iris. A large portion of the iris is then removed from its attachment.

The instruments used for the operation are eye speculum, keratome, fixation forceps, iris forceps, iris scissors, and spatula (Fig. 101). The technique is as follows: The keratome (bent), or a thin bladed cataract knife, is used to make the incision, which is most always above. The cut should be made with great care in order that the aqueous may flow out slowly. The iris is withdrawn from the wound and cut on one side near its base, then drawn to the other side, cut and excised. The iris is then replaced, great care being taken that no portion is left in the wound, especially near the angles, where it is most apt to be overlooked.

The hæmorrhage which usually occurs in the anterior chamber is of little consequence, and will be absorbed in from twenty to forty-eight hours. The conjunctival cavity is thoroughly washed out, and into the eye is instilled one drop of ½ per cent. atropine. Some operators use eserine, but atropine dilates the pupil and prevents possible iritic adhesions. A mild antiseptic ointment is then applied to the

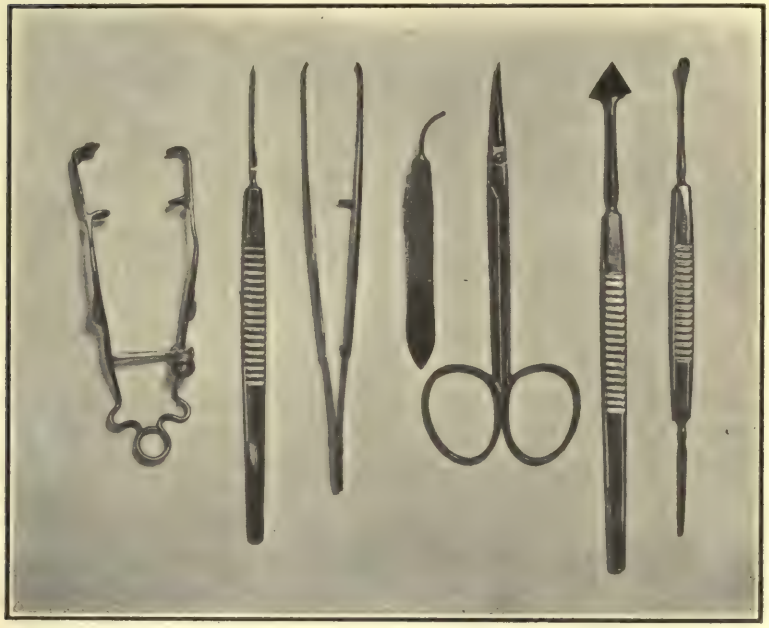

Fig. 101.—Instruments necessary for iridectomy.

edges of the lids and a double bandage placed over the eyes. The first compromise on this operation was to perform a much smaller iridectomy, which still extended to the base of the iris, but which did not cause such deformity. The most recent procedure, which gives rise to the least deformity and which also has equal curative effect, is to perform an iridectomy similar to that made in the Modified Graefe extraction of cataract. This iridectomy is more easily performed and

causes less traumatism to the eye than the larger one. Henderson has recently shown that the reason a small iridectomy answers the purpose as well as the large is due to the fact that the cut edges of the iris never heal and thus constant drainage is possible after iridectomy.

The bandage should be removed daily under antiseptic precautions, and the eye carefully inspected. The anterior chamber will reform in from a few hours to a week, and, depending upon this closure, the bandage may be removed from the fourth to the eighth day.

Paracentesis of the cornea is an operation of but temporary value as the tension is again elevated as soon as the anterior chamber is re-established. The technique is as follows: Under cocaine the corneal incision is made on the temporal side about 1 mm. from the corneo-scleral junction with a keratome, and the aqueous allowed to flow out gradually. After making sure that the iris is not caught in the wound, a light bandage is applied and the patient kept quiet for twelve or twenty-four hours.

Sclerotomy, either anterior or posterior, has not the beneficial effect of an iridectomy, but may be tried as a secondary operation, if the iridectomy fails to relieve tension. The technique of both operations is described in the chapter on the sclera.

Chronic Glaucoma may be primarily chronic, or it may result from mild repeated attacks of the acute form in which the eye eventually becomes in a state of constant tension. There is rarely any pain in this form, and the patient may not be aware of any definite symptoms until the vision becomes greatly impaired. It may make itself manifest by failure of accommodation which requires frequent change of glasses for near, and there may be definite scotomata in the visual field. The tension is increased, the pupil dilated and the anterior chamber narrowed. The ophthalmoscope reveals turbid media, and the typical glaucomatous cupping of the optic disc. The visual field is mostly contracted on the nasal side as in other forms of glaucoma, and in addition almost always shows definite scotomata or large seg-

ments cut out of the area of vision. The retinal veins are dilated and tortuous, and the arteries contracted, and at the optic disc are seen to pulsate. Chronic glaucoma may rarely manifest an acute attack.

Treatment.—Iridectomy is the most satisfactory treatment in that it reduces tension and often checks further progress of the disease. The vision is not improved by the operation because of structural changes in the eye, but it is frequently held near the same acuity as that preceding the operation. It must be stated, however, that iridectomy in chronic glaucoma is less satisfactory as a curative agent than in acute glaucoma, many eyes going on to complete blindness following operation. The continued use of miotics has a much better effect than in the acute form. They may keep the disease from progressing for a period of years in favorable cases, but the ultimate result is blindness. For continued use pilocarpine in ½ to 1 per cent. solution is more valuable than eserine, in that it does not irritate the iris with the tendency toward iritis.

Glaucoma Simplex, or non-inflammatory glaucoma, is a condition of the eye which gives the ophthalmoscopic appearance of the disease without the inflammatory symptoms.

Symptoms.—The eye appears normal on inspection with the possible exception of a moderately dilated and sluggish pupil. The eye is usually white, or at most a few dilated veins. The cornea is clear, the anterior chamber of good depth, and the tension is usually normal. At times it is possible to determine a slight increase in tension. With this slight increase in tension there may be a slightly noticeable cloudiness of the cornea. Many cases, however, under constant observation for long periods of time, show no evident increase in tension. The ophthalmoscope reveals excavation of the optic disc in proportion to the duration of the disease. The subjective symptoms are confined almost exclusively to disturbances of vision. The failure of vision is gradual and is accompanied by a contraction of the visual field. The contraction of the visual field is more

general than in other forms of glaucoma, and more nearly resembles the field of an optic atrophy. Simple glaucoma may at any time become acute, which fact must be borne in mind in considering the treatment. The disease usually attacks both eyes, and the end result without treatment is blindness.

Treatment.—There is great diversity of opinion in regard to the treatment of this disease. Many men regard an operation as giving but temporary relief. Some believe that operation in this form is absolutely unjustifiable, while others regard operation as the only means of saving an eye which will otherwise become blind. Iridectomy for the relief of simple glaucoma is receiving more ardent supporters each year. Cheney[1] puts the matter concisely as follows: "Admitting that iridectomy is a perfectly rational procedure in glaucoma simplex, and that it may bring the process to a permanent standstill in a few cases, and delay the progress of failing vision in others, there are, nevertheless, certain questions to be carefully considered in each individual case before operation should be advised. There are two facts that deserve special prominence in this connection. One is that the eye may retain useful vision for years if not interfered with, and the other is that absolute and permanent blindness may quickly follow as a direct result of iridectomy."

Age is of great consideration. Should the disease appear before fifty years or even sixty, an operation may be advised with justice, but later than sixty the risk of an operation is too great, considering that the eye under proper miotic treatment may retain useful vision for many years.

Risley, in an excellent article on "The Surgical Treatment of Chronic Glaucoma"[2] gives the exhaustive histories of seven cases which prove that the benefits of operation are greater than the continued use of miotics. As the

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1 Ophthalmoscope, April, 1905.

2 Journal of the American Medical Association, July 27, 1907.

ophthalmoscope reveals a cupped optic disc it must be reasonable to suppose that the intra-ocular tension is more than normal for the eye, even if the tension on palpation seems to the observer to be normal. Consequently I am of the opinion that, taking age and the condition of the eye into consideration, an iridectomy is the rational form of treatment in most cases of glaucoma simplex. Miotics may be used with great benefit over a period of years, but there is always danger of an acute attack appearing at any time and miotics have only a retarding action, not a curative effect.

Prognosis.—Every case of glaucoma proceeds toward inevitable and incurable blindness if left untreated. This end result is almost as certain, but is more or less delayed by the use of miotics. Iridectomy is the best mode of treatment, and is best performed as early as possible in the progress of the disease, at which time it is frequently curative. In later stages it may arrest the process entirely or at least produces more definite benefit than other forms of treatment.

CHAPTER XVI.

DISEASES OF THE LIDS.

THE numerous forms of inflammation to which the lids are liable will be described from without inward *i.e.*, from skin to the conjunctiva.

The *skin* is subject to the same diseases which are manifested in this tissue elsewhere in the body. The eruptions of the infectious fevers are seen on the skin of the lids quite frequently. This is especially true of measles and small-pox.

Dermatitis Venenata is particularly liable to attack the skin of the lids, the condition usually being due to rubbing of the eyes with the fingers, which have come in contact with poisonous substances. The swelling is usually very great; it often being impossible to separate the lids in order to see the condition of the globe. This swelling usually subsides in a few days under the application of mild antiseptics. Camphor water may relieve the itching.

Ulceration of the Lids may be due to syphilis, epitheliomata, or tuberculosis. It may also be due to purulent infection following injury or violent rubbing with infected fingers. It may also occur in the course of herpes zoster ophthalmicus. Ulceration frequently follows burns.

Syphilis of the eyelid is rare, and occurs at times as a primary lesion. It is important to differentiate it from cancer, or sarcoma, and this can quite easily be done from the history of its rapid growth, its indurated base, and the pseudo-membranous, ulcerated surface. There is enlargement of the lymph glands, usually post-cervical. There is no local treatment other than cleanliness. Constitutionally there should be given mercury as soon as the diagnosis is certain.

Epithelioma of the lids is usually quite superficial, and very slow of growth. The lesion occurs in elderly people and begins as one or more yellowish pustules, and it may take years before there are signs of definite ulceration. The ulcerated surface may be elevated or depressed and the edges are indurated. The area of inflammation bleeds readily, and there is a moderate discharge of yellowish fluid. The growth causes no general debility, or cachexia, and is not liable to metastasis. The treatment consists in as early removal as possible, which may be by excision, caustics, or by the use of the X-ray. The X-ray has on the whole given the best results.

Tubercular Ulcer of the Lids is rare but has been demonstrated by microscopic examination, and more recently by the tuberculin reaction. It probably is a condition due to direct infection. Bull reports two cases of lid tuberculosis[1], which entirely cleared up under tuberculin treatment in three and one-half months. He used the tuberculin TR, beginning with a dose 0.002 mg. and increasing gradually, avoiding febrile attacks. The injections are given every second day, and the maximum dose was 2 mg. The diagnosis may be aided by the tuberculin reaction, which consists in the injection of a large dose, getting the rise in temperature with the increase of local symptoms. The old tuberculin of Koch is considered much safer to use than the new tuberculin.

Nevus of the Lids is frequently seen and is congenital. Many cases improve without treatment in the first few years of life, but later it may become necessary to operate. Electrolysis is the best treatment but must be very carefully done. Much scar tissue resulting from this treatment may be remedied by skin grafting.

Dermoid Cysts are sometimes seen in the lids, but more frequently occur in the orbit or on the eyeball. They should be excised, and will be found to contain hair, sebaceous matter, etc.

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[1] Journal of the American Medical Association, August 3, 1907.

Lupus Vulgaris very frequently attacks the eyelids, which in healing leaves scars. When the lids are involved the disease usually covers a large portion of the face. The disease is of exceedingly slow growth and lasts indefinitely. The best results are obtained from the use of the X-ray.

Xanthelasma is a benign tumor, which grows in the skin of the lids, mostly near the inner canthus. The tumor is flat and of yellow color. It usually occurs in elderly people, and most always in women. The growth is slow and the only cure is excision. Other growths such as warts, cutaneous horns, molluscum contagiosum may be mentioned as occurring on the lids.

Congenital Anomalies of the lids are seen in two forms: *coloboma* of the lids, which is rare, may be found associated with other congenital malformations, such as coloboma of iris, or dermoid cysts, etc.

Epicanthus is a fold of skin which projects out like a shelf over the inner angle of the eye. It is always bilateral and is usually seen in people who have no bridge to the nose. Many children normally have this condition to a very slight degree, which is overcome as the nose develops. As a congenital deformity it is usually associated with ptosis. There are two operations which may correct this condition if the deformity persists, or is large. The first, the one most always performed, consists in the removal of the elliptical piece of skin from the bridge of the nose, bringing the edges of the skin in exact apposition by a subcutaneous suture. The second operation consists in excising the projecting fold of the skin as described by Arlt.

Œdema of the Lids cannot be called a disease, but it is necessary to know several of the most important causes. The two most important general causes are those which lie without the contents of the orbit, and those which lie within the orbit. There are also two types of œdema, inflammatory and non-inflammatory. The inflammatory œdema is readily determined by its redness, its increased temperature, and its sensitiveness, and by the fact that the lid is usually more swollen and frequently closes the eye entirely. Should

the lid show these signs and examination reveals a *hordeolum* the cause of the œdema is in the inflamed gland. This is especially true if the sty is situated near the outer canthus.

Dacryocystitis is a frequent cause of inflammatory œdema. In these cases the site of the inflammation is easily determined at the inner canthus.

Abscess of the lids or orbit causes acute inflammatory œdema of the lid. These abscesses are frequently secondary to diseases of the accessory sinuses, especially the frontal.

Erysipelas causes uniform swelling of the lids, which may be so great as to completely close the eyes. It can usually be determined by its appearance elsewhere on the face, its definite line of demarcation, etc., together with severe constitutional symptoms.

Neurotic Œdema is less red than inflammatory œdema and is determined by the suddenness of its appearance and the equal rapidity in which it disappears. It can usually be demonstrated elsewhere on the body at the same time, especially on the arms, legs, and lips.

Traumatic Œdema is almost always accompanied by ecchymosis and frequently emphysema due to the fracture into the air passages.

Non-inflammatory Œdema is seen frequently as a symptom of general œdema which is secondary to heart disease and nephritis.

Œdema is very frequently due to diseases of the globe and orbit and may be found in severe irido-cyclitis, acute glaucoma, thrombosis of the cavernous sinuses, any of the accessory sinuses of the nose, orbital cellulitis, panophthalmitis, ulcer with hypopyon, and virulent diseases of the conjunctiva.

Inflammation of the Lid Borders.—Hyperæmia of the borders of the lids is of frequent occurrence, and is due to numerous causes, chief of which are eye strain, due to uncorrected or faulty correction of refractive errors, smoking, prolonged weeping, sleeplessness, dissipation, etc. The condition can usually be relieved by removal of the cause.

Inflammation of the Margins is seen under these principal forms.

Hordeolum (sty) (Plate V, Fig. 2) is an acute inflammation of one of the glands of Zeiss. The first symptom is a slight inflammatory œdema of the lid, near the outer canthus. Palpation will reveal a localized area of marked tenderness. Within a day or two the lid borders in this tender area will show a yellow point which will discharge the pus spontaneously if left long enough, or this point is elected for incision of the inflamed gland. Until the pus is excavated the pain is usually very severe. The disease lasts but three or four days.

Treatment.—It is possible in certain instances to shorten the attack by the application of an ointment of yellow oxide of mercury, combined with frequent bathing of the eye in very hot water. As soon as the sty points it should be incised, and the pus excavated. The cavity may then be touched with 95 per cent. carbolic or allowed to heal by itself, which will occur within a day or two. Should there be a frequent recurrence of hordeola the eyes should be examined for a refractive error. Proper glasses will frequently prevent this recurrence.

Squamous Blepharitis (Plate V, Fig. 3) is an inflammatory condition of the lids characterized by the presence of white or grayish scales on the skin between the cilia. These scales are not unlike the dandruff of the scalp. Upon removal of the scales by gentle washing in hot water or the application of ointments the skin beneath is found reddened but not ulcerated. In this form of ulceration there is little or no loss of cilia, but it is found that the cilia are not so firmly attached in the follicle as is normal. The follicles, however, are usually uninjured and if the disease is stopped in this stage the cilia will grow again, in all their former abundance.

Ulcerative Blepharitis (Plate V, Fig. 3) is characterized by more marked inflammatory symptoms. The crusts are more purulent in appearance, the margins of the lids are more inflamed and swollen, and there is usually a marked

diminution in the number of the cilia. Upon removal of the crusts the surface beneath is found inflamed and ulcerated. In the midst of the ulcerated area may be found a cilium which drops out easily. In other spots may be seen small scars the site of previous ulceration. The disease is essentially chronic and quite resistant to treatment.

Etiology is both general and local. General causes are anæmia, tuberculosis, or scrofula as it used to be called; excessive heat, such as stokers are exposed to; vitiated air, smoke, continued late hours, etc. Local causes are chronic inflammation of the conjunctiva, uncorrected or faulty correction of refractive errors, epiphora, and, frequently, purulent disease of the nose and nasopharynx.

Sequelæ are quite numerous if the condition is in anyway neglected. Chronic conjunctivitis is frequently caused by a persistent blepharitis. *Destruction of the cilia* and the hair follicles is common in the more advanced ulcerative type. When all hair follicles are destroyed the disease stops spontaneously, because these are the site of the disease.

Hypertrophy of the lid border is common, especially in the active stage of the disease.

Entropion and Ectropion are due to cicatricial contraction. Entropion is the turning in of the lid, and ectropion the turning out of the lid. Eversion of the puncta causes very marked epiphora, and usually can only be remedied by some surgical procedure which will replace the puncta in their proper position.

Treatment must be applied to the cause as well as locally. Any general condition which may be causative should receive appropriate treatment. Faulty habits should be corrected, anæmia should have suitable tonic treatment, and tuberculosis should be treated climatically or otherwise as best suits the individual needs of the patient.

Locally.—Refractive errors should be accurately corrected, and the correcting glass worn constantly. The classical treatment for blepharitis, both squamous and ulcerative, has been the use of ointments, and of these the red oxide of mercury four grains to the ounce and the yellow

oxide of mercury eight grains to the ounce are most frequently used. The yellow oxide is less irritating and usually prescribed, but it is best to alternate the latter with red oxide occasionally. These ointments are applied to the edges of the lids night and morning, after the eyes have been thoroughly bathed in hot normal salt solution. This form of treatment will relieve some cases, but only after some time. The crusts will disappear but quickly reform. I have had excellent results for the past few years in using a treatment suggested by Reynolds, which consists in the application to the lid borders at the base of the cilia a solution of carbolic acid crystals in alcohol (Formula 21). This solution is extremely concentrated and should be used with great care, and only by a physician. The acid is applied over a small area with the point of a large needle and rubbed gently over the skin between the cilia. A white escar quickly forms which should be allowed to remain for several days when it will flake off. This area is then treated with mild yellow oxide ointment twice a day until ten days have elapsed when the treatment can be repeated. It is best not to treat too large an area at one sitting. Where the hair follicles have not been destroyed the cilia will grow abundantly and many mild cases will be cured within two months, others take longer. This treatment combined with general treatment and the use of glasses when necessary, has been so far superior to all other methods of combating blepharitis that I now use it to the exclusion of all others.

Prognosis.—The disease is chronic at best, but responds beautifully to the above treatment.

Chalazion is a disease of the Meibomian glands which is essentially chronic in character, but which may have acute or sub-acute attacks of inflammation.

Symptoms.—It appears as a hard tumor-like mass which can usually be plainly seen, and which can be readily palpated (Plate V, Fig. 4). The skin, as a rule, is easily movable over it. Eversion of the lid reveals a roughened conjunctiva which is usually elevated and reddened, and scattered throughout the area are whitish-gray or yellowish

PLATE V.

Fig. 1. Ptosis, showing the smooth upper lids and the wrinkling of the brow caused by contraction of the occipital frontalis muscle.

Fig. 2. Hordeolum of the lower lid.

Fig. 3. Blepharitis, showing both squamous and ulcerative variety. (Note the scales at the base of the lashes and the loss of cilia.)

Fig. 4. Chalazion of the upper lid.

Fig. 5. Lachrymal obstruction, showing large mucocele.

PLATE V.

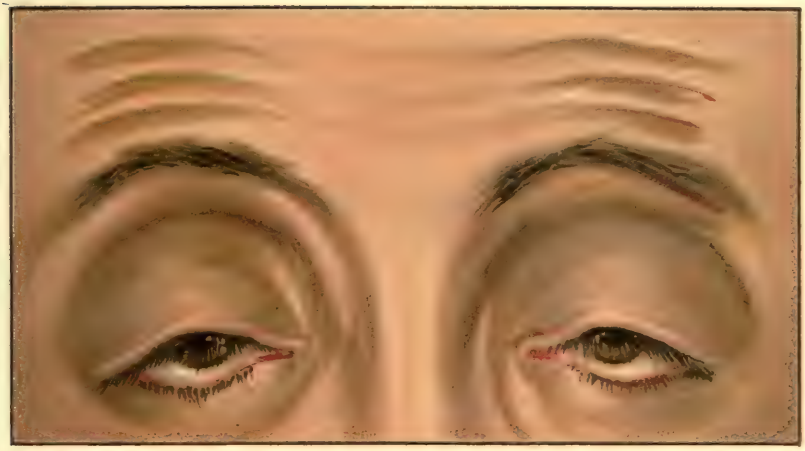

Fig 1.

Fig. 2.

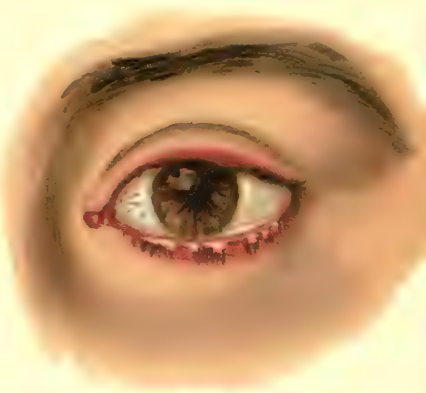

Fig. 3.

Fig 4.

Fig 5.

spots. Several chalazia may be found in the lids of a patient, which may grow slowly and persist for many years. There may be accompanying refractive errors, or those not properly corrected. In several instances I have seen tumors gradually disappear after the use of proper glasses.

Treatment, aside from correction of refractive errors, is largely surgical. The operation through the skin and orbicularis has many advocates, but I have yet to see a chalazion removed in its entirety by this method without the unnecessary loss of much good tissue. So that I advocate the removal of the contents of the sac through the conjunctiva. The eye is cocainized and clamp (Fig. 102, *a*) put on

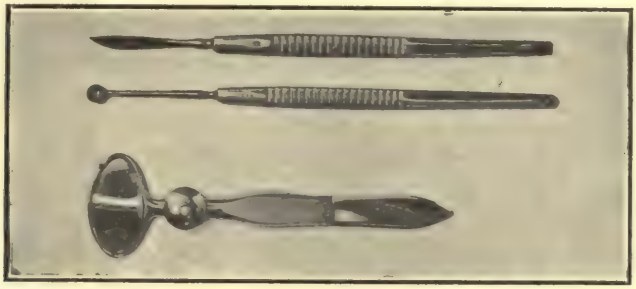

Fig. 102.—Instruments for chalazion operation.

the lid which is everted. A vertical cut is then made with a small scalpel (Fig. 102, *c*) in the area of the tumor and the contents squeezed out. The cavity is then curetted out with a sharp spoon (Fig. 102, *b*), and later with a rough curette in order that the lining of the cavity may be destroyed. The cavity may then be touched with iodine, but I think this is unnecessary. The conjunctival cavity is then washed out thoroughly, and no dressing is necessary. The result is considerable swelling for several days, after which the lid becomes normal in appearance. The chalazion will not return if the excavation of the contents and the destruction of the sac have been thoroughly performed.

Internal Hordeolum is much rarer than external hordeolum and is due to an acute suppuration of the Meibomian

glands. The condition is very painful and the pus should be evacuated as soon as possible. Hot applications frequently applied will relieve pain. After evacuation of the pus, the conjunctival cavity should be frequently irrigated with boracic acid solution.

Trichiasis is a distortion of the cilia, due to contractions which cause them to be directed inward toward the cornea. These cilia are seldom normal, being stunted and whitish which makes them difficult to see. The condition may involve only a portion of the lid, which is usual, or the whole lid may be involved. As a consequence of this malposition the eye is kept in a continued state of irritation and ulceration of the cornea is not an infrequent complication. Trichiasis is a frequent complication of trachoma and adds to the many discomforts of this dreaded disease, although burns, injuries, ulcerations, etc., which contract in healing, are also causative.

Treatment.—If but a few cilia are distorted they may be removed by epilation, but as this does not destroy the hair follicles the benefit is but temporary. Electrolysis is by far the best mode of procedure as this destroys the hair follicles. The negative pole of the battery should be connected with the needle which is inserted into the follicle, the positive pole held to the temple or neck. When the circuit is closed bubbles will be seen to exude around the cilium. The cilium can then be removed without effort. Eight or ten may be removed at a single sitting, but it is wise to go slowly as the process is quite painful and there is some after irritation.

If the distorted cilia are numerous they had best be removed by the scalping operation, which consists in the removal of a V shaped portion of the lid border, the tip of the V including the hair follicles (Fig. 103). The edges of the wound may then be apposed by fine silk sutures. Hotz's operation consists in making a horizontal incision along the upper border of the tarsus (if the operation is performed on the upper lid), throughout its entire extent. The wound is then separated and the fibers of the orbicularis, which

are seen at the bottom of the wound, are removed. The lips of the wound are then brought together by passing the suture first through the upper lip and out the lower, including in the suture the upper border of the tarsal cartilage. As many sutures should be taken as to produce the desired effect. The idea of the operation being to attack the skin to a fixed point and thus evert the lashes.

Entropion is a rolling in of the lid. Fuchs states that, "The distinction between entropion and trichiasis is one of degree." I cannot quite agree with him in that in trichiasis the cilia are misplaced on the lid border, while in entropion the whole border is turned in.

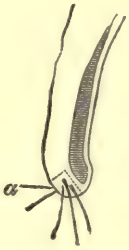

Fig. 103.—Flarer's method of removing lashes in trichiasis. *(Fuchs.)*

Spastic Entropion, due to spasm of the orbicularis, accompanies many of the acute inflammatory diseases of the eye, especially the cornea. It is due to irritation and marked photophobia. Relief of the cause will bring the lid back to its normal position.

Senile Entropion is due to a lax condition of the skin of the lids which so frequently accompanies old age. It is more common in the lower lid than in the upper, and may often be relieved permanently by the use of surgeon's tape, which will keep the lid in its proper position for some time. Should this fail the excision of an elliptical piece of skin parallel to the border of the lid will relieve all trouble, especially if the sutures used to bring the edges of the wound together are deeply placed.

Cicatricial Entropion is due to contraction of the conjunctiva, and is a frequent complication of trachoma, burns, and ulcerations.

Treatment may be operative or otherwise. Entropion, as I have suggested under the senile form, may be relieved by holding the lid in position by means of surgical tape, or should the entropion be caused by wearing a bandage this may be removed when the entropion will disappear. The bandage and tape may be combined if necessary.

Operations for entropion are very numerous. A few of the best will be described.

Canthoplasty is an operation which enlarges the palpebral fissure. This is performed by separating the lids widely and the external angle of the lids cut with a pair of blunt pointed scissors. The part of the conjunctiva directly opposite the outer angle of the wound is then sutured to this angle and a couple of sutures taken above and below. This operation is of value in entropion due to spastic condition of the orbicularis, or in cases where great œdema of the lids causes extreme pressure on the eyeball.

Hotz's Operation, previously described, is frequently of value in entropion.

Green's Operation consists in making an incision in the conjunctival surface of the lid parallel to and 2 mm. from the openings of the Meibomian glands. The incision should be made through the conjunctiva and the tarsus extending the whole length of the lid. A strip of skin is excised from the lid at a distance of about 2 mm. above the ciliary margin. This strip should be about 2 mm. wide. The orbicularis muscle may be dissected out or may be left intact. A curved needle carrying a suture is then inserted a little to the conjunctival side of the cilia and is brought out just within the wound made by the skin incision. It is drawn through and reintroduced in the wound at its upper margin, and passes deeply backward and upward in front of the tarsus where it emerges from the skin about 1 cm. above its point of entrance. Three or four such sutures

usually suffice to turn the lid outward. The entropion should be over-corrected, as it will contract back somewhat in healing. The sutures may be removed on the second or third day.

Arlt's Modification of Garltaird's Operation is as follows: One needle of a double-needled suture is entered at the junction of the middle and inner thirds of the lower lid. The point of entry lies close to the border of the lid (*c*, Fig. 104, *B*), the point of exit at a distance below it upon the cheek equal to the breadth of a thumb (*d*). The second needle is passed in a similar manner and near the first, so

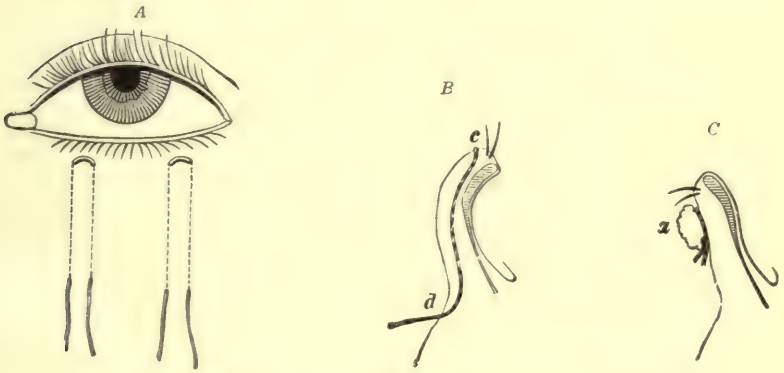

Fig. 104.—Methods of operating upon entropion. *(Fuchs.)*

that the loop end of the thread lies upon the skin near the border of the lid, and the two threads run downward beneath the skin in a parallel direction. A similar loop of thread is applied at the junction of the middle and outer threads of the lid. If the two ends of each thread are tied over a roll of adhesive plaster or sterile gauze and drawn tight, a horizontal fold of skin is pinched up upon the lower lid and the entropion made to disappear (Fig. 104, *C*). The threads are pulled tight enough to produce an *over-effect,* as there will be some tendency to return in healing.

Ectropion is a turning of the lids outward, so that the conjunctival surface appears. This condition varies greatly

in degree from that of a slight eversion of the lid border to an eversion of the entire lid.

Symptoms.—Epiphora from eversion of the punctum; chronic enlargement of the lid border. The conjunctiva becomes dry and much thickened and covered with granulation tissue. In high degrees the cornea may be only partially covered which causes a secondary keratitis from constant exposure to the air and lack of moisture. The principal forms are arranged according to their etiology.

Spastic Ectropion is found principally in children and young adults, and is secondary to acute inflammatory conditions causing blepharospasm, such as gonorrhœal ophthalmia and trachoma.

Paralytic Ectropion is due to paralysis of the orbicularis frequently associated with facial paralysis, and on account of the palpebral fissure not being properly closed is called *lagophthalmus*. Because of this paralysis the lids are not held close to the eyeball and the lower lid sinks of its own weight.

Senile Ectropion is found only in the lower lid, and is a part of the general relaxation of the tissues in age.

Cicatricial Ectropion is due to scar contraction following injuries, operations, ulcers, etc.

Treatment of Ectropion is both non-operative and operative. The non-operative treatment is most successful in spastic ectropion and consists in holding the lids in proper position by a well-fitting bandage. This of course is only applicable in cases where the bandage is not contra-indicated. Senile ectropion may be relieved and even cured by instructing the patient to rub his eyes in such a way that the faulty position is overcome. This may be augmented by the application of a bandage at night.

Operative Treatment.—Snellen's suture gives good results in senile ectropion not otherwise corrected. This operation is accomplished by the use of two double-needled sutures: one at the junction of the inner and middle thirds, and the other at the junction of the middle and outer thirds of the lid. The point of entrance for the needles is at the

summit of the everted conjunctiva, which is usually near the posterior margin of the tarsus (*a*, Fig. 105, *A*). From this point the needle is passed down beneath the skin to a point about opposite the margin of the orbit where it emerges (*b*). The second needle of the same suture is passed down parallel to the first, emerging near the first. These ends are tied over a mattress which is usually gauze or a roll of tape (Fig. 105, *B*). This operation should also give an over-effect at first. The same procedure should be used with the outer suture.

Cicatricial Ectropion gives more trouble to correct, and demands the ingenuity of the operator to suit the indi-

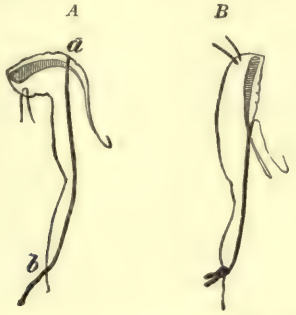

Fig. 105.—Snellen's suture for ectropion. *(Fuchs.)*

vidual case. The V Y operation has value in many cases. This operation consists in making an incision in the shape of a V which includes the cicatricial area, the apex of the V pointing toward the cheek (if the lower lid), the base being the border of the lid. This area is dissected up freely and the whole mass pushed upward into its true position. This will make it possible to unite the lower parts of the sides of the V into one line by means of sutures. The sides are then sutured and the resulting scar is a Y.

Other cases need skin grafting and plastic surgery dependent upon the location and degree. These operations do not differ from operations described in any good treatise on surgery.

Symblepharon is a cicatricial adhesion between the conjunctiva of the globe and the conjunctiva of the lids. This condition is usually brought about by burns, but may be secondary to any form of conjunctival ulceration. Hence having two raw conjunctival surfaces which appose each other it is necessary to exert the greatest possible care that these do not grow together. There are several kinds of symblepharon to be noticed. One in which the adhesion is well back in the fornix, when it is known as *posterior symblepharon;* another in which the adhesion does not extend so far back, when it is called *anterior symblepharon* and a third in which the whole conjunctival surface of the lid is attached to the globe, which is called *total symblepharon.*

Treatment is operative. Anterior symblepharon is most easily cured. The simplest operation is to sever the adhesion and keep the raw surfaces from healing together again. If the adhesion is small the two divided areas can each be covered with conjunctiva by means of sutures. If larger they may be made to heal by continually drawing the lid away from the globe, or interpose between them a piece of cotton, which has been soaked in an antiseptic ointment or an oil until the surfaces have healed.

In posterior symblepharon the adhesion is separated well back into the fornix and then, by means of a plastic operation on the conjunctival surface of the eyeball, one surface is covered which will prevent it uniting with the denuded surface of the lid. Following the operation there should be kept a liberal supply of oiled cotton in the cavity.

Total symblepharon demands grafting for its relief. A Tierch graft gives much better satisfaction than the grafting of mucous membrane. After the application of grafts they are held in place by means of a shell made for the purpose.

Ankylopharon is a condition in which the edges of the two lids have grown together in whole or in part. This adhesion is operated upon by severing the attachment and keeping the lids from growing together again, as in symble-

pharon. The best way to accomplish this is by means of oiled cotton.

Blepharophimosis is a narrowing of the palpebral fissure at its outer angle. In separating the lids there will be noticed a fold of skin which extends vertically holding the lids together. This band should be severed and the divided conjunctiva brought together with sutures.

Ptosis is due to paralysis of the levator palpebrarum muscle and may be congenital or acquired. This paralysis manifests itself by a drooping of the upper lid which varies greatly in degree from that which is hardly noticeable to an almost complete closure of the eye.

Symptoms.—The upper lid is devoid of wrinkles and has lost some power of motion. The vision is interfered with in proportion to the degree of ptosis. Some patients having the ability to see only when the lids are lifted with the fingers or by marked contraction of the frontalis muscle (Plate V, Fig. 1). This causes a constant wrinkling of the brow. Congenital ptosis is usually bilateral, and is due to an absent or poorly developed muscle. Acquired ptosis is usually unilateral and is due to a lesion either of the muscle itself or the nerve supplying it. Lesions of the muscle are most frequently caused by injuries. As the third nerve supplies the levator palpebram acquired ptosis is usually associated with paralysis of the muscles supplied by this nerve. It may occur alone, but this is rare.

Treatment is constitutional and operative. Paralysis of the third nerve due to syphilis, will frequently respond to antisyphilitic treatment. For this reason it is plain that this treatment should receive a good trial, especially in the presence of other symptoms of oculo-motor paralysis, before resorting to operation. Congenital ptosis, ptosis due to trauma and cases of very long standing require operative interference.

Operations.—Panas's operation is undoubtedly one of the best known operations, and one very frequently used for the correction of ptosis. Its object is to attach the lid to the frontalis muscle and at the same time shorten the lid some-

what. Fig. 106 shows how the pedicle is cut from the skin of the lid. The pedicle is freely dissected from its attachment to the subcutaneous tissue. Then a horizontal incision is made through the skin to the frontalis muscles directly above the eyebrow, *a*. From this incision to the wound made in the eyelid the tissue is freely undermined so that a bridge of tissue is formed, beneath which the detached pedicle *s* can be slipped. Its upper margin should reach as high as the incision, *a*. Its attachment to the latter is made by means of a looped thread, the center of which

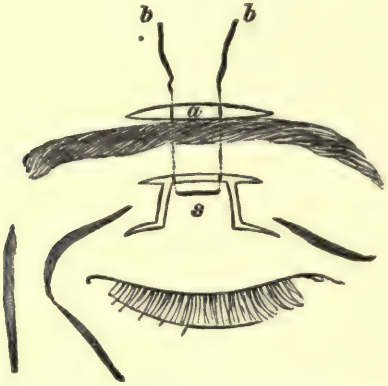

Fig. 106.—Panas's operation for ptosis. *(Fuchs.)*

lies on the cutaneous surface of the pedicle, while its ends are passed through the upper lip of the incision *a* at *bb*. The free edges of skin should be brought in position by means of interrupted sutures. The higher the pedicle is placed the greater the effect of the operation. One objection to this operation is the accumulation of sebaceous matter under the bridge of skin through which the pedicle was run. This has been partially obviated by first denuding the pedicle of all its epidermis.

Pagenstecher's Operation has a similar effect to that of Panas. He endeavors to attach the lid to the frontalis muscle by means of contraction bands beneath the skin. These are formed by double-needled sutures placed

at regular intervals along the lid border and brought out above the brow. One needle of a double-needled suture is entered at the free border of the lid and is carried up beneath the skin to above the brows when it is brought out. The second needle is passed parallel to the first, leaving the loop on the lid border. As many as three or even four of the double sutures may be passed in this manner. The free ends are tied over a piece of gauze, and the effect is that of an over-correction. The sutures may be tightened after the œdema has subsided if necessary. These sutures should remain in place until cicatricial bands have formed along their courses.

CHAPTER XVII.

DISEASES OF THE ORBIT.

THE orbital tissue surrounding the eyeball is liable to many pathological changes, some of which are primary, others are secondary to diseases of the eyeball, and others are secondary to diseases of the accessory sinuses of the nose. These sinuses, the ethmoid, sphenoid, frontal, and maxillary surround in great part the orbital cavity, the bony walls separating them being often the line of least resistance in the advancement of purulent inflammation. Hence it is that we so frequently find orbital abscess as an accompanyment of purulent disease of the sinuses.

All affections of the orbit manifest an increase in the size of its walls or contents, producing *exophthalmos,* or a diminution in size producing *enophthalmos.*

Exophthalmos is a frequent symptom of all forms of orbital disease, as is also diplopia which is brought about by displacement of the eye from its normal position, or by lack of motion in the eye from great swelling. Pain is very common, as is also local tenderness, especially in inflammatory conditions.

Periostitis of the orbit may be either acute or chronic, and is caused by trauma, syphilis, extension of disease from the accessory sinuses, etc.

Symptoms.—The inflammation may be localized or diffused, but the localized form is more common. This is usually manifested by a tender swelling along the orbital margin, which is more or less hard and immovable. There may be secondary exophthalmos, and usually there is œdema and redness of the lids and conjunctiva.

A periostitis situated in the depths of the orbit is more difficult of recognition and may only become manifest after

involvement of the cellular tissue of the orbit producing cellulitis or abscess. Either form may become absorbed or may lead to caries and subsequent formation of a fistula. The diffuse form gives rise to severe constitutional symptoms, such as high fever, delirium, headache, and stupor. Should the purulent material find its outlet posteriorly the result would be meningitis; if anteriorly, the result would be orbital abscess.

Treatment.—General treatment should be iodide of potassium combined with sodium salycilate or aspirin and such symptomatic treatment as will meet the requirements of the individual case. Locally hot applications frequently applied may aid in bringing the purulent processes to a focus, as well as give some relief to pain. An incision through the lid in the area of greatest swelling is indicated early in the disease in order that pressure may be relieved, and an outlet made for the passage of pus. This incision should be irrigated, wicked, and dressed daily.

Prognosis is on the whole good. Syphilitic cases respond to anti-syphilitic treatment and the localized form to incision and drainage. Cases extending posteriorly have a grave prognosis.

Caries is secondary to periostitis and as the particles of bone seek an outlet a continued inflammation is kept up until these are discharged. This frequently gives rise to a fistula. This condition is more frequently seen in tuberculous and syphilitic children than in adults.

Treatment.—Tubercular cases should have a tonic treatment of iron and cod-liver oil; they should have a suitable hygienic environment, and plenty of nourishing food. Fresh air and sunshine are of great value. Locally, irrigation and wicking may be sufficient, but in persistant cases incision followed by thorough curetting of the diseased bone is necessary.

Exostosis is occasionally seen and is usually found in the area of the frontal sinus. It is frequently accompanied by chronic suppuration of the frontal sinus. It produces displacement of the eye down and out and gives rise to

diplopia, lack of motion inward and upward, and, in marked cases, exophthalmos. The growth should be removed, but great care should be taken that the cranial cavity is not penetrated.

Cellulitis is an acute inflammation of the cellular tissue of the orbit which leads to suppuration, or orbital abscess. The condition is secondary to injury, sinus disease, diseases of the eyeball, and general septicæmia or pyæmia.

Symptoms.—There are usually constitutional symptoms such as pyrexia, chills, headache, and prostration. Locally there is a great œdema of the lids, exophthalmos, chemosis, marked pain both in the eye and head. There is usually considerable loss of motion, and consequent diplopia if the œdema of the lid is not so great as to cover the pupil. Vision may be normal or there may be an optic neuritis. In the absence of signs of neuritis the ophthalmoscope will usually reveal tortuous retinal veins. Pus makes its appearance in from four to seven days after the onset of symptoms, and fluctuation can be easily felt through the upper lid.

Diagnosis.—The condition is usually easily diagnosed, but great care is frequently necessary to determine the cause, which is of great importance in proper treatment of the condition. Thrombosis of the cavernous sinus will produce exophthalmos and œdema similar to orbital cellulitis, but in the former condition the constitutional symptoms are much more severe, and the ocular condition may be bilateral. Aside from this there is no suppuration in cavernous sinus thrombosis unless it be that the sinus thrombosis is secondary to accessory sinus disease; two cases of which have come under my care.

Treatment.—Constitutionally the treatment should be directed toward the reduction in temperature, which is accomplished by cold sponges or cold baths. The pain is relieved by mild analgesics at first, and if these fail, morphine. There should be given an active saline cathartic at once, and later the bowels kept freely open. Supportive treat-

ment in shape of easily assimilated nourishing food preferably in liquid form, also strychnia and alcohol. Locally hot applications frequently applied will relieve pain and hasten suppuration. Leeches to the temple may be of slight value. Deep incision into the inflamed area is indicated early; the incision should be wicked and a moist hot dressing applied. Care should be taken that drainage be properly kept up. It may be necessary to make two or more incisions. If any of the accessory sinuses are inflamed and suppurating, they should receive appropriate treatment.

Prognosis.—A cellulitis originating from without the eyeball rarely endangers this organ. Although sight may be lost subsequent to an optic neuritis. Mild and even moderately severe cases have on the whole a good prognosis. There is of course danger of extension backward to the meninges.

Tenonitis is an inflammation of the capsule of Tenon. The diagnosis is dfficult and is usually made by eliminating other orbital diseases. The condition is accompanied by chemosis, mild œdema of the lids, some limitation to the motion of the eye, and pain on motion of the eye. The inflammation rarely leads to suppuration.

Mild, local and constitutional measures are all that are necessary, as the disease is practically self-limited, symptoms disappearing in from two to four weeks.

Panophthalmitis is an inflammation of the entire eyeball, or really an acute purulent inflammation of the entire uveal tract, as mentioned in Chapter IX.

Etiology.—This condition is an infection following injury, or the result of operation. Penetrating injuries of the eye are the most frequent cause, especially if a foreign body remains in the eye. Another frequent cause is perforating corneal ulcer, especially accompanied by hypopyon. The condition may follow extraction of cataract, when the wound becomes infected.

Symptoms.—Early in the disease the condition is not unlike a severe irido-cyclitis. The cornea is hazy and infiltrated; the iris is tied down to the lens by numerous

synechiæ. The eye is greatly injected, and is painful on palpation. The lids are œdematous and there is usually quite marked chemosis. Pain is very severe, being relieved only by morphia. Tension is much diminished. Vision, of course, is greatly impaired and may be finally lost. The whole eyeball finally becomes infiltrated and purulent and is destroyed. There may be a secondary tenonitis and cellulitis producing the symptoms of these conditions described above. The eyeball may rupture, after which the symptoms gradually subside. The eye shrinks and assumes a condition known as phthisis bulbi.

Treatment.—General supportive treatment should always be given in connection with the local measures. It is also essential that the patient receive a saline purge and the bowels kept freely open. Mercury in the form of inunctions and protiodide pills is of great value in many cases. For pain we have hot fomentations frequently applied, and if necessary morphine. Should the case be seen early and the case be secondary to a severe ulceration of the cornea, a Sæmisch operation, as described in the chapter on the cornea, may be of great value and a means of saving the eye. Should the whole uveal tract be involved and suppurating this operation will have no value in saving the eye, but may be resorted to for relief of pain. Removal of the eye or its contents is indicated sooner or later, and perhaps the best procedure during the active stage is *evisceration.* For this operation the patient is anæsthetized and the lids held open by means of a large speculum. The cornea is entirely removed by means of a large flap similar to that of a cataract operation, and the remainder cut away with scissors. A good-sized curette is then inserted in the globe and the entire contents removed, leaving nothing but the white sclera. The cavity is then thoroughly irrigated, after which the optic nerve may be cauterized with 95 per cent. carbolic acid, or the lips of the sclera may be brought together and sutured without resorting to cauterization.

Mules's Operation is similar in technique to the above except that before uniting the wound a glass or gold ball

(Fig. 107) is inserted into the vitreous cavity by means of an instrument made for this purpose (Fig. 108). This serves the purpose of giving a good foundation for the shell of an artificial eye, which, owing to the fact that the muscles are still attached to the sclera, will have considerable motion.

The Mules operation causes great reaction and pain. Several ophthalmologists have reported sympathetic ophthalmia following this operation, which may or may not have been coincidental. It has no advantage over the simple evisceration and should not be performed.

Enucleation is not so generally practised in the treatment of panophthalmitis, because of the supposed danger of infecting the orbit. This danger I believe to be slight, yet on the whole evisceration seems the safer procedure. The

Fig. 107.—Glass balls for insertion in sclera in Mules's operation.

technique of enucleation is described in the chapter on injuries.

Orbital Tumors are of quite frequent occurrence and are either primary or secondary. Under this head must be discussed the different forms of exophthalmos that are seen.

Simple Exophthalmos is a symptom common to all orbital affections, especially tumors. It is also seen as a symptom of Graves's disease, and in ocular paralysis.

Pulsating Exophthalmos is due to an arterio-venous aneurism, caused by a rupture of the internal carotid artery into the cavernous sinus. The condition is directly due to traumatism. Pain is most always present, and ptosis is an accompanying symptom. A bruit may be heard over the eye and, occasionally, the forehead. Compression of the common carotid usually causes the bruit and pulsation to

cease. The cornea is usually clouded. Vision is impaired and the retina is congested.

Treatment consists in absolute rest in bed. The common carotid may be tied, or electrolysis, which has been reported successful in several cases, may be tried.

Prognosis is grave. The vision is usually impaired, even if life is saved. Some cases recover without treatment.

Thrombosis of the Cavernous Sinus is a severe affection which gives rise to certain ocular symptoms, such as exophthalmos, œdema of the lids, chemosis, partial or complete immovability of the globe, corneal haziness, and possibly corneal anæsthesia; there may also be congestion of the retina and an optic neuritis.

Treatment.—Thrombosis of the cavernous sinus following pulsating exophthalmos has been mentioned above.

Fig. 108.—Instrument used for placing glass balls in sclera.

Suppurative cases secondary to acute purulent disease of the accessory sinuses are almost invariably fatal. Extension backward to the cavernous sinus may be prevented by early recognition of accessory sinus disease.

Orbital Tumors are divided into those affecting primarily the orbital tissue, such as gummata, sarcomata, dermoid cysts, and vascular tumors and those secondary to ocular disease such as sarcoma, epithelioma, and glioma. The common signs of all orbital growths have been given. The primary orbital growths are:

Sarcomata, which occur with great rarity. When present the growth is rapid and is extremely painful. The treatment is exenteration of the entire orbital contents. It must be stated, however, that the X-ray has given excellent results in some cases and should be given a thorough trial if possible before resorting to exenteration.

Gummata occur in the orbital cavity, and are usually accompanied by bone complications. The condition is relieved by antisyphilitic treatment.

Cysts are almost invariably dermoid in character and can be made out as definite fluctuating masses which are usually palpated through the upper lid. They are of very slow growth and give rise to few symptoms. If large they may cause exophthalmos, diplopia, and displacement. There is little or no pain connected with them.

Treatment is extirpation. The cavity should first be tapped to be certain that we are not dealing with a meningocele.

Vascular Growths are usually congenital, and should not be operated upon unless they cause symptoms, or show signs of enlargement.

Secondary involvement of the orbit from the eye is not uncommon in glioma, sarcoma, and epithelioma. These cases usually require complete exenteration of the orbital contents after removal of the eye. The orbital cavity may be subsequently treated with the X-ray if there is a recurrence of the growth. Exenteration of the contents of the orbit includes all tissues, even the periosteum. It is usually possible to save the lids and their conjunctiva. When malignant growths have involved the orbital tissue secondary to the disease of the eye there are usually metastases elsewhere in the body. The operation of exenteration is, however, justifiable in the hopes of saving life.

Enophthalmos is a retraction of the eyeball, which may be congenital, but which usually follows injury. There is no treatment.

CHAPTER XVIII.

DISEASES OF THE LACHRYMAL ORGANS.

Diseases of the lachrymal organs are divided into those which affect the excretory portion, which includes the puncta, canaliculi, lachrymal sac, and nasal duct, and those which affect the secretory portion, which includes the lachrymal gland and the accessory gland. The excretory portion of the lachrymal system is by far the more liable to pathological change.

Epiphora is the overflowing of tears. This condition is not a disease but a symptom, and as it is a most common symptom of lachrymal disease, its cause will be briefly considered. The flow of lachrymal secretion is continuous and under normal conditions is drained off perfectly by the excretory ducts. The puncta dip backward into a small tear cavity in the conjunctiva and the tears are sucked into the canaliculi and from these pass into the sac. It follows from this that epiphora may be due to hypersecretion as in crying, or reflexly from some irritative disease of the eye. It is also due to displacement of the puncta or obstruction in any part of the outlet system. Certain cases of the absence of the puncta exist, but this condition is of extreme rarity, and if the physician be persistent and use a fine enough probe the puncta can usually be penetrated. Obstruction may lie anywhere between the puncta and the entrance of the nasal duct into the middle fossa of the nose. The most common place is in the nasal duct just as it emerges from the sac.

Facial paralysis is practically always accompanied by epiphora. Displacement is also caused in the various forms of ectropion and entropion, or by contractures for operations or burns.

Treatment.—Epiphora caused by displacement can, of course, only be relieved by operations on the cause of this displacement and should not, as is so frequently the case, be directed toward treatment of the lachrymal organs unless they have become involved secondarily.

Epiphora without signs of displacement, or obstruction as manifested by a mucocele, had best be treated by a mild astringent such as zinc sulphate, ½ grain to the ounce, followed by a three or four per cent. argyrol solution. This solution if passed readily into the nose will show a lack of obstruction and we should look elsewhere for the cause. Nasal obstruction, especially if there is pressure on the nasal end of the nasal duct, will require operative interference. Eye-strain will frequently give rise to epiphora and should receive appropriate correction by glasses, when the epiphora will disappear.

Lachrymal Blennorrhœa (Mucocele) (Plate V, Fig. 5) is a condition giving rise to epiphora and usually a collection of mucoid or muco-purulent material in the lachrymal sac.

Etiology.—The immediate cause is usually stricture in the nasal duct. Because of this stricture the tears accumulate in the sac and distend it. This accumulated fluid soon decomposes by germ action and produces an inflammation of the mucous membrane lining the sac.

Symptoms.—Epiphora is usually quite marked and annoying. The area of the lachrymal sac is swollen and more or less tense. Pressure over this area usually results in evacuation of the contents back into the conjunctival cavity through the puncta. This material is found to contain pus cocci in great numbers, but it does not as a rule infect the unbroken conjunctiva or corneal epithelium. Should, however, the corneal surface be broken either by injury or operation a virulent inflammation usually results, which may threaten the destruction of the eye. Hence all cases of corneal injury in the presence of lachrymal blennorrhœa need heroic treatment directed toward the lachrymal as well as the corneal condition. Operations on the

cornea are contra-indicated in the presence of lachrymal blennorrhœa.

Strictures of the nasal duct are secondary to inflammation of the nasal mucous membrane, tumors, or ulceration. The various forms of inflammation of the nasal mucous membrane are acute rhinitis, chronic rhinitis either of the atrophic or hypertrophic variety, and the various forms of tubercular and syphilitic inflammation. The inflammation extends directly from the nasal cavity into the nasal duct giving rise to swelling and consequent stenosis. Engorgement of the blood-vessels, which accompanies the inflammation of the nasal mucous membrane, is in itself sufficient to cause obstruction of the nasal duct. Ulceration extends also into the nasal duct from the nasal cavity, and these in healing give rise to strictures. This form of stricture is frequently met with in children suffering from syphilis, or who have a tubercular tendency. *Tumors* in the nasal cavity which press upon the duct and exclude it are usually enlarged turbinates or polypi occurring in the course of a chronic rhinitis.

Mucocele is essentially chronic in its course, and even if correctly treated extends over a long period of time. There is constant danger of the chronic inflammation becoming acute and giving rise to an acute dacryocystitis. Rarely under local treatment of the nose the lachrymal condition will become spontaneously cured. All cases of lachrymal obstruction should have thorough nasal treatment when such is necessary. In sixty cases of lachrymal obstruction examined by me in 1906, 50 per cent. showed appreciable nasal inflammation. The lachrymal sac from over-distention finally becomes atonied and is no longer able to perform its function. Should a blennorrhœa be stopped at this stage by rendering the nasal duct patent, epiphora may persist through lack of a suction action on the tears. The distended sac may grow to large proportions and in some cases may even cause displacement of the eyeball, giving rise to symptoms similar to a tumor of the orbit, which in reality it becomes.

Treatment.—Most text-books say far too little in regard to preliminary treatment of lachrymal blennorrhœa, but jump immediately into a description of the treatment by means of probes. It is undoubtedly essential that there be a free passage into the lachrymal sac and from there into the nose, but in order to make this passage it is not necessary in most cases either to slit the canaliculus or use a probe greater in diameter than a Bowman No. 8 (Fig. 109). The greatest good arises from a thorough syringing of the

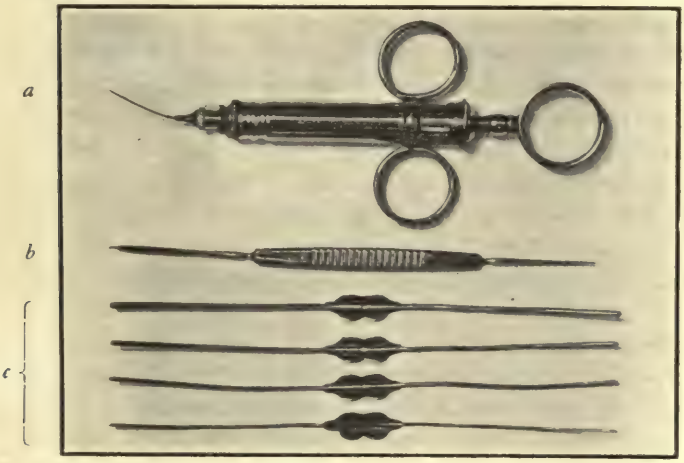

Fig. 109.—Instruments necessary to syringe and probe lacrimal sac. *(a)* Syringe; *(b)* dilator and canaliculus knife; *(c)* Bowman's probes Nos. 1 to 8.

lachrymal sac before resorting to the use of probes to dilate the stricture in the nasal duct. The lower punctum which can practically always be opened with a very fine pointed dilator is carefully enlarged so that it will admit easily the fine point of a syringe canula and the sac washed out through the upper punctum. If the case is recent some fluid may run into the nose, but this is rare at this stage of the treatment. For syringing I use a normal salt solution or a 3 per cent. boracic acid solution, wishing merely to get the mechanical effect of the fluid. After the sac is well washed out a few

drops of a mixture of 4-per cent. cocaine and adrenalin chloride is injected into the sac and allowed to remain there for a few moments. Then into the sac is injected a 10 per cent. solution of argyrol. The solution is allowed to remain in the eye, the patient being told to watch for its appearance in the nose. Snyder, in an article on "The Treatment of the Duct Without Operation,"[1] says he forces, or attempts to force, a very weak solution of argyrol through the nasal duct, even clamping the upper canaliculus, but I have had just as good results with less trauma by merely allowing a 10-per cent. solution to remain in the sac as long as it will. After one or two such treatments the patient will usually report a brown stain on the handkerchief after blowing the nose. In giving local treatment I of course infer that any nasal trouble shall, at the same time, receive appropriate treatment. This treatment may be repeated every other day for a week or two, the patient simply bathing the area three times daily with very hot water, and instilling into the eye a $^1/_{2000}$ sulphate of zinc solution the base of which is $^1/_{5000}$ adrenalin chloride. Usually at the end of ten days or two weeks there is much less discharge and much less epiphora. There is also more evidence of argyrol in the nose. If the patient is comfortable and there is little or no epiphora I continue the treatment using more force in syringing and getting more fluid into the nose. This treatment in itself may be sufficient to cure some cases. The more obstinate cases I probe at the end of about two weeks. Before probing, the sac is carefully cleaned out and the cocaine and adrenalin solution injected into it; the punctum is then dilated enough to admit a No. 3 Bowman easily, and as the probe strikes the beginning of the nasal duct the pressure is very gradually increased until the probe passes the stricture or the pressure becomes so great that only damage is likely to result. If this is the case the probe is withdrawn and further effort deferred until a day or two later. Should the probe have

[1] Ophthalmology, October, 1906.

passed easily it is withdrawn and a No. 4 passed. No. 8 probe is the highest I use, as this can be passed without slitting the canaliculus or at most by making a nick in the punctum with a pair of scissors. Probing and syringing is kept up until all symptoms disappear or until this method has proved a failure. Should the treatment fail after two or three months and annoying symptoms persist, extirpation of the lachrymal sac should be advised. This can be accomplished much better in the mucocele stage than after a dacryocystitis.

Extirpation of the Lachrymal Sac is accomplished under general anæsthesia. The sac is thoroughly cleaned out and may or may not be redilated with paraffine. If dilated with paraffine the outlines are more easily made out and the operator aided in his work. The initial incision is down and slightly out over the area of the sac and through the internal palpebral ligament. The incision should extend through the skin to the sac, but not into it. The sac can be told from surrounding tissue by its grayish color.

It can then be carefully dissected from its cavity, preferably from its nasal side first. If care is taken it can be removed whole. After removal the skin is brought together with interrupted sutures. It is unnecessary to wick the wound. The scar resulting from the operation will usually entirely disappear. Following this operation there is rarely any epiphora; I should say none in those cases in which the sac has been entirely removed. From this it can be readily seen that the combined operation of removal of the sac and gland is unnecessary.

Obliteration of the sac by means of caustics has been practically given up in recent years, but has some value in cases not easily dissected out.

Dacryocystitis is an acute inflammation of the lachrymal sac. The condition is always secondary to lachrymal obstruction and usually to lachrymal blennorrhœa.

Symptoms.—The area of the sac is greatly swollen, reddened and hot. Patients often call the condition erysipelas. The pain is very marked and there is usually second-

ary œdema of the lids and a purulent or muco-purulent conjunctival inflammation. There is increase of temperature and usually fever. If the condition remains untreated the abscess will point in a few days and spontaneously rupture through the skin, evacuating a large amount of pus. After which the symptoms all gradually subside until the discharge through the opening becomes perfectly clear, thus forming a lachrymal fistula; or the skin may heal and give rise to frequent exacerbations of abscess formation. Should a fistula form there is no danger of purulent inflammation as long as it stays open.

Dacryocystitis results in an infection of the tissue lying around the sac and in healing almost invariably results in a lachrymal obstruction which cannot be relieved by probing.

Treatment.—Cases seen very early may be aborted by thorough irrigation of the sac, followed by filling the sac with 10 per cent. or 20 per cent. argyrol. This should be accompanied by frequent bathing in hot water and the use of argyrol as a collyrium. Ordinarily the case is seen too late for such treatment and incision and evacuation are indicated. The incision is made over the area of the sac well into its substance, the pus evacuated, the cavity irrigated thoroughly with $^1/_{2000}$ bichloride, after which a wick of iodoform gauze is inserted and a hot moist dressing applied. The wound should be kept open and the cavity thoroughly cleaned out daily until it heals. Granulation may destroy the sac and prevent further trouble.

In some cases it may be possible to probe the old stricture and permit of drainage through the proper channels. Most frequently the sac is not destroyed, the stricture remains and the condition requires extirpation for its relief.

Disease of the Lachrymal Gland is very rare. Occasionally it is the site of a purulent inflammation (dacryoadenitis) in which case there is abscess formation and discharge of pus through the lid. Tuberculosis of the gland has been observed, as have also cysts and new growths such as carcinoma, adenoma, sarcoma, etc. Atrophy of the

lachrymal gland occurs in xerosis and pemphigus conjunctivæ.

Extirpation of the gland is sometimes performed for diseased condition or as an accompanyment of extirpation of the sac, although the latter is very rarely necessary. The site of the incision may be in the outer part of the area of the eyebrow or just beneath the outer part of the superior orbital ridge. The gland is found in a recess in the frontal bone just inside the ridge of the orbit. The accessory gland which lies beneath the conjunctiva of the upper lid is not excised in this operation.

CHAPTER XIX.

INJURIES AND SYMPATHETIC OPHTHALMIA.

INJURIES to the eye and its appendages are among the common causes of ocular trouble. Their classification is important and will be considered separately in this chapter, especial stress being laid upon penetrating injuries through the ciliary region and intra-ocular foreign bodies.

Lids.— The most frequent injuries of the lids are abrasions, cuts, and burns. In 205 cases of recent injury treated at the Massachusetts Charitable Eye and Ear Infirmary in 1906, twenty-two cases showed lid injury, either alone or complicated with injury to other parts. The most severe injuries to the lids are caused by burns, for these in healing give rise to contractures which produce entropion or ectropion, or, if the conjunctiva is involved, the various forms of symblepharon. Penetrating injuries of the lids heal with great readiness, because of abundant vascularity, and leave little or no scar. Ectropion, entropion and symblepharon require operative interference for their correction. The operative measures have been described in previous chapters. Other lid injuries are treated according to general surgical rules. Those cases in which the orbicularis muscle has been separated need deep suturing in the hope of reuniting the muscle.

Conjunctival Injuries are very frequent and occur in all penetrating injuries of the eye except those involving the cornea alone. Slight cuts or abrasions of the conjunctiva are very apt to involve a conjunctival vessel or vessels and produce a sub-conjunctival ecchymosis, a condition which may alarm patients out of all proportion to its severity. Such abrasions or cuts heal rapidly under mild antiseptic treatment; larger cuts need one or more sutures. Burns

of the conjunctiva are serious because of the great tendency toward ulceration and subsequent formation of symblepharon. Foreign bodies often lodge in the conjunctiva and require excision for their removal, a favorite site for the lodgment of cinders, particles of dust, etc., being in the concavity of the upper lid formed by the tarsal cartilage. Eversion of the lids brings their area into view, when the particle can be easily removed with a piece of moist cotton.

Corneal Injuries are divided into the non-penetrating and penetrating. Non-penetrating injuries consist in cuts, abrasions, foreign bodies, etc. Should, however, there be a lachrymal obstruction with blennorrhœa the denuded surface is liable to become infected and serious ulceration result. Foreign bodies in or on the cornea frequently require surgical interference before they can be removed. They are usually removed as follows: The eye is flushed out with normal salt solution, or some similar bland wash and then 4-per cent. cocaine instilled two or three times. A sterilized eye spud is then passed around the particle to loosen it, when it drops out readily as a rule. Should the spud be insufficient for this purpose, a needle usually used for secondary cataract operations will dislodge the foreign body. Hot cinders frequently leave a brown zone in the area of the foreign body and this should also be carefully removed in order that the surface may heal rapidly, and that there may be left no scar. No treatment is necessary other than through irrigation after the simpler cases. Large denuded areas will require the application of some antiseptic ointment in the conjunctival cavity for a day or two following the removal of the foreign body. Abrasions and cuts are similarily treated.

Penetrating injuries of the cornea evacuate the anterior chamber and may or may not cause injury to the iris or lens. Flying particles of metal usually penetrate into the vitreous cavity, although I have seen several cases in which the foreign body has been successfully removed from the anterior chamber of the eye, the particle having spent its force in penetrating the cornea. If particles remaining in

the anterior chamber are of iron or steel they can be readily removed with the small tip of an electro-magnet, which is inserted into a corneal incision. Should the particle be non-magnetic the ingenuity of the operator may be called into play for its removal. A successful method in such an instance is to place the patient in such a position that the foreign body floats to that portion of the cornea through which an incision is to be made. The rush of aqueous following the incision will carry out the foreign body.

Penetrating injuries of the cornea frequently cause *prolapse of the iris* into or through the wound. If such cases are seen early the iris may be replaced successfully. Usually, however, it becomes incarcerated and needs to be excised before the remaining portion can be replaced, or, failing in this, before the wound can heal.

Injuries of the Ciliary Body are always serious because of the tendency of such wounds, even in the absence of direct infection, to cause a plastic irido-cyclitis, which is a danger signal for possible sympathetic ophthalmia in the uninjured eye. A zone corresponding to about 5 mm. in width, which immediately surrounds the cornea is called the danger zone, because wounds in this region involve the ciliary body, and are extremely serious. Penetrating wounds of the sclera outside the danger zone are not serious in the absence of much loss of vitreous, in the absence of direct infection, and where there is no foreign body lodged within the eye.

Treatment of all penetrating wounds of the globe *without* intra-ocular foreign body is cleanliness, atropine to dilate the pupil and keep the ciliary muscle to rest. A bandage is usually of assistance, and should be removed twice daily for irrigation and other treatment. An ointment of nosophen 25 per cent., or the pure powder, put in the conjunctival cavity twice daily is of distinct advantage in infected cases. For pain, hot fomentations and leeches are of great value. The vision of the good eye should be tested as soon after the injury as possible and a careful record made of it, which can be referred to. Should the patient

have a refractive error in the uninjured eye the vision should be taken with the correcting glass before the eye. A visual test of the uninjured eye should be made at least every other day, and the eye carefully watched for symptoms of sympathetic involvement. Should the injured eye remain in an irritable condition and refuse to respond to treatment, or grow worse under treatment, enucleation should be advised, in order to prevent, in so far as possible, sympathetic ophthalmia. This is especially true if the injury is in the ciliary region, or when there is a marked incarceration of the iris in the wound.

Non-infected wounds of the sclera heal quite readily and are not considered dangerous. Infected wounds on the contrary invariably induce panophthalmitis, which condition requires evisceration. Where the vitreous prolapses through the scleral wound it should be cut off and the lips of the wound held in apposition by means of a snug bandage.

Rupture of the sclera which usually follows a blow on the eye is serious because of the usual coincident rupture of the choroid and intra-ocular hæmorrhage. The tension in these cases will be found diminished, and should the absorption of the hæmorrhage progress slowly with an absence of good light projection it is advisable to enucleate, as such an eye will not regain its function and will slowly progress to phthisis bulbi.

Penetrating Injuries of the Eye, with Intra-ocular Foreign Bodies, are extremely serious, and besides the treatment described under penetrating injuries they require additional measures which are directed toward the location and removal of the foreign body.

Diagnosis is largely made by the history of the injury and a careful questioning in regard to the character and material of the tools used at the time of the injury. A fresh scar on the hammer or other tools would at once give a clue. The character of the wound would also be of value together with examination of the fundus, if possible. For this purpose the pupil should be widely dilated with atro-

pine. The X-ray is of greatest value in diagnosing and locating intra-ocular foreign body, especially in conjunction with some localizing method. Sweet's method of localizing intra-ocular foreign bodies, with his charts for record, is without doubt the best known and the most practical. The giant magnet of Haab will in most cases reveal an intra-ocular foreign body if it be of iron or steel. Probing for a foreign body in the globe is an unjustifiable procedure, and is unnecessary with our present methods of diagnosis.

Symptoms are those of an injury to the eyeball which has penetrated the iris, ciliary body, or sclera. The wound of entrance can be made out somewhere in the anterior segment of the eye. As mentioned under diagnosis the ophthalmoscope may reveal a foreign body in the retina or vitreous, or may show a whitish streak through the lens where the foreign body has penetrated. A blood streak in the vitreous would be a similar guide. Usually, however, the lens or vitreous is so opaque that ophthalmoscopic examination is impossible. In many instances the foreign body carries infection into the eye which sets up a panophthalmitis, but in the majority of instances the eye does not become infected.

Treatment.—Foreign bodies cannot with safety be allowed to remain within the eye. Should the foreign body be of iron or steel it can usually be removed with the electro-magnet. In my opinion the giant magnet is of value only for diagnostic purposes, and then only after extraction by means of the small magnet has failed. The magnet which has given the best satisfaction in my hands is one devised by Heckel (Fig. 110). This magnet can be attached to any street current and the make and break is easily made by an assistant. The magnet contains a long bar with one blunt and one sharp end. The bar is removable and can be easily sterilized. It is also adjustable so that a strong or weak effect can be obtained.

The patient is placed on the operating table and the eye cleaned and cocainized. The lids are held apart by means of a non-magnetic eye speculum and the small point

of the magnet gently inserted into the original wound of entrance; then the current is turned on. The patient usually has a slight sensation of pain in the eye and the operator can frequently feel a little tug at the magnet. The tip is then slowly withdrawn, on which will frequently be found the foreign body. In some instances it is necessary to enlarge the wound or make an entirely new incision. Should a new incision be necessary it must be made either in the cornea or the sclera, not in the danger zone. After extraction of the foreign body the eye is treated as described under penetrating wounds of the eye.

Should the history chiefly point toward magnetic metal in the eye and extraction with the small point of the magnet fail, the blunt end of the magnet may be placed over the

Fig. 110.—The Heckel electromagnet.

wound of entrance and the current turned on. This will frequently start a particle that the small end has failed to reach; the result will be shown by pain or a localized bulging in the area of the wound, or wherever the magnet end may be placed. Should this fail we are justified in using the giant magnet which has more power, but at the same time is more destructive. Large pieces of iron or steel sometimes cause more damage in their removal than in the original injury. Intra-ocular foreign bodies which cannot be removed by magnetic force require enucleation or evisceration of the eye, because of the great danger of causing sympathetic ophthalmia. Enucleation is the operation of choice in a non-infected eye, and eviscreation when the eye is in a condition of acute infection or panophthalmitis.

Sympathetic Ophthalmia is a condition wherein the inflammation of one eye suffering from irido-cyclitis is

carried to the other. The inflammation appearing in the eye previously sound is also an irido-cyclitis.

Etiology.—This condition is largely secondary to penetrating wounds of the eyeball, especially wounds which have penetrated the ciliary region (danger zone), and in cases where the intra-ocular foreign body has not been removed from the injured eye. Irritable eyes which refuse to become quiet after treatment, old cases of perforating corneal ulcers, and phthisis bulbi are occasionally causative.

Theories of Manner of Extension are numerous and none have been really satisfactory. Mackenzie first called attention to the fact that the condition was a secondary one and he believed that the inflammation was a direct extension along the optic nerve. This theory was later given up because the inflammation in the second eye was not an optic neuritis, but an irido-cyclitis like the offending eye. The ciliary nerves were later held responsible for the extension of the inflammation. This was also given up and the theory now most advocated is the extension along the optic nerves either through irritation or direct infection by migratory bacteria or toxins.

Symptoms.—The majority of cases are preceded by prodromal symptoms of a well-defined character. These symptoms are eye strain, and blurring of vision because of lessened power of accommodation. Photophobia is another common symptom and a diminished visual acuity for distance. These symptoms last for a comparatively short time and soon the eye assumes the appearance of irido-cyclitis.

Irido-cyclitis is manifested by ciliary injection, discolored iris, contracted pupil with posterior synechiæ, muddy aqueous, opacities in the vitreous, diminished vision frequently reduced to mere light perception, deposits on the membrane of Descemet, much pain, lachrymation, photophobia and tenderness on palpation, in fact the classical symptom of a severe irido-cyclitis.

Sympathetic inflammation is most likely to occur at the height of the inflammation in the offending eye, hence it is to be looked for in from four to eight weeks after the

injury. It may occur, however, at any time following a severe irido-cyclitis due to injury in one eye, especially if the offending eye remains irritable. An intra-ocular foreign body is a source of constant irritation and even if it becomes encapsulated is always dangerous. Eyes which have become free from inflammation and which do not contain a foreign body are not dangerous so long as they remain free from inflammatory symptoms, tenderness, or pain. Such an eye should be frequently palpated in order to be certain that it is quiescent. It can thus be seen that sympathetic inflammation may occur as early as three weeks following injury, but there is no real limit to the maximum amount of time that may elapse before involvement of the other eye.

Treatment should be mostly directed toward prophylaxis in that an eye once involved with sympathetic inflammation is in a very serious condition and may become entirely lost. An injured eye which has become sightless and remains irritable should be removed. This is especially true if the injury has been in the danger zone or the eye still contains a foreign body. A patient must be told of the danger of sympathetic involvement, and should the injured eye remain painful and tender to pressure consultation should be advised and responsibility shared if operation is refused by the patient.

Should the injured eye retain some useful vision the question of operation is difficult to decide. If the injured eye in this instance remains painful, tender and irritable, operation of enucleation may be justifiable. It must be borne in mind that delay is frequently dangerous. I have seen but three cases of sympathetic ophthalmia and they all occurred in cases where the injured eye retained some vision, and strangely enough the sympathetic involvement followed enucleation of the injured eye. Enucleation in each instance had been advised and refused on the average of three weeks previous to sympathetic involvement. From this it can be readily seen that enucleation of the offending eye after sympathetic inflammation has begun is of no avail. Frequently an injured eye may in the end have more useful

vision than the one sympathetically involved. If, however, the offending eye is blind it should be enucleated in order that it may not aggravate the condition in the sympathetic eye.

The treatment after sympathetic ophthalmia has developed is that of a severe irido-cyclitis, described in Chapter IX.

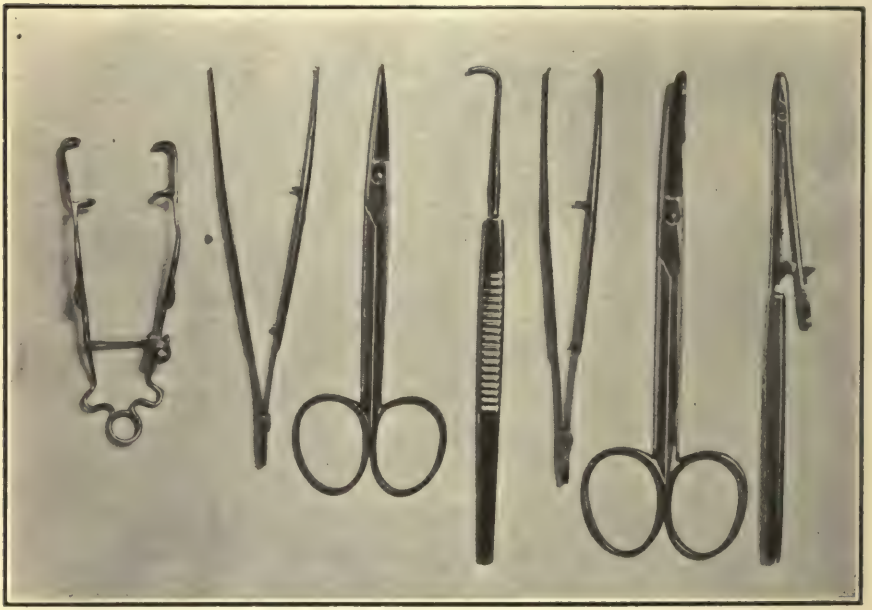

Fig. 111.—Instruments necessary for the operation of enucleation.

Prognosis is exceedingly grave. Vision may be altogether lost. Treatment, however, should be carried out heroically, for some cases do regain useful vision.

Enucleation (Fig. 111).—A general anæsthetic is necessary, although rarely the operation may be performed under local anæsthesia. After the lids have been separated with the speculum the conjunctiva near the cornea is seized with forceps and this membrane cut immediately around the limbus. The conjunctiva is then dissected up as far back as

the insertions of the four recti muscles. A tenotomy hook is then inserted under the recti tendons and these are cut in succession as near the scleral attachment as possible, with the exception of the internal rectus. A small tag of this muscle is left in order that it may be grasped with fixation forceps when the optic nerve is cut. After cutting the four recti the globe can be dislocated forward through the palpebral fissure. The next step is to grasp the tag of the internal rectus tendon left attached to the sclera with a pair of fixation forceps, and then pass the large curved scissors (blades closed) back to the optic nerve, which readily is felt with the blunt point. It is best to insert the scissors on the nasal side as the nerve is thus more easily reached. After the nerve is felt the point of the scissors is passed backward, the blades opened and the nerve cut; care must be taken that a tag of the nerve is left attached to the globe. The globe is now easily pulled out of the orbital cavity, the two oblique muscles cut close to the sclera and the globe is free. Considerable hæmorrhage may follow enucleation, but it can readily be checked by irrigating the orbital cavity with quite warm saline. The operation had best be completed by a purse string suture of the conjunctiva and Tenon's capsule. This procedure gives a better looking socket.

CHAPTER XX.

THE RELATION OF THE EYE AND THE NOSE.

WITHIN the past ten years the effect of diseased nasal conditions on the eye has received a great deal of attention, especially in Europe, and our knowledge has advanced to such a point that the intimacy of this relation and its far-reaching effects must receive special consideration.

The relation between lachrymal blennorrhœa and nasal inflammation has been recognized for many years. Seifort in 1898 reported thirty-eight cases of lachrymal blennorrhœa in which nasal diseases were found in all but seven cases, and in another series of forty-eight cases examined by him nasal disease was found in all. In sixty cases of lachrymal obstruction examined by me in 1906 but 50 per cent. showed appreciable nasal disease, and yet this does not of necessity preclude the fact that a greater number than 50 per cent. might have been originally caused by nasal inflammation. Mechanical obstruction of the nasal end of the lachrymal duct may be caused by congestion, enlarged inferior turbinates, crusts, spurs, and enlarged middle turbinates, which crowd down the lower turbinates. Tumors, ulcerations, and cicatricial contractions must also be considered causative.

It is undoubtedly true, as Friedreichs says, that, "It is often difficult to determine at a single examination whether or not there is any connection between the nose and the eye, as the condition in the nose is much influenced by the presence of swelling, and the amount of the mucus is variable, especially in scrofulous patients, who furnish the bulk of the material." I have frequently had a lachrymal case referred back to me as negative by the rhinologist, who has at some further examination found nasal disease, or at

least marked traces of former nasal trouble. Some rhinologists go so far as to say nasal disease is responsible for less than 10 per cent. of the cases of lachrymal blennorrhœa. I believe the percentage to be above 50.

The phlyctenular conditions of the eye are almost invariably dependent upon nasal or post-nasal disease. At the Massachusetts Charitable Eye and Ear Infirmary, where from 30,000 to 35,000 new cases are treated yearly, there is seen one case of phlyctenular involvement of the conjunctiva or cornea in every thirty-seven cases. This clinic is rich in opportunity for the observation and study of this condition, and I have repeatedly demonstrated that practically every case is dependent upon nasal or post-nasal disease. Local treatment of the eye combined with suitable hygienic measures will be sufficient in many cases to give an apparent cure, but it is usual to see these cases relapse after a varying period of time if the nose does not receive appropriate treatment in conjunction with the ocular and general measures.

Scrofulous rhinitis of the purulent or muco-purulent variety is the most common etiological factor. Adenoids, enlarged tonsils, and hypertrophied conditions of the nose are also seen with great frequency. The vast majority of cases of phlyctenular involvement of the eye will continue to relapse just as long as the nasal or post-nasal condition remains neglected.

Disease is transmitted from the nose to the eye in three ways; by way of the naso-lachrymal duct, through the blood-streams, and by way of the nerves. Perhaps the most important of all these routes is the naso-lachrymal duct. Aside from the phlyctenular inflammation alluded to above, many other diseases originate in this way. Seifert reports many cases of spreading ulcer of the cornea in patients whose nose showed an atrophic rhinitis; Fuchs mentions ozena as a common complication of trachoma; while many authors assume a definite connection between trachoma and disease of the nose. I have constantly failed to find such connection except in so few cases that they must be con-

sidered coincidental. Transmission of tuberculosis from the nose to the eye has been observed by Fuchs and I had under my care two cases of diphtheritic conjunctivitis which manifested a nasal diphtheria; which was the primary lesion in either case I am not able to state, as the membrane was present in both the eye and the nose when the cases came under my observation. That infection can spread downward toward the lachrymal canal as well as upward has been demonstrated by Miller, who repeatedly found gonococci in the diseased nasal mucous membrane of infants suffering from ophthalmia neonatorum.

There is an intimate relation between the vascular system of the nose and the eye; especially seen in the arterial anastomosis by means of the ethmoidal arteries, by branches of the ophthalmic artery, and a collateral trunk along the naso-lachrymal duct. There is an intimate connection also between the veins of the lachrymal plexus, nose, face, and orbit, besides the ethmoidal veins which run from the nose to the orbital and cranial cavities. Through this intimate vascular system, it can readily be imagined, pass many bacteria giving rise to secondary inflammatory conditions in the eye. Ziem has observed several cases of iritis which improved only after treatment of the nasal inflammation, and Kuhnt agrees with the observation of Zeim. According to the theory of Ziem, who lays great stress on the connections of the vascular system, it is possible for the whole uveal tract to become infected from the nose.

Haskell has had under observation two cases of typical monocular glaucoma which were relieved entirely by operation on hypertropic conditions of the nose. Haskell's cases may possibly be more properly classified under nervous reflex conditions and yet the vascular connection seems more logical.

The fifth nerve supplies a portion of the nose through its nasal division which explains the reflex sensations felt in the nose following irritation of the ciliary nerves, as, for instance, in inflammatory disease of the eye. Reflex nervous

irritation from the nose to the eye is by far the most common. Seifert has described a ciliary neurosis due to nasal synechia following extensive cauterization of the nose. There is no doubt in my mind that reflex nervous irritation is the cause of severe symptoms of asthenopia. The asthenopia may be due to muscular insufficiency or to an apparently irregular contraction of the ciliary muscle. I have repeatedly examined patients whose astigmatism changed its axis three or four times during one examination. This, of course, was without the use of a mydriatic. In nearly all such cases there has later been found nasal or accessory sinus disease, the vast majority showing a hypertrophic condition of the turbinates. Certain cases suffer from what Haskell calls a "potential contact," that is a contact in the nose which is only present at times. On days in which the turbinates are not in contact with the septum the patient suffers no ocular symptoms. Other days when the nose does not offer free passage of air the ocular symptoms return. Such cases as these, even if the refraction is corrected by mydriatic test, cannot wear their glasses with comfort, and it is not until nasal obstruction is relieved, usually by operation, that the refractive error remains constant and the ocular symptoms disappear. Most of my cases showed this variation in the axis of the astigmatism on but one side, and the nasal examination revealed most congestion and hypertrophy on the corresponding side. Muscular insufficiencies are also caused by enlarged turbinates, spurs, deviations of the septum and other nasal conditions, but in the muscular cases we usually find accessory sinus disease. One case, which I reported,[1] manifested an esophoria, varying from 6 to 60 prism degrees, which disappeared entirely after the removal of each enlarged middle turbinate and curettage of the anterior ethmoidal cells. Fish, in his study of thirty-six cases of optic neuritis, in which accessory sinus disease was found in twenty-six, mentions muscular insufficiency as a marked and usual symp-

1 Boston Medical and Surgical Journal, March, 1907.

tom. Posey has also called attention to the numerous cases of muscular insufficiency caused by sinus disease. The great number of cases of irregularity in the muscle-balance, which show nasal or accessory sinus disease, has let me make the statement that patients suffering from muscular error

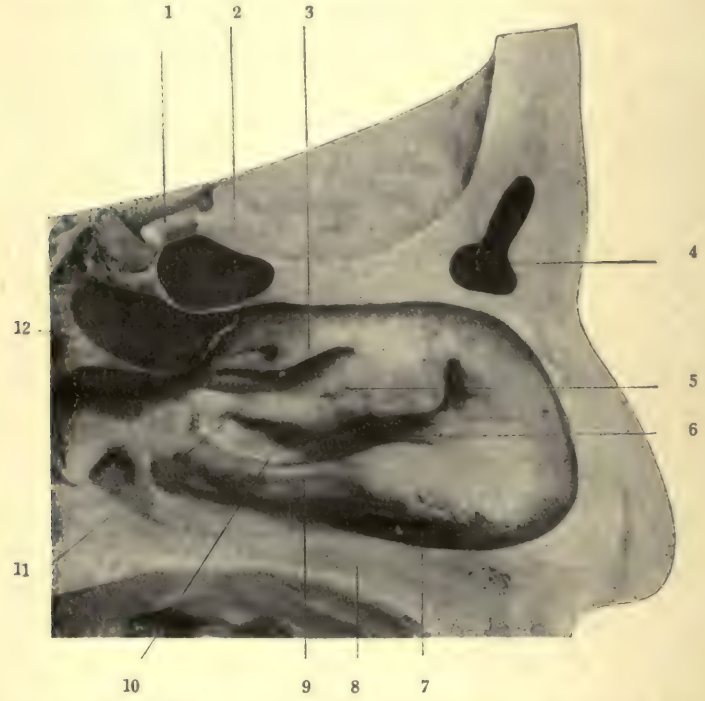

Fig. 112.—A plate showing the anatomical relation between the eye, the nose, and its accessory sinuses (reduced). *(O'nodi.)*

1. Left optic nerve. 2. Posterior ethmoidal cells. 3. Superior turbinate. 4. Frontal sinus. 5. Middle turbinate. 6. Maxillary bone. 7. Inferior meatus. 8. Palate. 9. Inferior turbinate. 10. Middle meatus. 11. Superior nasal meatus. 12. Left sphenoidal sinus.

should have a thorough nasal examination and treatment of the nasal disease, if found, before resorting to the use of prisms, or before performing tenotomy or partial tenotomy for correction of these errors. The operative treatment of muscular insufficiency has given rise to more neurasthe-

nics and less relief than any other form of ophthalmic treatment in recent years.

Laurens reports a case of blepharospasm which disappeared after operation on nasal synechiæ and removal of enlarged turbinates. Bernstein reported improvement in errors of refraction after removal of nasal hypertrophies.

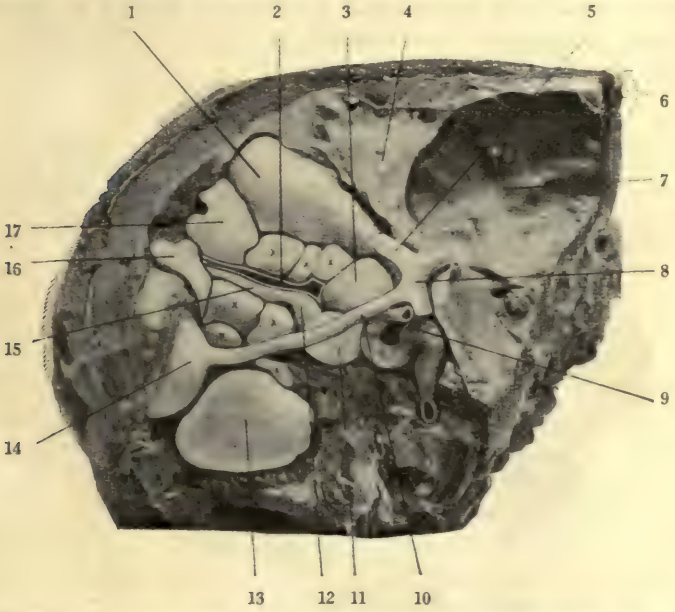

Fig. 113.—A plate showing the anatomical relation between the eye, the nose, and its accessory sinuses (reduced). (*O'nodi.*)

1. Supraorbital plate. 2. Nasal cavity. 3. Right sphenoidal sinus. 4. Scala anterior. 5. Right optic nerve. 8. Chiasm. 9. Internal carotid artery. 10. Left optic nerve. 11. Left sphenoidal sinus. 12. Left sphenoethmoidal recess. 13. Left maxillary sinus. 14. Globe of left eye. 15. Left olfactory ridge. 16. Left frontal sinus. 17. Right frontal sinus. xxxxxx=Anterior ethmoidal cells.

There are many observers who report from one to a series of cases which confirm the close intimacy in many instances between the nasal hypertrophy and ocular disturbances.

Hypertrophic and polypoid changes in the nasal cavities most always accompany disease of the accessory sinuses, which may in themselves cause similar symptoms to those already described. The ocular symptoms of acute accessory

sinus involvement, in a measure, differ slightly from the symptoms caused by nasal obstruction *per se*. Headache, for example, is an almost constant symptom in accessory sinus trouble; it is most always unilateral; it does not depend upon use of the eyes; it is more severe in the morning than later in the day, and is greatly accentuated when the patient stoops for anything. A catarrhal history is usually elicited, but this is by no means necessary. The headache

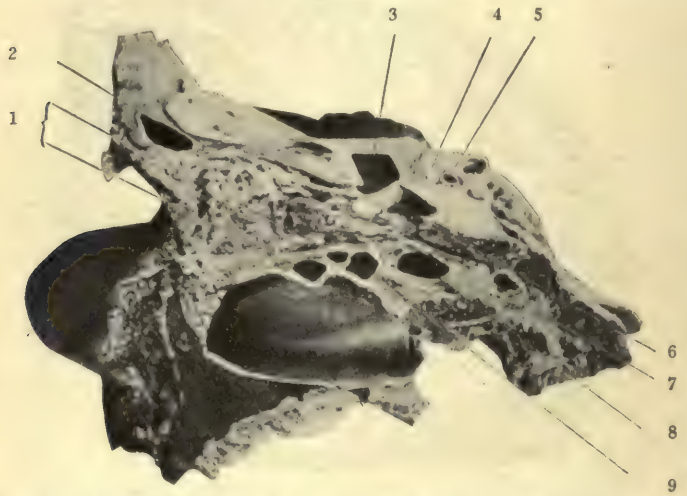

Fig. 114.—A plate showing the anatomical relation between the eye, the nose, and its accessory sinuses (reduced). (*O'nodi.*)

1. Ethmoidal cells. 2. Frontal sinus. 3. Posterior ethmoidal cells. 4. Optic nerve. 5. Internal carotid. 6. Optic canal. 7. Optic nerve. 8. Sphenoidal sinus. 9. Posterior ethmoidal cells.

may be paroxysmal in character and simulate closely a migraine. Treatment of the nose with thorough drainage and possibly irrigation of the sinus will relieve all ocular symptoms. I am in the habit of referring all cases of monocular headache to the rhinologist, as, in a vast number of cases, they are due to nasal or accessory sinus disease.

Purulent sinus disease especially of the frontal causes various ocular symptoms by direct transmission of the infection to the orbital cavity. Kuhnt described the suppura-

tion as attacking the bony wall of the sinus, then by means of small vessels (or necrosis) this infection is passed to the periosteum of the orbit, where it causes a periostitis or a subperiosteal abscess, which in time becomes an orbital abscess with exophthalmos, limitation of motion, pain, tenderness, etc. The condition may stop here by rupture

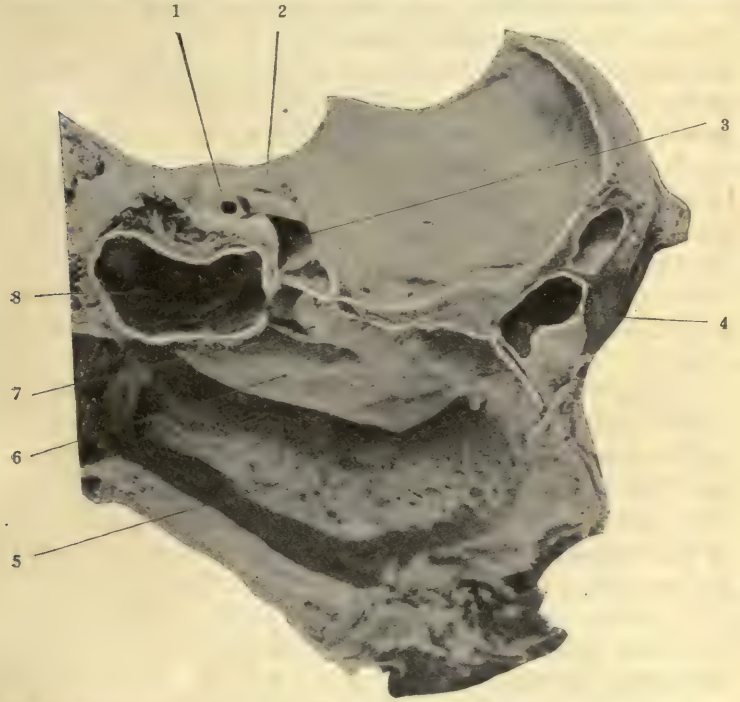

Fig. 115.—A plate showing the anatomical relation between the eye, the nose, and its accessory sinuses (reduced). (*O'nodi.*)

1. Internal carotid. 2. Optic nerve. 3. Posterior ethmoidal cells. 4. Frontal sinus. 5. Inferior turbinate. 6. Middle turbinate. 7. Superior turbinate. 8. Sphenoidal sinus.

forward or incision, or it may cause thrombosis of the central vein of the retina with subsequent panophthalmitis. Further complications may be extension to the cavernous sinus, brain, or general pyæmia. The infection may extend through the pterygoid plexus posteriorly, or anteriorly to the facial veins with subsequent pyæmia. Two cases have

come under my observation with involvement of the cavernous sinus and subsequent pyœmia, which had been treated by poulticing a supposed lid abscess until the patients were practically moribund. In both instances the primary infection was in the frontal sinus which had broken through the floor of the sinus into the orbital cavity.

Fish reports thirty-six cases of optic neuritis, twenty-six of which had accessory sinus disease. Treatment of the sinuses in the twenty-six cases gave improvement of the ocular symptoms in fifteen, including three binocular cases restored to normal. Another interesting point he brought out in his report of these cases was that the sinus condition in some instances was completely overlooked by the rhinologist, also that many ophthalmologists had treated the neuritis without avail for a number of months or years without determining the underlying cause. It is well to mention in this connection that sinus disease may cause a retro-bulbar neuritis.

O'nodi[1] shows a great number of anatomical dissections which give the relation of the accessory sinuses to the optic nerve (Figs. 112, 113, 114, 115). After describing minutely the close relation of these cavities to the orbit and optic nerves he gives a résumé of the recent work on this subject and suggests many possible lines of investigative work. He especially laments the dearth of accurate post-mortem reports of these cases, the pathologist having been content to tell the conditions found without attempting to trace the paths along which the infection spread.

From the anatomic positions of the accessory sinuses it can be seen how readily the infectious process passes from them to the orbit. The os planum of the ethmoid, which is very thin, forms the inner wall of the orbit; the floor of the frontal sinus forms part of the upper wall of the orbit, and it is this sinus which involves the orbit more often than any of the others. Beneath the floor of the orbit is the antrum.

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[1] "Der Sehnerv und dis Nebenholen Der Nase," 1907.

or maxillary sinus, but disease of this sinus does not often involve the eye by direct infection, the ocular symptoms accompanying empyema of the antrum being more of a reflex nature. The sphenoid sinus does not often come in contact with the orbit, but it may, and under such circumstances the dividing wall may be so thin as to offer the line of least resistance to the advancement of purulent disease. The bony walls dividing the orbit from the sinuses are usually of good strength, but the study of a number of anatomical specimens of this region will reveal extremely thin walls in some cases, or walls which are partly deficient in bony tissue. I have collected nineteen cases of frontal sinus empyema admitted to the Massachusetts Eye and Ear Infirmary all of whom applied for admission because of the ocular condition alone. All the cases complained of monocular pain and tenderness; most showed displacement of the eye down and out, with limitation of motion. Nearly every case was treated by radical sinus operation externally. Not one of the cases showed optic neuritis or retro-bulbar neuritis, including the two cases that had extension to the cavernous sinus and died of pyæmia.

Empyema of the ethmoid and antrum will almost invariably rupture into the nasal cavity, so that most cases of orbital abscess due to accessory sinus disease are traceable to the frontal sinus, the remaining few being due to the sphenoid and rarely the ethmoid.

Emphysema of the lids and orbital tissue is due to fracture which involves the nose or its accessory sinuses and in this way allows air to enter the tissues.

I do not wish to assert that treatment of the nose in itself relieves the ocular conditions. It will only be a valuable adjunct to the local treatment, and if properly investigated will reveal the true cause of many otherwise obscure ocular conditions and put in one's hands the means of relieving symptoms through their true cause.

CHAPTER XXI.

THE EYE IN RELATION TO GENERAL DISEASES.

MANY constitutional diseases have a direct influence on the eye, of which syphilis, tuberculosis, Bright's disease, diabetes, rheumatism, malaria, influenza, paresis, locomotor ataxia, leukæmia, chronic toxæmia, hysteria, and infectious diseases are the most important.

Syphilis is perhaps the one disease which gives rise to the most serious ocular trouble, especially in the early stages of the disease. Iritis and irido-cyclitis, as well as syphilitic nodules, or gummata, of the iris are common to the early second stage, while the later stage is more prone to attack the posterior segment of the eye, as is manifested by retinitis, neuro-retinitis, choroiditis, and vitreous opacities. True gummata may give rise to all the symptoms of an orbital tumor, and gummata of the brain may cause an optic neuritis of retro-bulbar neuritis. Paralysis and paresis of the extrinsic muscles of the eye are most commonly due to syphilis, and interstitial keratitis is due usually to hereditary syphilis, although acquired syphilis is causative in rare instances.

Tuberculosis causes certain inflammatory diseases of the eye such as episcleritis and scleritis, as recently demonstrated by Verhoeff and Bull. Probably the vast majority of phlyctenular cases are tubercular or at least "scrofulous" in origin. True tubercle of the iris is occasionally seen, and also tubercles of the choroid—seen mostly in cases of miliary tuberculosis. Tuberculosis affects the eye largely through its depression of the whole physical tone. Errors of refraction and muscular insufficiencies, which in the healthy individual would require no correction, need the best of our care in tubercular patients that they may be freed from this cause of nervous exhaustion.

Bright's Disease gives rise to well-defined ocular conditions, the chief of which is albuminuric retinitis. This inflammatory condition of the retina is a danger signal in the disease; patients manifesting it seldom live longer than a year after its appearance. An exception to this rule is noticed in patients who have had albuminuric retinitis during pregnancy. Puffiness of the eyelids is an early symptom of renal dropsy and temporary loss of vision is due to uræmic toxæmia.

Diabetes gives rise to a retinitis in some cases, which, like the retinitis of Bright's disease, gives a grave prognosis as to life. Diabetes is also considered etiological in some cases of cataract, which may have some foundation in fact because of impaired nutrition.

Rheumatism gives rise to more cases of iritis than any other disease except syphilis. Rheumatic iritis is especially prone to relapse. A rheumatic diathesis is in whole or in part responsible for other ocular conditions, such as optic neuritis, and in some instances scleritis and episcleritis. Anti-rheumatic remedies combined with mercurial treatment is of great benefit in many ocular diseases.

Malaria is the cause of a persistent form of dendritic keratitis, which is very difficult to heal except in conjunction with quinine.

Influenza is also responsible for a certain form of superficial dendritic keratitis, and also vitreous opacities. Certain cases of acute conjunctivitis have been seen in which the bacterial findings have revealed the influenza bacillus in pure culture. I have had one case of retinitis which could be attributed to no other cause than a severe attack of *la grippe*.

Leukæmia gives rise to a characteristic retinitis in which the fundus appears yellow, and shows numerous hæmorrhagic spots. Iritis and choroiditis have been noticed in connection with this disease.

Chronic Toxæmia gives rise to a form of amblyopia in which the visual field shows a central scotoma and usually loss of color sensation. The vision is usually greatly

reduced. The causes are alcohol, wood alcohol, tobacco, lead, quinine, and other toxic agents.

Hysteria accounts for many cases of amblyopia in which there is a concentric contraction of the visual fields, and there may be a reversal of the color fields. Hysteria is also manifested frequently by blepharospasm and ptosis. Coincident with the ocular symptoms are found areas of anæsthesia, especially noticeable in the conjunctiva and back of the pharynx. Absolute blindness is not uncommon. The treatment of these cases is isolation and suggestion. Cases respond very well indeed to treatment with static electricity combined with extremely bitter medicine taken internally. I have used quinine and strychnine successfully in several instances.

Neurasthenia manifests itself in a multitude of ocular symptoms most of which are refractive and muscular. In my opinion the smallest refractive error should be corrected, and yet little can be gained unless the physician has the entire confidence of the patient. These trying cases are worthy of our best endeavor because so many are relieved who, otherwise, might relapse into a more serious neurotic condition.

Pyæmia may give rise to metastatic abscesses, which, if occurring in the eye cause panophthalmitis.

Consanguinity of Parentage causes numerous ocular diseases; among them are retinitis pigmentosa, colobomata, and other malformations.

Hæmophilia may cause grave hæmorrhage in cases of slightest injury to the eye as well as other parts of the body. One case came under my observation in which the punctured wound of the iris bled for over three days. The loss of vision was complete but the eye at present appears quite normal.

Tumors of the Brain, or any increase of intracranial pressure, usually causes an optic neuritis (choked disc). This symptom, combined with others, often is a valuable diagnostic point.

Hemianopsia and other defects in the visual field greatly aid in the localization of intracranial tumors.

Meningitis may cause optic neuritis, nystagmus, conjugate deviation, and lagophthalmos.

Paresis may give rise to numerous ocular symptoms, such as the Argyll-Robertson pupil, irregularity of the pupils, hemianopsia, atrophy of the optic nerve, muscular spasm, and nystagmus.

Locomotor Ataxia also manifests the Argyll-Robertson pupil, numerous forms of muscular paralysis, optic atrophy, diplopia, ptosis, scotomata, etc.

Disseminated Sclerosis may give rise to variations in the visual fields, nystagmus, optic neuritis, and atrophy, as well as abnormal pupillary reactions.

The relation of the *nose* and naso-pharynx to ocular disease was discussed in the previous chapter.

The Stomach and Digestive System are responsible for many ocular manifestations of a pathological order. Dyspepsia gives rise to the usual symptoms of asthenopia, eye strain, fatigue, photophobia, muscular insufficiencies, etc. It is probably true that the stomach has a direct influence in these cases only from the fact that general nutrition is impaired, and the patient becomes less resistant. The retina may show marked anæmia or even opacities following a severe hæmorrhage from the stomach or intestines.

Diseases of the Liver may cause failing accommodation beyond that which is to be expected at the patient's age. Jaundice is very quickly noticeable in the conjunctiva, and this is the only method of diagnosing jaundice in negroes and the yellow races.

The Teeth give rise reflexly to many severe ocular symptoms. These are largely neuralgic in character and are chiefly unilateral. Caries of the teeth may give rise to such ocular symptoms as photophobia, lachrymation, visual field disturbances, dimness of vision, and thorough irritation keep active an inflammatory condition of the eye, which may not quiet down until the teeth are filled or extracted.

The acute infectious diseases give rise to a number of ocular symptoms which deserve tabulation.

Diphtheria may directly infect the eye producing a diphtheritic conjunctivitis. The description and treatment of this disease can be found in the chapter on the conjunctiva. A not infrequent symptom found after recovery from an acute attack of diphtheria is paralysis of the accommodation. This condition is usually coincident with paralysis of the pharynx and should be temporarily corrected by convex lenses for near use. As the health of the individual returns to normal the paralysis of accommodation will disappear.

Measles is usually preceded by a "cold in the head" and an acute conjunctivitis. If this condition is neglected it may give rise to chronic conjunctivitis and ulceration of the cornea with subsequent scar formation.

Scarlet Fever may give rise to conjunctivitis and catarrhal ulceration of the cornea. This condition, as a rule, appears late in the disease, and can be avoided by proper care of the eyes during the disease, the simplest rules of cleanliness usually being sufficient to prevent ocular complications.

Erysipelas may frequently cause such inflammation of the skin of the lids that the eyes are forced shut by the swelling.

Small-pox causes more severe eye lesions than any other acute infectious disease, the usual form of inflammation being corneal ulcers, which are very apt to perforate. During the epidemic of small-pox in Boston, in 1901, many eyes were lost through perforation of the corneal ulcers. Iritis is not uncommon in this disease.

Whooping-cough frequently causes a sub-conjunctival hæmorrhage, which is alarming to the parent, but which is not in the least serious. Conjunctivitis is a frequent complication.

There seems to be a direct influence on the eye caused by affections of the genital organs in men and women. At the age of puberty many ocular inflammations become manifest, especially in girls. Among the more usual are interstitial keratitis, phlyctenular disease of the eye and even optic

neuritis. I have seen three cases of optic neuritis in young girls which could be attributed to no other cause than beginning menstruation.

Pregnancy may give rise to ocular symptoms other than those caused by albuminuria. In certain cases the oculist is able to detect a possible albuminuria in time to prevent an attack of eclampsia. Inability to use the eyes for any length of time, especially shown by weakness of the accommodation, is not an unusual symptom in pregnant women. Other disturbances of vision may become manifest in women who are affected nervously during this period.

Parturition has its dangers to the eyes of the child other than the chance of gonorrhœal infection. The danger lies usually in instrumental delivery. Forceps frequently cause ecchymosis of the lids, and may cause rupture of the eyeball. Exophthalmos caused by hæmorrhage behind the eye has been observed several times.

Exophthalmic Goiter is a constitutional disease but patients suffering from this condition frequently consult the oculist first because of the prominence of the ocular symptoms. The principal ocular symptoms are exophthalmos, and it is noticeable in these cases that the upper lid fails to follow the globe when the latter is directed downward. This is known as Graefe's Sign. The angle of the lids is very much widened, called Stellwag's Sign. The vision is usually not involved, but the cornea may ulcerate, due to exposure. The ocular symptoms combined with tremors, irregular and rapid pulse, and goiter make a diagnosis certain. Any one of the symptoms may be present alone or in combination with one or two others.

FORMULARY.

1.

℞ Zinci sulphatis..... gr. ss.
Acidi borici..... gr. xij.
Aquæ destillatæ..... ℥j.

M.

Sig.: A drop or two in the eye three or four times a day.

2.

℞ Acidi borici..... ℥iss.
Aquæ destillatæ..... ℥viij.

M.

Sig.: Use as eye lotion for irrigation.

3.

℞ Argyrol..... gr. x.
Aquæ destillatæ..... ℥ss

M.

Sig.: Two drops in inflamed eye three or four times a day.

4.

℞ Protargol..... gr. iij.
Aquæ destillatæ..... ℥ss.

M.

Sig.: Use as collyrium.

5.

℞ Tincturæ benzoini..... *m*xx.
Unguenti zinci oxidi U. S. P..... ℥j.

M. (Petrolati.)

Sig.: Apply to edges of the lids.

6.

℞ Atropinæ sulphatis..... gr. iij.
Hydrargyri oxidi flavi..... gr. viij.
Petrolati ..... ʒj.
M.
Sig.: For ulcers of cornea.

7.

℞ Sodii biboratis..... gr. x.
Acidi benzoici..... gr. iiss.
Vini opii..... ♏x.
Aquæ fœniculi..... ʒij.
Aquæ destillatæ.....ad ʒj.
M.
Sig.: Mild antiseptic collyrium.

8.

℞ Nosophen (pulvis)..... ʒij.
Atropinæ sulphatis..... gr. iv.
Petrolati ..... ʒj.
M.
Sig.: For corneal ulceration.

9.

For Vernal Catarrh (Fox).

℞ Solutionis chinosol 1:2000..... ʒj.
Sig.: Instill into the eyes freely every few hours for itching.

10.

Excellent Tonic in Children.

℞ Pilulæ kali arsenitis..... gr. 1/100.
Desp. No. 1.
Sig.: One pill t.i.d., p. c.

11.

℞ Liquoris plumbi subacetatis..... ♏xx.
Petrolati ..... ʒj.
M.
Sig.: Put small quantity in eyes three times a day for follicular conjunctivitis.

12.

℞ Sodii biboratis..... gr. v.
Aquæ camphoræ,
Aquæ destillatæ.....āā ℥ss
Sig.: Use as collyrium.

13.

White's Ointment.

℞ Hydrargyri chloridi corrosivi..... gr. j.
Sodii chloridi..... gr. v.
Petrolati ..... ℥vj.
M.
Sig.: For use along edges of the lids after operations on the eye.

14.

℞ Atropinæ sulphatis..... gr. iv.
Cocainæ hydrochloratis..... gr. iv.
Olei olivæ..... ℥j.
M.
Sig.: For burns.

15.

℞ Hydrargyri iodidi rubri..... gr. j.
Cocainæ hydrochloratis..... gr. iv.
Atropinæ sulphatis..... gr. v.
Petrolati ..... ℥j.
M.
Sig.: For severe corneal ulceration.

16.

℞ Hydrargyri oxidi rubri..... gr. iv.
Petrolati ..... ℥j.
M.
Sig.: Apply in eye three times a day.

17.

℞ Pilocarpinæ nitratis..... gr. iij.
Cocainæ hydrochloratis..... gr. viij.
Aquæ destillatæ..... ℥j.
M.
Sig.: Drop in eye three or four times a day.

18.

℞ Scopolaminæ hydrobromatis..... gr. ss.
Aquæ destillatæ..... ℥j.

M.

Sig.: As substitute for atropine.

19.

℞ Hyoscinæ hydrobromatis..... gr. ij.
Aquæ destillatæ..... ℥j.

M.

Sig.: As substitute for atropine.

20.

Episcleritis Tonic.

℞ Decocti aloes compositi..... ℥ij.
Elixiris ferri compositi..... ℥viii.

M.

Sig.: Tablespoonful three times a day in water after meals.

21.

℞ Phenolis (crystallorum)..... ℥ij.
Alcoholis (95 per cent.)..... *m*xx.

M.

Sig.: For blepharitis. To be applied by the physician only.

22.

℞ Aluminis ..... gr. v.
Aquæ destillatæ..... ℥j.

M.

Sig.: Use as mild astringent collyrium.

23.

℞ Homatropinæ ..... gr. ss.
Cocainæ hydrochloratis..... gr. ss.
Aquæ destillatæ..... *m*xl.

M.

Sig.: For mydriatic test in adults and older children.

24.

℞ Pilocarpinæ hydrochloratis..... gr. iv.
Aquæ destillatæ..... ℥j.

M.

Sig.: Use as miotic in acute or chronic glaucoma.

25.

No. 1. ℞ Argenti nitratis,
Aquæ destillatæ.....āā ℥j.
Glycerini ..... ℥ij.

No. 2. ℞ Potassii iodidi,
Aquæ destillatæ.....āā ℥j.
Glycerini ..... ℥ij.

No. 1, 3 gtts. No. 2, 6 gtts. Mix fresh each time.

Sig.: Used for painting lids in cases of trachoma with success in many instances.

26.

℞ Unguenti hydrargyri, U. S. P.
As inunctions in syphilis.

27.

Dr. Chandler's.

℞ Casaripe ..... gr. xx.
Petrolati ..... ℥j.

M.

Sig.: For corneal ulceration and nebulæ.

28.

℞ Unguenti hydrargyri ammoniatæ, 1 per cent.

Sig.: For blepharitis.

29.

℞ Fluorescinæ, 2 per cent.

Sig.: Used for staining denuded areas of the cornea.

30.

℞ Powdered aristol.
" nosophen.
" iodoform.
" calomel.

Sig.: May be used in various corneal ulcerations or wounds.

31.

℞ Argenti nitratis..... gr. v.
Aquæ destillatæ..... ℥j.

M.

Sig.: One or two drops in both eyes as prophylaxis in ophthalmia neonatorum.

32.

℞ Argenti nitratis..... gr. xij.
Aquæ destillatæ..... ℥j.

M.

Sig.: Used to paint lids in trachoma, and in acute gonorrhœal conjunctivitis. After use, flush out conjunctival cavity with normal salt solution.

33.

Local Hæmostatics.

℞ Adrenalin chlorid. Solutions 1-5000 to 1-1000.
℞ Adnephrin chlorid. Solutions 1-5000 to 1-1000.

34.

℞ Cocainæ hydrochloratis..... gr. xvj.
Aquæ destillatæ..... ℥j.

M.

Sig.: For local anæsthesia.

35.

℞ Cocainæ hydrochloratis..... gr. xvj.
Adrenalinæ chloridi, 1-2000..... ℥j.

M.

Sig.: For local anæsthesia in muscle operations.

36.

℞ Cupri sulphatis..... gr. xl.
Glycerini ..... ℥j.

M.

Sig.: Dilute with water to required strength when needed, and use in trachoma.

37.

℞ Hydrargyri chloridi corrosivi, 1-500.
Used in scrubbing trachomatous lids after grattage operation.

38.

℞ Dionin ..... gr. xx.
Aquæ destillatæ..... ℥j.

M.

Sig.: Drop in affected eye every hour for pain in iritis.

39.

℞ Dionin (crystallorum).
May be put in conjunctival cavity in small amount for pain in iritis.

40.

℞ Eserinæ sulphatis..... gr. ss.
Aquæ destillatæ..... ℥j.

M.

Sig.: Use in acute glaucoma, or for miotic effect.

41.

℞ Holocaine, 1 per cent.
Used as local anæsthetic.

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