

MILITARY MEDICAL MANUALS

GENERAL EDITOR:
SURGEON-GEN. SIR ALFRED KEOGH
G.C.B., M.D., F.R.C.P.

FRACTURE OF
THE LOWER JAW

L. IMBERT & P. RÉAL

EDITED BY
J. F. COLYER



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FRACTURE OF THE LOWER JAW

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WITH A PREFACE BY
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GENERAL INTRODUCTION

THE infinite variety of injuries which any war presents to the surgeon gives to military surgery a special interest and importance. The special interest and importance, in a surgical sense, of the great European War lies not so much in the fact that examples of every form of gross lesion of organs and limbs have been seen, for if we read the older writers we find little in the moderns that is new in this respect, but is to be found in the enormous mass of clinical material which has been presented to us and in the production of evidence sufficient to eliminate sources of error in determining important conclusions. For the first time also in any campaign the labours of the surgeon and the physician have had the aid of the bacteriologist, the pathologist, the physiologist, and indeed of every form of scientific assistance, in the solution of their respective problems. The clinician entered upon the great war armed with all the resources which the advances of fifty years had made available. If the surgical problems of modern war can be said not to differ sensibly from the campaigns of the past, the form in which they have been presented is certainly as different as are the methods of their solution. The achievements in the field of discovery of the chemist, the physicist and the biologist have given the military surgeon an advantage in diagnosis

and treatment which was denied to his predecessors, and we are able to measure the effects of these advantages when we come to appraise the results which have been attained.

But although we may admit the general truth of these statements, it would be wrong to assume that modern scientific knowledge was, on the outbreak of the war, immediately useful to those to whom the wounded were to be confided. Fixed principles existed in all the sciences auxiliary to the work of the surgeon, but our scientific resources were not immediately available at the outset of the great campaign; scientific work bearing on wound problems had not been arranged in a manner adapted to the requirements—indeed, the requirements were not fully foreseen; the workers in the various fields were isolated, or isolated themselves, pursuing new researches rather than concentrating their powerful forces upon the one great quest.

However brilliant the triumphs of surgery may be—and that they have been of surpassing splendour no one will be found to deny—experiences of the war have already produced a mass of facts sufficient to suggest the complete remodelling of our methods of education and research.

The series of manuals, which it is my pleasant duty to introduce to English readers, consists of translations of the principal volumes of the "Horizon" Collection, which has been appropriately named after the uniform of the French soldier.

The authors, who are all well-known specialists in the subjects which they represent, have given a concise but eminently readable account of the recent acquisitions to

the medicine and surgery of war which had hitherto been disseminated in periodical literature.

No higher praise can be given to the Editors than to say that the clearness of exposition characteristic of the French original has not been lost in the rendering into English.

MEDICAL SERIES

The medical volumes which have been translated for this series may be divided into two main groups, the first dealing with certain epidemic diseases, including syphilis, which are most liable to attack soldiers, and the second with various aspects of the neurology of war. The last word on *Typhoid Fever*, hitherto "the greatest scourge of armies in time of war," as it has been truly called, will be found in the monograph by MM. Vincent and Muratet, which contains a full account of recent progress in bacteriology and epidemiology as well as the clinical features of typhoid and paratyphoid fevers. The writers combat a belief in the comparatively harmless nature of paratyphoid and state that in the present war hæmorrhage and perforation have been as frequent in paratyphoid, as in typhoid fever. In their chapter on diagnosis they show that the serum test is of no value in the case of those who have undergone anti-typhoid or anti-paratyphoid vaccination, and that precise information can be gained by blood cultures only. The relative advantages of a restricted and liberal diet are discussed in the chapter on treatment, which also contains a description of serum-therapy and vaccine-therapy and the general management of the patient.

Considerable space is devoted to the important question of the carrier of infection. A special chapter is devoted to the prophylaxis of typhoid fever in the army. The work concludes with a chapter on preventive inoculation, in which its value is conclusively proved by the statistics of all countries in which it has been employed.

MM. Vincent and Muratet have also contributed to the series a work on *Dysentery, Cholera and Typhus* which will be of special interest to those whose duties take them to the Eastern Mediterranean or Mesopotamia. The carrier problem in relation to dysentery and cholera is fully discussed, and special stress is laid on the epidemiological importance of mild or abortive cases of these two diseases.

In their monograph on *The Abnormal Forms of Tetanus*, MM. Courtois-Suffit and Giroux treat of those varieties of the disease in which the spasm is confined to a limited group of muscles, e.g. those of the head, or one or more limbs, or of the abdomino-thoracic muscles. The constitutional symptoms are less severe than in the generalised form of the disease, and the prognosis is more favourable.

The volume by Dr. G. Thibierge on *Syphilis and the Army* is intended as a *vade mecum* for medical officers in the army.

Turning now to the works of neurological interest, we have two volumes dealing with lesions of the peripheral nerves by Mme. Athanassio-Benisty, who has been for several years assistant to Professor Pierre Marie at La Salpêtrière. The first volume contains an account of the anatomy and physiology of the peripheral nerves, together with the symptomatology of their lesions. The

second volume is devoted to the prognosis and treatment of nerve lesions.

The monograph of MM. Babinski and Froment on *Hysteria or Pithiatism and Nervous Disorders of a Reflex Character* next claims attention. In the first part the old conception of hysteria, especially as it was built up by Chareot, is set forth; and is followed by a description of the modern conception of hysteria due to Babinski, who has suggested the substitution of the term "Pithiatism," *i.e.* a state curable by persuasion, for the old name hysteria. The second part deals with nervous disorders of a reflex character, consisting of contractures or paralysis following traumatism, which are frequently found in the neurology of war, and a variety of minor symptoms, such as muscular atrophy, exaggeration of the tendon reflexes, vasomotor, thermal and secretory changes, etc. An important section discusses the future of such men, especially as regards their disposal by medical boards.

An instructive companion volume to the above is to be found in the monograph of MM. Roussy and Lhermitte, which embodies a description of the psychoneuroses met with in war, starting with elementary motor disorders and concluding with the most complex represented by pure psychoses.

SURGICAL SERIES

When the present war began, surgeons, under the influence of the immortal work of Lister, had for more than a quarter of a century concerned themselves almost exclusively with elaborations of technique designed to shorten the time occupied in or to improve the results

obtained by the many complex operations that the genius of Lister had rendered possible. The good behaviour of the wound was taken for granted whenever it was made, as it nearly always was, through unbroken skin, and hence the study of the treatment of wounds had become largely restricted to the study of the aseptic variety. Septic wounds were rarely seen, and antiseptic surgery had been almost forgotten. Very few of those who were called upon to treat the wounded in the early autumn of 1914 were familiar with the treatment of grossly septic compound fractures and wounded joints, and none had any wide experience. To these men the conditions of the wounds came as a sinister and disheartening revelation. They were suddenly confronted with a state of affairs, as far as the physical conditions in the wounds were concerned, for which it was necessary to go back a hundred years or more to find a parallel.

Hence the early period of the war was one of earnest search after the correct principles that should be applied to the removal of the unusual difficulties with which surgeons and physicians were faced. It was necessary to discover where and why the treatment that sufficed for affections among the civil population failed when it was applied to military casualties, and then to originate adequate measures for the relief of the latter. For many reasons this was a slow and laborious process, in spite of the multitude of workers and the wealth of scientific resources at their disposal. The ruthlessness of war must necessarily hamper the work of the medical scientist in almost every direction except in that of providing him with an abundance of material upon which to work. It limits the opportunity for deliberate critical observation

and comparison that is so essential to the formation of an accurate estimation of values ; it often compels work to be done under such high pressure and such unfavourable conditions that it becomes of little value for educative purposes. In all the armies, and on all the fronts, the pressure caused by the unprecedented number of casualties has necessitated rapid evacuation from the front along lines of communication, often of enormous length, and this means the transfer of cases through many hands, with its consequent division of responsibility, loss of continuity of treatment, and absence of prolonged observation by any one individual.

In addition to all this, it must be remembered that in this war the early conditions at the front were so uncertain that it was impossible to establish there the completely equipped scientific institutions for the treatment of the wounded that are now available under more assured circumstances, and that progress was thereby much hampered until definitive treatment could be undertaken at the early stage that is now possible.

But order has been steadily evolved out of chaos, and many things are now being done at the front that would have been deemed impossible not many months ago. As general principles of treatment are established it is found practicable to give effect to them to their full logical extent, and though there are still many obscure points to be elucidated and many methods in use that still call for improvements, it is now safe to say that the position of the art of military medicine and surgery stands upon a sound foundation, and that its future may be regarded with confidence and sanguine expectation.

The views of great authorities who derive their knowledge

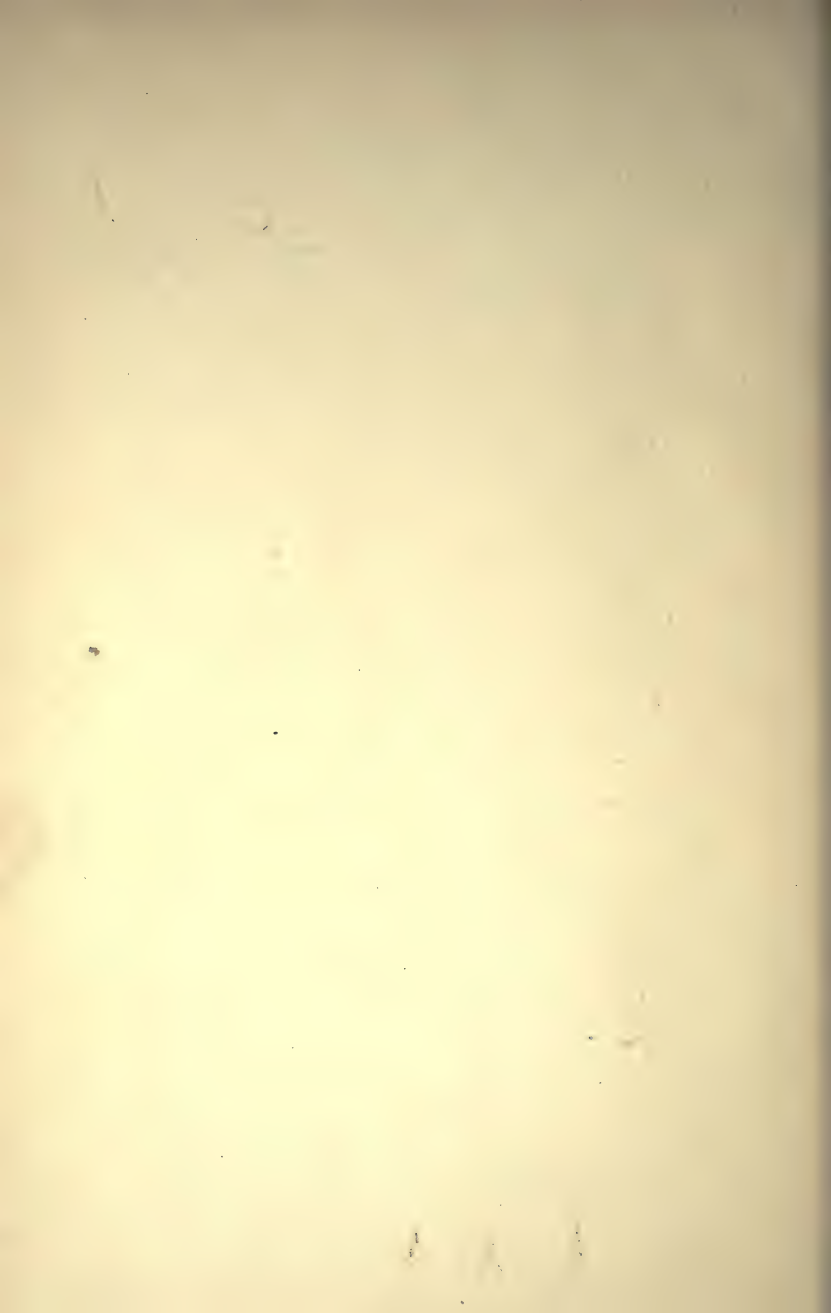
from extensive first-hand practical experience gained in the field cannot fail to serve as a most valuable asset to the less experienced, and must do much to enable them to derive the utmost value from the experience which will, in time, be theirs. The series covers the whole field of war surgery and medicine, and its predominating note is the exhaustive, practical and up-to-date manner in which it is handled. It is marked throughout not only by a wealth of detail, but by clearness of view and logical sequence of thought. Its study will convince the reader that, great as have been the advances in all departments in the services during this war, the progress made in the medical branch may fairly challenge comparison with that in any other, and that not the least among the services rendered by our great ally, France, to the common cause is this brilliant contribution to our professional knowledge.

A glance at the list of surgical works in the series will show how completely the ground has been covered. Appropriately enough, the series opens with the volume on *The Treatment of Infected Wounds*, by A. Carrel and G. Dehelly. This is a direct product of the war which, in the opinion of many, bids fair to become epoch-making in the treatment of septic wounds. It is peculiar to the war and derived directly from it, and the work upon which it is based is as fine an example of correlated work on the part of the chemist, the bacteriologist and the clinician as could well be wished for. This volume will show many for the first time what a precise and scientific method the "Carrel treatment" really is.

The two volumes by Professor Leriche on *Fractures* contain the practical application of the views of the great Lyons

school of surgeons with regard to the treatment of injuries of bones and joints. Supported as they are by an appeal to an abundant clinical experience, they cannot fail to interest English surgeons, and to prove of the greatest value. It is only necessary to say that *Wounds of the Abdomen* are dealt with by Dr. Abadie, *Wounds of the Vessels* by Professor Sencert, *Wounds of the Skull and Brain* by MM. Chatelin and De Martel, and *Localisation and Extraction of Projectiles* by Professor Ombrédanne and R. Ledoux-Lebard, to prove that the subjects have been allotted to very able and experienced exponents:

ALFRED KEOGH.



PREFACE

THE conditions of modern warfare, and especially of trench-warfare, by multiplying injuries of the face and skull, have furnished a very much richer clinical material in regard to fractures of the mandible than has been the case in former wars.

On looking back through the literature of war-wounds, one is struck by the fact that recovery from gunshot injuries of the mandible was largely left to the agency of time and nature. In the case of those severe injuries which are so frequently accompanied by large loss of substance, the misplaced fragments became fused with the soft parts in a kind of irregular, indurated, cicatricial mass, covered by a muco-cutaneous envelope intersected by bands of scar-tissue. This mass prevented mastication; frequently it gave rise to a permanent flow of saliva; and, by immobilising the tongue in the cicatricial mass, it considerably impeded the movements of deglutition.

It is obvious that, in the case of the fractured mandible, the guiding principles of surgery, namely, reduction and immobilisation, were disregarded. Why this neglect of principles universally believed to be

sound? The explanation is simple. Reduction is, in practice, almost invariably synonymous with the application of an immobilisation apparatus. Hence the surgeon, dependent upon his own resources, was unable to bring about the effective immobilisation of these fractures. To-day the state of things is very much altered, and the constant collaboration between the general surgeon and the dental surgeon has effected a most favourable transformation in methods of treatment.

Recent clinical observations, together with the therapeutic modifications which proceed from them, have formed the subject of numerous articles, scattered through the medical press or to be found in the proceedings of learned societies. MM. Imbert and Real enjoy the distinction, not only of having collected these observations in one book, but of having published the results of their personal experiences, spread over a period of more than two years and enriched by the clinical opportunities afforded by the large number of cases which have passed through their hands.

In the introduction to their book, the authors insist upon a point of therapeutic principle which has a general bearing of very great importance. Where there is fracture of the mandible with loss of substance, the clinician is faced with two dangers; he either, by restoring the fragments to their anatomical position, maintains them in a state of separation which may terminate in pseudo-arthritis; or, by bringing the fragments together without consideration of the loss

of substance, he destroys the dental occlusion, with consequent definitive impairment of the function of mastication.

MM. Imbert and Real hold the view that, where the bony breach is small, perfect occlusion should be sacrificed to union ; that the degree of occlusion under these circumstances is sufficient to permit of satisfactory mastication ; and that it is only in extreme cases, with excessive loss of substance, that reduction should be confined to the re-establishment of normal dental articulation.

The anatomico-pathological and clinical studies of the different varieties of fracture, with their complications, are described with great clearness. After a survey of the immediate surgical treatment of fractures of the mandible, the authors proceed to a discussion of prosthetic methods. The last chapter is devoted to the treatment of pseudo-arthrosis by osteo-synthetic methods and by bony and cartilaginous grafts.

Finally, the authors recall the fact that they are members of the Army Medical Service, and as such are called upon to assess the disabilities arising from fractures of the mandible. Their study of this aspect is particularly serious and conscientious. The extensive knowledge which they have of their subject, enables them very clearly to define the different clinical varieties of fracture, and thus to formulate an accurate estimate of degrees of disablement, which they assess in an entirely judicious manner.

In "Fracture of the Lower Jaw" questions of prac-

tical surgery are discussed which are still unfamiliar to many of our colleagues. Precise instructions are given for the treatment of the different classes of fracture, and the book should prove a *vade mecum* to surgeons, both military and civil, who have felt the need of a text-book on the subject.

The book appears at an opportune moment. It cannot fail to be received with favour and to meet with well-deserved success at the hands of the medical public.

CH. FÉVRIER,

Médecin-Inspecteur-Général de l'Armée.

It is our agreeable task to express our obligations and thanks to our colleagues of the Service de Chirurgie et Prothèse Maxillo-faciale de la XV^e Région.

MM. L. Gauthier, Ch. Lheureux, Médecins aides-major, Assistants du service; Granier, military dentist; Bosano, Audibert, Vaulbert, surgeon-dentists; Carlavan, chief of the workshops. Valuable services have been rendered by M. Agussol, who is not only a talented draughtsman, but also a very competent surgeon-dentist.

L. I and P. R.

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FRACTURE OF THE LOWER JAW

CHAPTER I

INTRODUCTION

THE study and therapeutics of fracture of the mandible are not, in their inception, the outcome of the war. It cannot be denied, however, that our knowledge of the subject has been greatly advanced and consolidated by the vast amount of clinical material which has come under observation since the outbreak of war. The writings and research-work of Claude Martin had previously provided a source of knowledge of the most fundamental kind, but the literature of the subject, with this exception, was mainly bibliographic in character, no surgeon or stomatologist at that time possessing personal experience of any great value. Claude Martin alone, by his patient investigations and his undeniable genius, was able to evolve the basic principles of this branch of surgical science.

But even he was able to bring together only a comparatively limited number of facts. His observations were largely founded upon the operative results of

resection of the mandible, valuable clinical material being contributed by Ollier. His knowledge of fractures was, however, unfortunately confined to the few cases which in normal peace-time come under observation. Not only are such cases comparatively rare, but they are observed under the most favourable conditions, loss of substance being an infrequent complication. Claude Martin's investigations are already ancient history, and since his day the methods of clinical procedure, especially in the domain of surgery, have become transformed, and it is obvious that the results to which they lead must also be very much modified.

One of the most unexpected revelations of the surgery of the war is the small number of fatal results in wounds of the face. If we exclude those cases in which there is severe hæmorrhage or in which the general condition is bad, cases which never reach a base hospital, the mortality is extraordinarily low. The present generation of surgeons has been brought up in the wholesome dread in these cases of septic complications, such as pyæmia of buccal origin, and septic broncho-pneumonia, conditions whose occurrence one would naturally expect in cases where there is great difficulty in feeding the patient. Statistics derived from every centre of treatment, however, show entirely favourable results. The mortality barely reaches 1 per 1,000, and is frequently lower. Monthly reports from the surgeons in charge of these centres

show that their work is practically confined to the restoration of function, life in any case being assured.¹

It is not surprising that, under the present conditions, technical research has attained a development and yielded results which were undreamt of before the outbreak of war. In those past days a fractured mandible was a serious matter. Few civilian surgeons had any practical experience of the various appliances

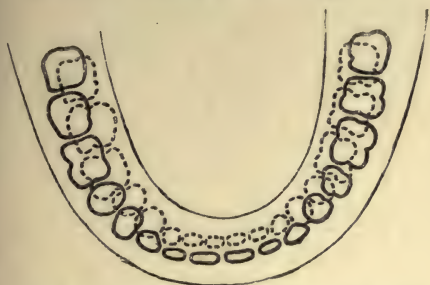


FIG. 1.—Normal dental adjustment seen in the horizontal plane. The inferior arch articulates within the superior arch, the inferior median teeth being behind the superior median teeth, and the inferior lateral teeth inside the corresponding teeth of the upper jaw. (The inferior teeth are indicated by means of dotted lines.)

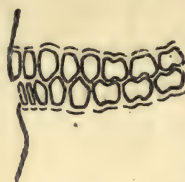


FIG. 2.—Normal dental adjustment viewed in the vertical plane. The posterior two-thirds of the inferior molars corresponds to the anterior two-thirds of the corresponding teeth of the upper jaw.

recommended by the text-books, appliances, moreover, which were largely unobtainable. In later years, however, dentists were appointed to the hospitals in most of the larger towns, and where these worked in collaboration with the surgeons better results were obtained,

¹ Emphasis is laid upon the fact that these favourable results depend upon the exclusion of hopeless cases, such as do not leave the first dressing stations.

though even here the paucity of clinical material stood in the way of both surgeon and dentist.

Before entering upon a detailed description of fractures of the mandible it is advisable to enumerate certain physiological peculiarities of this bone, which differs considerably from those upon which surgeons are usually required to operate. The minuter details of the movements of mastication need not detain us here ; it will suffice to describe them on broad, general lines.

Mastication can only be performed when the upper and lower teeth are in normal occlusion with one another. Their position in regard to one another is shown by figs. 1 and 2, which illustrate respectively the horizontal and vertical planes. Fig. 1 shows that the position of the mandibular dental arch is within that of the maxilla, the mandibular median teeth being behind the maxillary median teeth and the mandibular lateral teeth within the corresponding teeth of the maxilla. Fig. 2 shows that the maxillary teeth are slightly superimposed, in such a way that the mandibular first molar articulates with the anterior portion only of the corresponding tooth of the maxilla, one-third of its surface being in contact with the maxillary second premolar. The combination of these relationships constitutes what is known to dentists as the "dental articulation" (occlusion of the teeth). To avoid confusion in terminology, however, we propose throughout this book to employ the term "dental adjustment."

Efficient mastication is dependent upon normal dental adjustment, and the ideal method is to preserve it. Rigidity of the mandible is, however, of equal importance, for it is evident that, once this rigidity is lost, the power of the mandible is reduced by half, for each fragment is subject to the action of one only of two sets of muscles. A condition of instability is thus established which still further impedes the masticatory function.

Dental adjustment and mandibular rigidity are the fundamental conditions aimed at in the treatment of fractures of the lower jaw. Fracture by projectiles is, however, almost invariably accompanied by loss of substance, and the surgeon finds that he is faced with a choice between two evils. To preserve the adjustment the fragments must remain apart, with consequent pseudo-arthritis. To obtain rigidity the fragments must be brought together, with consequent disturbance of adjustment. In certain cases, as will be shown later, it is possible to avoid both evils, but in the majority of instances the surgeon is compelled to make a choice.

Claude Martin was inflexibly in favour of the preservation of dental adjustment, and it seems certain that in no case was he willing to sacrifice it in order to obtain rigidity of the bone. His views were undoubtedly influenced by the nature of the cases which passed through his hands. In his experience loss of substance was mainly the result of surgical intervention, and, the tissue removed being almost in-

variably morbid, economy in its removal would have been misplaced. Under these circumstances there would have been little wisdom in seeking to effect a union which, had it been practicable, must have been imperfect. This is no doubt the explanation of Claude Martin's adherence to the maintenance of adjustment. His method was, by means of an apparatus, to preserve the spacing of the teeth as it existed before operation. Not only did he not obtain rigidity, but the presence of the apparatus itself largely militated against it.

Experience in a large number of cases of maxillo-facial mutilation has led us to abandon Claude Martin's principle in its entirety and to sacrifice dental adjustment to bony rigidity. That pseudo-arthritis constitutes a grave functional defect cannot be denied ; that it is not susceptible to correction by means of an apparatus will be shown later. Our cases differ, of course, very considerably from those of Claude Martin ; we have to deal with extensive loss of substance, and pseudo-arthritis is frequently inevitable. Experiments in bone-grafting have been attempted, and this method may, at a later date, yield favourable results. There is, however, a large class of patients, perhaps the largest, in whom the loss of substance does not exceed two or three centimetres. In all these cases rigidity is obtainable either by means of an apparatus or by surgical means. In either event the fragments must be brought together, with consequent disturbance of adjustment. In our opinion the diminution of function is more than compensated by the benefit

which these patients derive from the rigidity of their lower jaw.

Where the loss of substance is small, the disturbance of adjustment is practically inappreciable ; up to one centimetre it appears to be negligible. Where there is a gap of two or three centimetres the case is different, but even here the error in adjustment is largely reducible. It is possible to confine the error to one fragment only, and that the smaller ; to arrange in fact, in a manner which will be described later, that it shall bear the entire brunt of the displacement. The larger portion, that which contains the greater number of teeth, remains in perfectly normal accord with the maxilla. Thus the disturbance of adjustment affects only a small portion of the jaw, and, owing to the vicinity of the site of fracture, it is usually in this portion that the greater number of teeth are missing. Indeed, it frequently happens that the posterior fragment does not contain a single tooth, and the disturbance of adjustment thus becomes purely theoretical, all the teeth present being in perfect occlusion.

To appreciate the advantage of this method, it is only necessary to compare the condition of a patient whose mandible is rigid with that of one suffering under the disabilities of pseudo-arthritis. The former requires merely an apparatus containing a few artificial teeth, and, more often than not, he is content to masticate upon the sound side of his jaw. His condition is practically normal, and it is not necessary to give him his discharge. The second class of patient

is in a very different position. He is furnished with a corrective mechanism which is indispensable to his existence. Even with this aid his mastication is so imperfect that it is necessary to discharge him with a grant, or even with a pension.

It has seemed to us imperative that this question of method should be clearly stated from the outset. We feel that the case for mandibular rigidity in preference to dental adjustment has been proven, and that, as we shall show later, in the vast majority of cases, it constitutes the only sound therapy.

The movements of the mandible are effected by means of the two temporo-mandibular joints. These are extremely complex, and, in addition to movements of elevation and depression, they effect also movements of projection and retraction. They possess a specific solidarity, each joint being incapable of action without the other. In the same way that torsion of the forearm is possible only when the interlines of both elbow and wrist are intact, so depressor movements of the mandible are suppressed by ankylosis of one or other of the mandibular joints, immobilisation of the entire bone resulting from a unilateral lesion. Cases of this sort, though rare, are not unknown.

On the other hand, the duplicate articulation of the mandible carries with it certain very decided advantages. These joints are so strong that the clenching capacity of the teeth amounts literally to a feat of strength. Their configuration, moreover, permits of

certain displacements which may become permanent without in any essential particular affecting their solidity. Dentists are able, with comparative ease, to manipulate the jaw in such a way that the whole of the lower row of teeth is brought slightly forward, and this position can be rendered permanent. This manœuvre, which is known as "jumping the bite," is obviously dependant upon the play of the two articulations.

The number and variety of the movements which it is able to effect lend to the mandible a peculiar physiological interest. It possesses yet another quality which, to the surgeon, is of even greater value, namely, its capacity for immobilisation. This is greater than that of any other bone in the body. By attaching an arch with studs to each row of teeth and firmly ligaturing the two arches together with brass wire, the jaw becomes absolutely immobilised. It is this capacity for complete immobilisation which renders possible the rapid consolidation of fractures, even those in which the loss of substance is comparatively extensive. More important still, the apparatus for immobilisation, though it debars mastication, does not prevent feeding. Liquids can readily pass through the dental interstices, the retromolar space, or through the gaps left by teeth which have been lost. As a matter of fact there are few patients who are content with a liquid diet; they usually manage to consume crumb of bread, purées of all kinds, minced meat, etc.

The mandible possesses yet other surgical advantages. In the case of a broken femur, for instance, it is not easy to operate directly upon the fragments without having recourse to an appliance such as a screw plate, Lambotte's splint, Lambret's apparatus, etc. The mandible is more amenable to treatment. The teeth present points of attachment which are exceptionally easy of negotiation, and, where the crowns are gone, the roots are probably still good. Thus, in addition to immobilisation, the surgeon is able to effect an almost mathematical reduction of the fracture. In the case of a fractured limb, length alone can be estimated with any degree of exactitude; other deviations, such as the angular, the rotatory, can only be approximately estimated. In the case of the mandible, a perfect and incontestable basis is provided by the dental adjustment. It may happen, however, that the teeth are missing. Occasionally they are entirely destroyed by the nature of the injury; sometimes the roots are so broken that extraction is the only possible course; or they may have been previously destroyed by dental caries. Finally, it may happen that the line of fracture passes beyond that part of the jaw which contains the teeth. Conditions such as these are very difficult to deal with, and they tax to the full the powers of both surgeon and specialist.

As we shall have occasion to show later on, the fragments of a fractured mandible do not, so far as we have been able to judge, present the phenomena of a

rarefying osteitis so frequently observed in fracture of the bones of the limbs. In both kinds of case pseudoarthrosis is frequent. In the management of fractures of the bones of the limbs, lack of resistance of the fractured parts constitutes one of the chief difficulties. Their consistency is sometimes so attenuated that it is not possible to keep a metal plate in position by means of screws. It is necessary to attach it by means of ligatures, a far less efficacious method. This is a difficulty with which, in the case of the mandible, we have never had to contend. It seems rather that the extremities of the fragments undergo a species of condensation. The retention of properly adjusted screws has been perfect in the patients upon whom we have operated.

Such are the general considerations which we desire to present to those of our readers who are unfamiliar with the methods and results of stomatological therapeutics. That this volume contains so few references to the name of Claude Martin may to such readers appear surprising. It is not that we fail to appreciate the great achievements of the venerable scientist, who was a pioneer at a date when there was some merit in being one. But we feel that of his work, which was largely therapeutic, very little ought to be preserved. It could hardly be otherwise, seeing that in the last quarter of a century surgical methods have undergone a complete transformation, while, in the last two and a half years, an abundance and variety of clinical

material has come to hand such as Claude Martin never dreamt of. As we have already shown, his fundamental principle has not stood the test of facts. His object at all costs, even that of pseudo-arthritis, was to preserve the dental adjustment. We have always supported the opposite view, namely, that in the vast majority of cases union of the fracture is the more important aim. Claude Martin's formula was : dental adjustment before mandibular rigidity. Our formula is : mandibular rigidity before dental adjustment. This view, which we were the first to advance, is the one adopted by the majority of surgeons and stomatologists.

But although the details of Claude Martin's work are becoming effaced by time, our admiration for the man who, first of all, perceived the necessity for the collaboration of the surgeon with the specialist must remain. Claude Martin was the first to face the problem of the re-establishment of the masticatory function after surgical intervention.

CHAPTER II

ETIOLOGY

FRACTURES of the mandible by instruments of war are usually comminuted. As a general rule they differ from those observed in civil life by loss of substance. It is, however, by no means exceptional to encounter war fractures in which there is no loss of substance, the injuries closely resembling those observed in civilian practice.

The etiology of the majority of cases is simple. The mandible is struck by a projectile which fractures it, producing fragments of varying size, which are either carried away by the projectile or are eliminated secondarily at the sequestration stage. It may happen, however, that the mandible is struck by a spent projectile, the force of which is exhausted by the shock of contact. In such a case the mandible is fractured, but either not, or only very slightly, splintered. Injuries of this nature we propose to describe as "fractures by contact," using the term in the sense in which it is employed to denote certain fractures of the cranium. In this class of case there is no loss of substance either primary or secondary, and the displacement is generally slight. Apart from the wound

there is nothing to distinguish these cases from those seen in general practice. The wound itself is unimportant, and cicatrises readily in spite of the presence of the projectile, whether a fragment of shell or a bullet.

It should be borne in mind that the accidents incidental to civilian life are not abolished in time of war. Fracture may be due to the kick of a horse, a fall, an earthslide, etc. In such cases the skin is unbroken, and, were it not for the injury to the mucosa, which is usually slight, the fracture would be a simple one.

CHAPTER III

PATHOLOGICAL ANATOMY

IN a former work (*Presse Médicale*, 25, x. 1915) we divided the fractures of the mandible into two main classes :

1. Anterior fractures, the site occupying the median line or its vicinity ;

2. Posterior or lateral fractures, situated within a space bounded by the median line or its vicinity on the one hand and the angle of the mandible on the other.

To these two groups we propose now to add a third, namely, fractures of the vertical portion or ascending ramus of the jaw. The distinction may be regarded as a fine one, but we are of the opinion that it has a definite clinical and anatomical value. Fractures of the angle of the jaw resemble those included in group two, with this reservation, that they are invariably characterised by absence of teeth in the posterior fragment. Finally, there are cases of multiple and of comminuted fracture.

The basis of classification is by no means purely anatomical. Each of the main groups—namely, anterior fracture, posterior and lateral fracture, fracture of the ramus—possesses distinct clinical, prognostic, and therapeutic characteristics.

The amount of substance lost varies considerably in each class. A loss of 1 to 2 cm. does not appreciably affect either the clinical appearances or the prognosis. Where the loss is large, however, very different conditions obtain, and these will be discussed later.

In all groups, both principle and secondary (fracture of the angle, multiple fracture), the continuity of the bone is broken and the fracture is described as "complete." In the case of the first two, fracture occurs between two groups of masticatory muscles. In the case of the third, it affects a portion of bone to which one group of these muscles is attached. Hence the functional derangement consequent upon fracture of one of the rami is not only different in character, but it is less grave.

In addition to these fractures, which, as they divide the bone into two parts, are termed "complete," there is yet another variety, obviously of minor importance, namely, the "incomplete" fracture. We propose to deal with this first.

I. INCOMPLETE FRACTURE

Incomplete fracture does not interrupt the continuity of the bone, though it may affect any part of it.

Fracture of the teeth is very frequent, and is usually a complication of complete fracture. Artificial replacement is the only method of dealing with the condition. It should be borne in mind that fractured roots do not unite, and, even where a tooth appears

to be sound, if the root is cracked, extraction is the only remedy.

Fracture of the alveolar border is common, and occurs frequently as a complication. There is a tendency on the part of the marginal fragment to bend inwards, probably as the result of attempts at mastication. Whether these fractures come under treatment or not, they invariably unite, with the consequent danger of malposition bringing the chewing surfaces of the maxillary molars over the external surfaces of the mandibular molars. At the beginning of the war such deformities were frequent. Now, however, that there is better provision for treatment they are rarely seen.

Fracture of the inferior border has little practical significance. Its presence is usually revealed by small detached splinters of bone which either unite or become sequestra.

Fracture of the coronoid process is very difficult of observation, and skiagrams give little help. The appearances resemble those of closure of the jaws.

Fracture of the temporo-mandibular joint is frequent and, the site of injury being immediately beneath the skin, it is easy of diagnosis. A patient who came under observation had in his possession the head and neck of the condyle, which had been eliminated as a sequestrum. He was able to perform masticatory movements without inconvenience. Closure of the jaw as the result of ankylosis suggests itself as a very possible complication, yet up to now no case has come

under observation. Except that lateral deviation and retrusion are more marked, the displacement of the fragments, where present, is precisely similar to that observed in fracture of the ramus.

Perforation is sometimes observed. In this case



FIG. 3.—Different types of incomplete mandibular fracture; fracture of the upper or alveolar border; fracture of the lower border; fracture of the coronoid process; fracture of the condyle; perforation.

the projectile, usually a bullet, traverses the mandible without disturbing its continuity and produces a simple loss of substance.

It is noticeable that, as in fractures of the cranium, the inner bony layer is more

extensively affected than the outer, with the result that the sequestra are sometimes larger than the apparent loss of substance. The analogy, however, ceases here, these lesions having none of the gravity and urgency associated with those of the cranium.

II. COMPLETE FRACTURE

As we have seen, it is expedient to divide the complete fractures into three main groups.

Loss of substance is usual, but certain fractures occur which, as in the case of the cranium, we propose to describe as fracture "by contact," which are con-

fined to a simple crack. It must not be forgotten that, among the casualties of war, patients come under treatment with injuries resembling those seen in civilian practice, the originating cause being not a projectile, but a landslide, a kick from a horse, etc. The skin in these cases is frequently unbroken.

(a) **Anterior fracture** (median or paramedian).—The position of the fracture site is sometimes exactly median, that is to say, it passes between the two median incisors. It then deviates more or less to either the right or left, and a small triangular portion of bone is frequently detached from the lower border. In some cases the line of fracture passes between the two lateral incisors or between the lateral and the canine. In any event the displacement of fragments is so similar that the types are easily included in one group.

In median or paramedian fracture without loss of substance the deformity is so slight that, unless attention is drawn to it, the lesion may pass unnoticed. There is occasionally a slight vertical dental error, but as a general rule, and particularly where the fracture is single, there is no displacement in the horizontal direction. The vertical error usually undergoes spontaneous correction by contact with the upper row of teeth, and this class of fracture shows a distinct tendency to unite spontaneously in good position. It is fractures of this nature which are most frequently encountered in civil life, and this accounts for the fact that, in spite of the inefficiency of the retentive measures

in general employment before the war, treatment of mandibular fracture was not entirely unsuccessful.

In the surgery of war, however, loss of substance is almost invariably present, and, in the simplest cases, it corresponds to the loss of one or two teeth.

Let us take a typical instance (fig. 4). The missing



FIG. 4.—Anterior median fracture. Loss of bony substance equal to two incisors.

portion of bone includes the two median incisors, and the loss of substance amounts to 1 cm. The two fragments tend to approach one another. As they are of practically the same length, and are subject to very much the same influences, each portion performs half the journey, the fractured surfaces again meeting at the median line (fig. 5). The effect upon the interdental articulation will be described in detail later. Suffice

it here to say that in cases of this sort the derangement is very slight, the effect upon the molars being practically nil. It is more apparent in the case of the anterior teeth, where the natural tendency to retreat behind the corresponding teeth of the upper jaw is intensified (fig. 8).

Where loss of substance is very extensive, this cannot



FIG. 5.—Displacement of fragments in the fracture shown in fig. 4. The union of the fractured surfaces produces a Gothic arch, the mandible assuming the characteristic serpent-form.

of course hold good. There is always a tendency on the part of the fractured portions to approach one another, but the mandible here takes on a triangular form (Sébileau's serpent jaw) which not only throws the front teeth very much behind those of the upper jaw, but also produces error in the molar articulation, with consequent functional deficiency.



FIG. 6.—Right paramedian fracture with moderate loss of substance.



FIG. 7.—Right paramedian fracture with moderate loss of substance. Loss of the teeth and alveolar border of the right side.

The tendency to approach one another, which is manifested by the fractured portions in injuries of this type, is so strong that unless the amount of substance lost is positively prohibitive, union is always effected. Cases have come under notice in which there was union, though with inevitable malposition, between two fragments, each of which contained only molars.

In paramedian fracture the tendency of the frag-

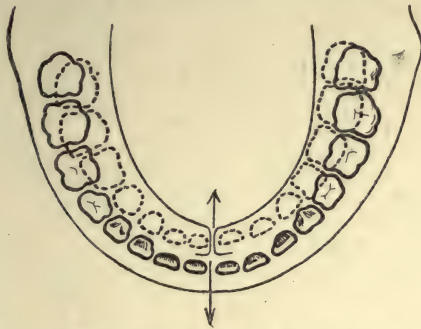


FIG. 8.—Anterior median fracture with loss of two incisors. The dental adjustment is only slightly disturbed. The median lines coincide; slight retraction of the inferior dental arch; slight displacement of the molars inwards. (The lower teeth are indicated by means of dotted lines.)

ments to unite without superposition is very marked. This tendency is common to all varieties of the anterior group, and constitutes the basis of classification. Where there is no loss of substance, deformity is slight, as in true median fracture.

Where there is slight loss of substance, the union of the two bony fragments takes place in the same manner. The disturbance of balance between the bony fragments and the forces which act upon them is

insufficient to produce overlapping. The surfaces come together in close contact, thus compensating for the absence of the intermediate bony structure. But the effects on the occlusion are naturally more important. The shorter fragment has no anterior teeth, but occludes satisfactorily with the upper teeth; the larger fragment is considerably displaced, as shown in fig. 9, the left fragment deviating to the right to the extent of at least the width of an incisor tooth.



FIG. 9.—Paramedian anterior fracture. There is union without superposition similar to that in fig. 8. The left fragment being the longer, the median line is deflected towards the right fragment. (The lower teeth are indicated by means of dotted lines.)

The derangement of dental articulation, though somewhat more marked than in median fracture, is still compatible with efficient mastication.

Where the loss of substance exceeds two centimetres, the deformity becomes much more marked. This is due to displacement of the larger fragment, the position of the smaller fragment remaining practically normal. The teeth are more numerous in the larger fragment and their articulation is very faulty, sometimes as

faulty as in lateral fracture. The tendency to unite is appreciably less than in true median fracture, and pseudo-arthritis is a fairly frequent occurrence.

(b) **Posterior or lateral fracture.**—The site of fracture varies from the canine to the last molar.

Even where there is no loss of substance, the dis-



FIG. 10.—Left lateral fracture with considerable loss of substance. Contact is established by a bony bridge which proceeds from the posterior fragment and meets the anterior fragment.

placement of fragments in these cases is frequently so great that the last tooth of the larger fragment is behind the first tooth of the smaller. As a general rule, however, deformity is the result of an appreciable loss of substance.

Take the case of a mandible fractured on the right

side with loss of substance corresponding to one tooth, the second premolar, for example. The displacement of the fragments is quite typical, so much so that it lends a characteristic appearance (to be described later) to the face.

It is usually the larger of the two fragments, the

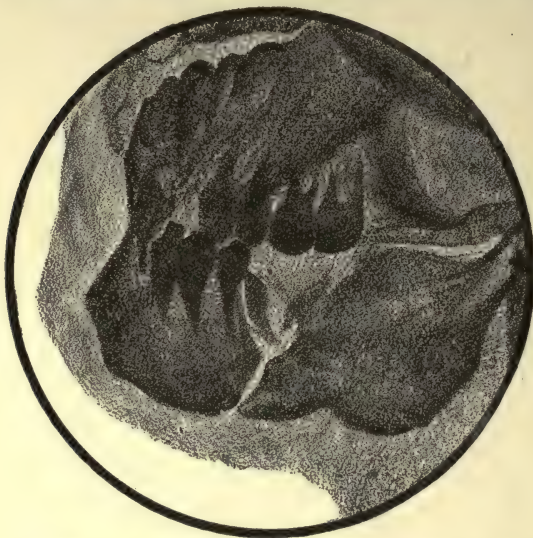


FIG. 11.—Right lateral fracture. Loss of substance corresponding to two molars. Union brought about by means of an apparatus after forward movement of the posterior fragment.

one bearing the median teeth, which undergoes the most marked displacement (fig. 12). It performs a sort of pivoting movement around a fixed point which corresponds approximately, though perhaps not actually, to the temporo-mandibular joint of the same side. The immediate effect of this movement is to push the middle teeth of the mandible backwards in

such a way that, when the jaws are closed, instead of touching the posterior surface of the maxillary incisors, there is a space between the two rows which is sometimes considerable, and may even amount to as much as a centimetre.

But this is not the only result of the pivoting movement. The middle incisors are thrown towards the fractured side, and although this result does not strike

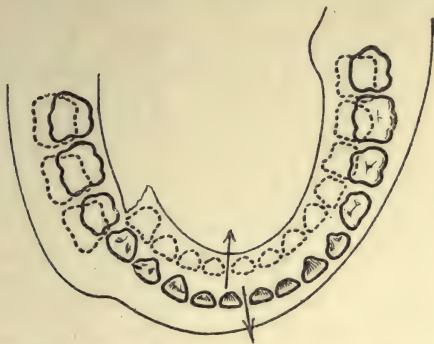


FIG. 12.—Lateral fracture. Union with superposition; retraction of the median line with deviation towards the fractured side.

one on casual observation, it is none the less evident if careful examination is made. If the jaws are closed and the lips are raised, it will be seen that the median line, as marked by the interspaces between the central incisors, is not continuous in the two jaws. In the mandible it leans towards the fractured side (fig. 12). The deviation frequently amounts to the space of one tooth, the interstice between the inferior median incisors corresponding to that between the superior central and lateral incisors of the wounded side. The

error may be even greater still, and may amount to the space occupied by two incisors.

Recission of the middle teeth and deviation of the median line in the direction of the fractured side are the two most fundamental effects of the displacement of the fractured portions. The relationship between the bony fragments is, however, complex, and these are not the only results of displacement.

The pivoting movement, then, tends to bring the two fractured surfaces together, and in some measure to compensate for the bony substance lost. In a few instances perfect union is the result, the fractured surface of the larger fragment uniting evenly with that of the smaller, as it is sometimes seen in paramedian fracture. Perfect union does not exclude the two deformities described above with their attendant facial asymmetry, but it does exclude pseudo-arthritis. Dental adjustment is imperfect, but mastication is quite possible, and the functional condition must be regarded as tolerable.

Such cases as these are, however, exceptional. As a general rule, lateral fracture with loss of substance is accompanied by marked superposition, similar to that seen in fractures of the leg and thigh. The superposition is from front to back; the segments of the dental arch remain approximately upon the same plane; and the end of the larger fragment is usually inside that of the smaller one (fig. 12).

What are the causes which tend to produce so constant an arrangement?

The immediate cause would seem to be the pivoting of the larger fragment upon its condyle. The fractured surface thus describes an arc which takes it within, or sometimes without, the fractured surface of the smaller fragment. The question arises, why should it be the larger fragment and not the smaller one which performs pivoting movements, or at least performs them to a preponderating extent? The ultimate

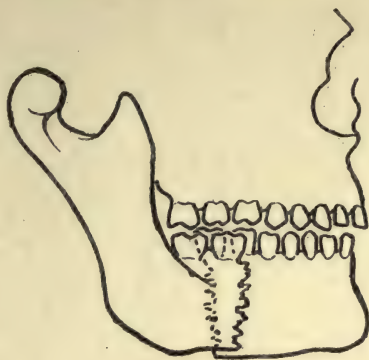


FIG. 13.—Lateral fracture. The posterior fragment is directed obliquely forwards, the obliquity being limited by the teeth which it contains.

cause of the movement seems to us to lie in the action of the muscles attached to the mental spines and the mylo-hyoid ridge. It is obvious that such action must exercise a preponderating influence upon the larger fragment.

Viewed in this light, it is easy to understand why the fractured extremity of the larger fragment is sometimes within and sometimes without that of the shorter fragment.

This, however, is not all. Superposition, whether slight or marked, is accompanied by lateral projection of the shorter fragment. The latter contains, or should contain, the inferior molars which become projected outwards. Where the lateral deviation is slight, the internal or lingual cusps of the inferior molars engage the intercuspidal hollows of the superior molars. Where the displacement is very marked,

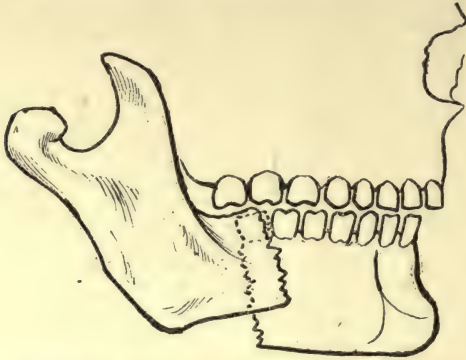


FIG. 14.—Lateral fracture. The posterior fragment is without teeth; its obliquity is more marked than that in fig. 13.

though this is rare, the inferior molars may pass quite outside the superior molars and fail to articulate with them at all.

The displacement of the larger fragment involves yet another issue which, though more difficult of observation, is none the less characteristic of lateral fractures, especially of those accompanied by important loss of substance: it determines the position of the smaller fragment.

As we have just seen, the smaller fragment is usually

driven outwards by the extremity of the larger fragment. It is also projected forwards in such a way that the posterior margin of the ramus, which with the subject in the upright position should be nearly vertical, becomes gradually more oblique, as shown in figs. 13, 14, 15.

In the case of a fracture such as that described, one, namely, in which the second premolar is absent, the

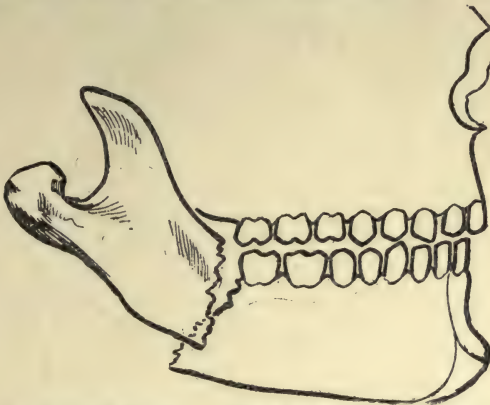


FIG. 15.—Lateral fracture. The line of fracture passes behind the molars; very marked obliquity of the posterior fragment.

other teeth being present in their entirety, the inclination from the vertical is slight. It could not become accentuated without altering in the vertical sense the dental plane of each fragment. Although the modification is slight, it is generally sufficient for the forward deflection of the lower border of the jaw to be appreciable. Where the smaller fragment is toothless (traumatism, previous dental caries), other conditions remaining the same, the degree of obliquity is greater

(fig. 14). It is still more accentuated where the position of the fracture is behind the last standing molar (fig. 15).

Where the loss of substance exceeds 2 cm., pseudoarthrosis seems to be the rule. It is frequent, even



FIG. 16.—Left lateral fracture with large loss of substance. Contact is effected by means of a bony bridge proceeding from the posterior fragment. Fixation of the fragment by means of an apparatus. The illustration shows the bridge by which the fragments are immobilised.

in cases where the break in the continuity of the bone is comparatively small.

(c) **Fracture of the angle.**—These cases closely resemble those in class (b), with this distinction, that the smaller fragment is of necessity invariably toothless. Hence, therapeutically they constitute a separate

group; anatomically and clinically they belong to class (b).

(d) **Fracture of the ramus.**—These fractures are difficult of observation: first, because the seat of injury is concealed beneath a dense muscular mass; second, because the derangement of function to which

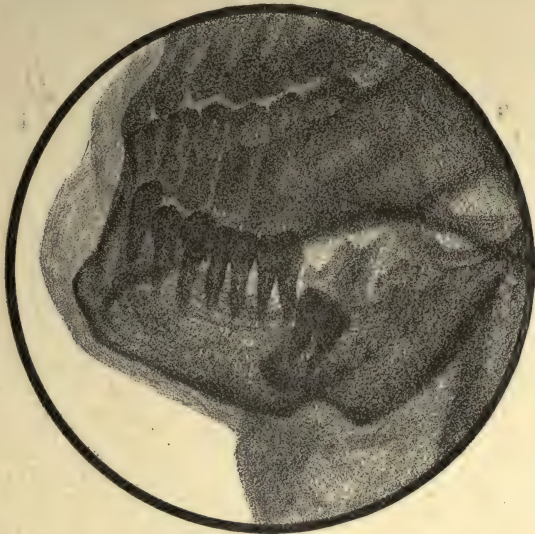


FIG. 17.—Right lateral fracture. Undeveloped third molar involved in the region of the fracture site.

they give rise is slight or even nil. As a matter of fact, we failed to recognise this particular injury for some months, and it was its apparent and incomprehensible rarity which led us to investigate the matter. We then discovered that it is far more frequent than we had imagined, its frequency being about the same as that of the other groups.

The teeth, valuable guides as they are in other classes of fracture, are useless or nearly so here. Hence it is much more difficult in cases of this sort to determine the exact nature of the injury and the nature and degree of displacement. Skiagrams are valuable aids, though difficult to obtain and also to interpret.

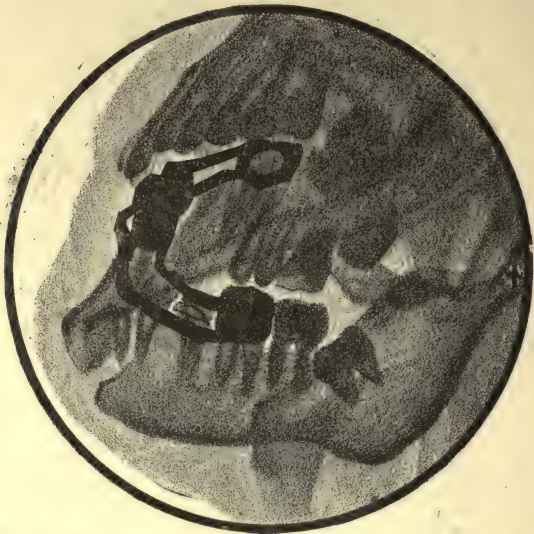


FIG. 18.—Right lateral fracture. Fixation by splint.

Fracture without loss of substance may occur in the ramus as well as in the body of the bone. These cases seem to progress simply without complications other than possible constriction. The fragments appear to be kept in place by the strong muscular bands which surround them, and there is no tendency to any marked displacement (fig. 20). Fig. 21 shows a possible dis-

placement of which up to now entire proof is not forthcoming. The two fragments are superimposed, the inferior being apparently outside the superior, the position resembling that seen in fractures of the following type.

Where there is loss of substance, a position very



FIG. 19.—Right lateral fracture with large loss of substance and numerous splinters. In process of union by immobilisation of the fragments in occlusion.

characteristic of the lower jaw is frequently though not invariably observed. The teeth of the fractured side are brought into contact with those above them, a condition which can only result from a union such as is shown in fig. 21a.

Do these fractures unite? From the difficulty ex-

perienced in correcting malposition in old fractures we assume that they do, but it is not certain that union

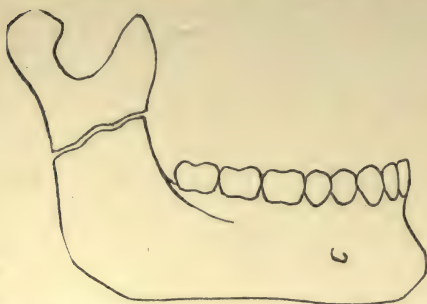


FIG. 20.—Fracture of the ramus without displacement of fragments or loss of substance. (This fracture does not in any way modify the shape of the mandible; its presence is not betrayed by any characteristic malposition; the subjective phenomena and skiagrams are the sole aids to diagnosis.)

is invariable. Pseudo - arthrosis is difficult to diagnose, which suggests that it has little functional significance. It is possible that it occurs with some frequency, but, as far as our experience goes, operation is not indicated.

(e) **Double and multiple fracture.**—These fractures are fairly frequent. In double fracture there may be



FIG. 21.—Fracture of the ramus with superposition of the fragments. (In fractures of this type the superposition of the fragments is accompanied by shortening of the ramus, which produces an error of occlusion.)

loss of substance at one or both fracture sites. A median fracture, or one included in the median line,



FIG. 21 *a*.—Fracture of the ramus with loss of substance and subsidence of the fragments. (The loss of substance has been followed by the union of the fractured surfaces, the length of the ramus being thus decreased by the length of the bony substance missing. The shortening of the ramus is accompanied by inevitable elevation of the body of the bone on the injured side, which is shown in occlusion by the malposition represented in this figure. There is contact between the superior and inferior molars of the fractured side, and an interval between those of the sound side. This interval is greatest in the incisor-canine region.)

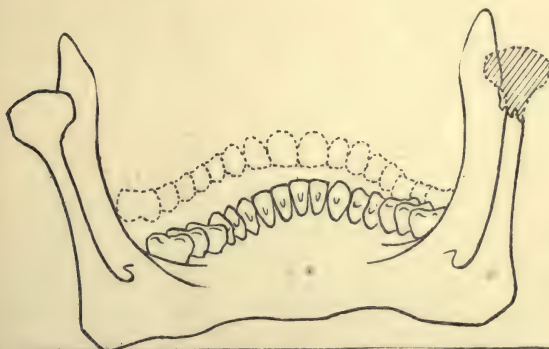


FIG. 22.—Loss of substance at the temporo-mandibular joint. (This lesion is accompanied by shortening of the ramus and consequent elevation of the body of the mandible. Union produces a malposition in occlusion identical with that shown in fig. 21 *a*.)

has a tendency to fall inwards. The consequent lingual displacement gives rise to dyspnœa, which has frequently been a cause of mystification to surgeons. Trachæotomy has been performed with regrettable frequency, in cases where simple traction of the displaced median fragment would have alleviated, or even abolished, the dyspnœa. The median fragment is occasionally displaced downwards.

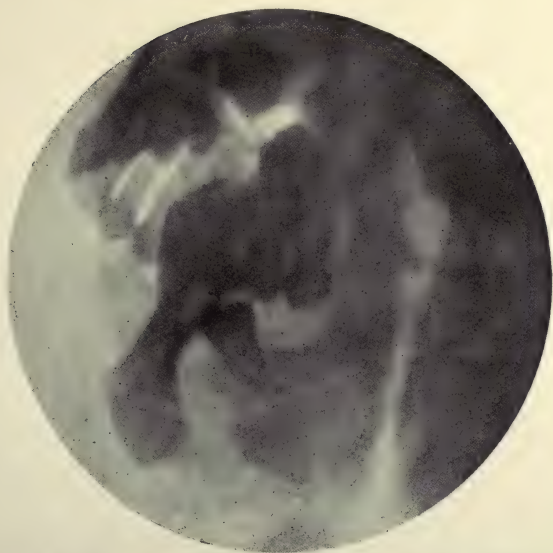
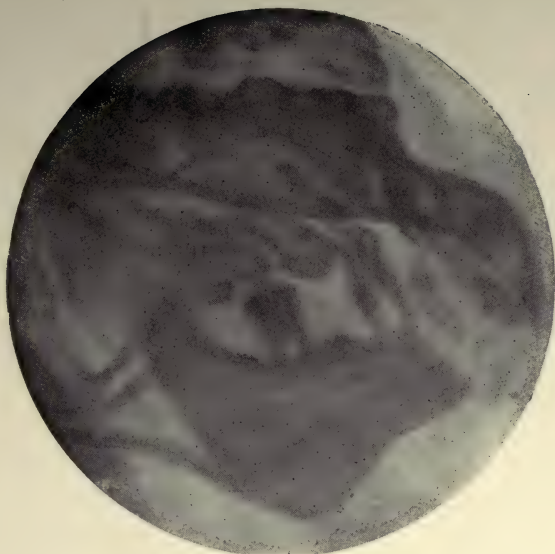
Where the position of the median fragment is lateral there is also a certain tendency to fall towards the buccal cavity. But as often as not it follows the line of deviation of one of the other fragments, with which its relation is approximately normal.

III. LARGE LOSS OF BONY SUBSTANCE. SHATTERING

We have up to now dealt exclusively with the specific characteristics of mandibular fracture in which the loss of substance does not exclude 2 to 3 cm. But there is a large class of case in which the loss of bony substance is far more extensive, the mandible being sometimes completely shattered. This class comprises two groups; those in which the injury is in the body of the bone, and those in which it is in the rami.

In a comparatively large number of cases the entire dental arch, together with its bony support, is missing. The fragments of the mandible still show a tendency to unite, but their small dimension renders this barely appreciable. The lesion is almost invariably accom-

PLATE I



Lateral fracture of the mandible. (Skiagrams. Direct reproduction.)



panied by considerable deficiency of the soft parts, with more or less complete suppression of the lower lip, and permanent salivary discharge.

Other cases are those in which the ramus, together with the angle and a more or less important portion of the dental arch, is missing. Here the injury is less serious, a certain number of teeth being preserved. The conditions somewhat resemble those seen in lateral fracture. In these cases the remaining portion of the mandible deviates towards the site of injury. The deviation is accentuated by the fact that a larger proportion of the horizontal part or body of the bone is involved in the fracture.

IV. LARGE LOSS OF SUBSTANCE OF THE SOFT PARTS

Gunshot injuries of the face are usually accompanied by more or less loss and laceration of the integument and soft parts. The study of such conditions forms no part of the object of this book. It should be kept in mind, however, that the degree of infirmity may be sensibly increased by the association of these lesions with those of the bony parts.

V. ANATOMICAL DEVELOPMENT

In common with all fractures, those of the mandible terminate in either union or pseudo-arthritis.

The length of time required for union varies considerably. As a general rule it is shorter in simple than in compound fracture. The vast majority of man-

dibular fractures, even where due only to contusion, are compound, and where there is no wound of the integument there is usually injury to the mucosa. Occasionally true simple fracture of the mandible is seen, no wound being present in either integument or mucosa. In cases of this sort the bony displacement

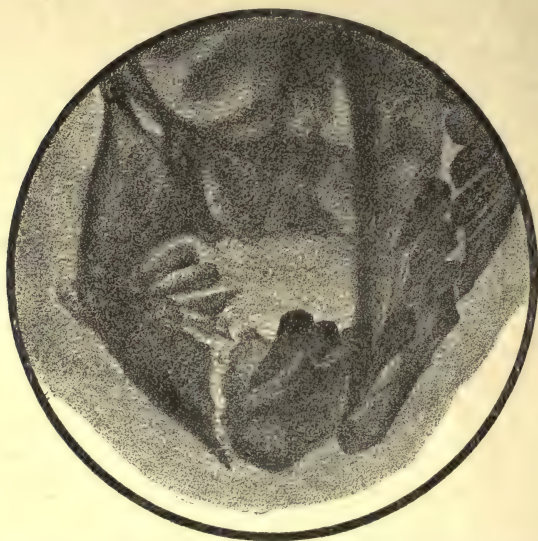


FIG. 23.—Double bilateral fracture with median third fragment.

must be either very slight or nil. It is our experience that even the small wound in the mucosa, by which fracture of the jaw without loss of substance is almost invariably accompanied, appreciably hampers the union of the bony fragments.

With rare exceptions all fractures without loss of substance unite. Muscular intervention seems to be

a negligible factor. Dental lesions, on the contrary, have considerable importance. Union is sometimes hindered by the presence of a root, especially if broken or carious, and more than once union has been effected by the simple expedient of extracting one or two teeth. Union of a simple fracture, or of a compound



FIG. 24.—Right lateral double fracture with intermedial fragment.

fracture with the wound in the mouth, without loss of substance, is usually effected in between two and three months. Pseudo-arthrosis has not been observed in cases such as these.

In the case of comminuted fractures with loss of substance the clinical conditions are obviously very different. A much more important part is played here

by accessory conditions (teeth projected into the fractured part, splinters in the sequestration stage). Operation invariably reveals a kind of fibrous callus between the fragments, which is probably due to intervention of the soft parts, and is a cause of the pseudo-arthritis. But it is the shape of the broken surfaces which seems to supply the chief factor in promoting pseudo-arthritis. In the cases which come under operation, the fractured ends are almost invariably pointed.

The progress of these fractures is a subject we shall return to later. For the moment it is sufficient to state that union may take place in one of two ways. In some cases the fractured surfaces come together, with consequent effacement of the fracture site and formation of a bony callus. This is undoubtedly the better process, and it should be promoted wherever possible. In certain other cases the loss of substance seems to be made good spontaneously, doubtless by ossification of the periosteal laminæ which have remained intact. But favourable results are hardly to be expected except where the loss of substance is slight. Spontaneous union occurs more readily in median than in lateral fractures, and this should be borne in mind where operation is contemplated.

Where there is loss of substance, union appears to be appreciably slower. Such fractures take at least three months to unite.

Pseudo-arthritis is fairly frequent. We must, however, define exactly what is meant by the term "pseudo-

arthrosis." Retarded union is not infrequent, and is almost invariably due to faulty methods of treatment. By means of a simple appliance we have succeeded in effecting a union in the case of fractures six months old or older. Pseudo-arthrosis cannot be regarded as a permanent condition until the fracture has been



FIG. 25.—Left comminuted fracture. (The two lateral fragments involve, one the alveolar border, the other the lower border. Union is accomplished by apparatus.)

under suitable treatment for a period which, to include exceptional cases, we propose to fix at six months. It must be considered, not in regard to the age of the fracture, but in relation to the results of a reasoned treatment, methodically pursued over a period of six months.

The arrangement of the fragments has the same significance in pseudo-arthritis as it has in recent fracture. In neglected cases the displacement is frequently exaggerated, but where treatment has been carefully and methodically pursued, the broken extremities, though separated by a varying interval, will face one another. They are quite solid, the bony canal being filled with a dense, compact, and resistant tissue. The extremity of the larger fragment seems, as a rule, to be the more bulky. The fractured surfaces are irregular, and are usually more or less pointed in shape. They are always united by a fibrous band possessing considerable resistance, a sort of fibrous callus, to which we shall have occasion to refer later, when dealing with the subject of surgical intervention.

CHAPTER IV

SYMPTOMS AND DIAGNOSIS

THE symptom-complex varies with the period at which the case comes under treatment.

All mandibular fractures pass through certain definite stages of development.

During the first stage, which lasts for a few days only, treatment must mainly centre around the preservation of life, for it is at this period that serious complications are likely to arise, such as infective conditions, dyspnœa, etc. At the second stage the fracture is termed "recent"; the work of reconstruction is not begun but the ground is prepared for it. The minimal duration of this stage is one month, its maximum two. At the third stage the fracture is termed "old." This is the really active stage of treatment. Its duration may last for six months or even for a year after the date of injury. The fourth stage comprises the treatment, if present, of pseudo-arthritis and malposition.

Fracture of the mandible is frequently accompanied by considerable damage to the face. Large wounds such as these are naturally liable to every kind of complication. Moreover, cases of this kind are frequently the subject of ill-judged intervention, the

results of which are a source of grave anxiety to the surgeons to whom the cases are ultimately referred. It may to a certain extent prevent repetition if we briefly enumerate these erroneous methods of procedure.

Every one knows, if only as the result of earlier researches in connection with resection of the mandible, that extensive loss of the median portion of the bone, or double fracture with a median third fragment, is accompanied by the falling of the tongue into the pharynx. This is due to the abolition of the points of attachment of the genio-glossal muscles. Yet in cases such as these, trachæotomy is frequently performed with the idea of relieving the dyspnœa or preventing asphyxiation. Such a proceeding cannot pass uncondemned. The obvious method is to pull either the fragment of bone or the tongue forward and so clear the air-passages. The result may be rendered permanent by means of a thread fastened either in the integument or in the ear. It must be borne in mind, however, that where dyspnœa is due to the presence of a foreign body, œdema of the glottis, etc., this method is quite useless.

Sébileau has protested very strongly against these trachæotomies, the gravity of which he emphasises. He also points out that in some instances gastrostomy has been performed. This operation can never be indicated except where all instruments for œsophageal catheterism, such as drains and œsophageal sounds, are lacking.

It was a common practice at the beginning of the

war to suture the flaps at an early stage, with the object of obtaining quicker and better repair of the wound. There has been a growing tendency on the part of surgery to discourage this practice. All surgeons with a war experience insist upon the absolute necessity of opening up all the passages, or, at least, of not closing them. This principle seems particularly applicable to injuries of the face, where the wounds almost invariably communicate with the buccal cavity which is naturally septic. These wounds should on no account be sutured on the skin side. On the other hand, it seems very expedient that wounds of the mucous surface should be sutured as soon as possible. Their restoration is not attended by troublesome after-effects, it has the advantage of eliminating a channel of infection, and at the same time facilitates any plastic operation which may be in contemplation. It has but one drawback—it is so rarely successful.

Although infective complications are undoubtedly facilitated by untimely intervention, these may also make their appearance in the case of wounds which have received appropriate treatment. Before and at the commencement of the war, surgeons insisted upon the frequency of septic troubles as well as upon their gravity. Now, however, such conditions are observed in very few cases, and when they do arise, continue for only a short period. The benignancy of wounds of the face is very generally recognised by surgeons attached to base hospitals, into whose hands patients are passed within an average period of four-

teen days from the date of injury. In our own service, the number of patients frequently exceeds 150, yet in eighteen months only one has died. In this instance death was due to general exhaustion consequent upon the rigours of the campaign rather than to a true septicæmia. Many of our colleagues, with a number of patients in excess of our own, have been still more fortunate and have not reported a single death. It has been observed from the beginning of the campaign that gas gangrene, which has had such terrible and far-reaching results in fractures of the limbs, does not occur in connection with wounds of the face.

Apart from general infective complications, local infections of the respiratory passages are also observed. If we are to believe the older text-books, these were formerly alarming in character and of considerable frequency. These local troubles may be occasionally observed at front-line stations; they are quite exceptional at the base.

The same observations apply in the case of secondary hæmorrhage, which occurs in connection with lesions of the face as of other parts, and which is undoubtedly of septic origin. It is liable to occur during the first few days. The suddenness of its onset, together with the impossibility in most cases of foreseeing it, constitute a grave source of danger.

All these complications are of septic origin. They may occur in connection with all traumatic wounds of the face, but their frequency is slightly greater in mandibular fracture.

I. RECENT FRACTURE

After the first period is over and septic complications are no longer to be feared, the symptoms of fracture should be carefully investigated.

Abnormal Mobility.—Of the two symptoms which are pathognomonic to fracture, that of abnormal mobility alone has a diagnostic significance in fracture of the mandible. Crepitation is invariably absent in fracture with loss of substance; in simple fracture it is difficult to obtain. Where obtainable its production causes great pain to the patient, and is liable to lead to further lesion of the soft parts, especially the mucosa. In fractures of the body of the bone, abnormal mobility is sufficiently characteristic to constitute a diagnostic sign. This is not the case in fracture of the ramus.

The method of determining abnormal mobility varies with the position of the fracture, whether anterior or lateral. Figs. 26 and 27 show the methods of obtaining the sign.

In median and paramedian fracture each portion of the mandible should be firmly held between the index finger and the thumb with the index finger uppermost, and the fragments should be moved one against the other. In posterior fracture, let us say of the right side, the left thumb is introduced into the mouth and pressure is exercised upon the teeth behind the fracture site, while the angle of the jaw is firmly grasped by the other fingers of the same hand. The right hand supports the other side of the jaw and

both hands endeavour to elicit movement at the site of fracture. Where the site of fracture is behind the last molar, the thumb is planted firmly upon the anterior border of the ramus.

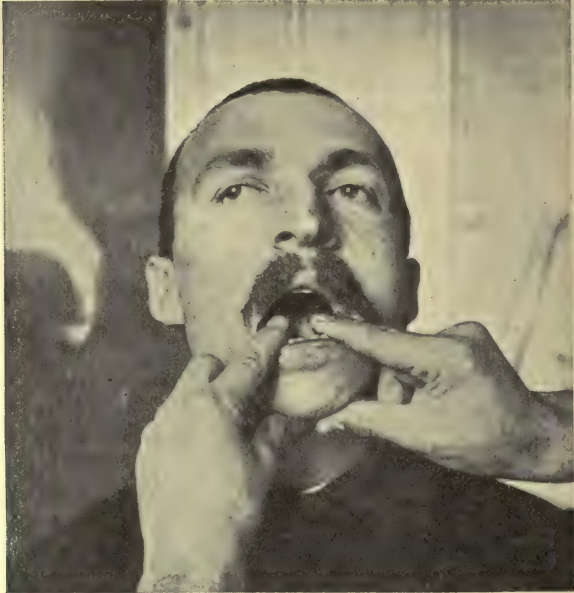


FIG. 26.—Showing method of examination for mobility in anterior fracture (median or paramedian). The two fragments are grasped by the thumb and index finger of the two hands and an attempt is made to move them one against the other.

As in the case of all fractures, slight mobility is not always easy of verification. When the teeth are all present the slightest movement between neighbouring teeth is apparent to the eye. But such a state of things is exceptional. The absence of several teeth

is the rule, and the sign is usually only perceptible to the touch. Opinions are not always in accord, especially as to whether or not the fractured portions have united. But these cases are exceptional, and, especi-



FIG. 27.—Showing method of examination for mobility in lateral fracture. The thumb of one hand is introduced into the mouth and is firmly planted upon the posterior fragment, which is supported by the fingers of the same hand. The anterior fragment is held in the other hand. An attempt is made to elicit movement at the fracture site.

ally where there is loss of substance, abnormal mobility is a diagnostic sign which is as a rule easy of verification.

In fracture of the ramus, however, this sign is usually absent and diagnosis is consequently very difficult.

Skiagrams when clear constitute the sole method of diagnosis.

Malocclusion.—Fracture with loss of substance is invariably accompanied by a certain degree of malocclusion. The malocclusions accompanying different types of fracture have been described in a previous chapter. The principal characteristics may be briefly summarised as follows :

1. In anterior fracture the fragments are in contact without tending to overlap. The dental arch is therefore narrowed, and tends to assume a pointed shape (reptilian jaw). The apex of the arch is consequently distal to the upper incisor teeth. The lower side teeth become internal to the upper side teeth. The deformity is more accentuated in the front than in the back of the mouth. In paramedian fracture, the whole of the teeth of the sound side tend to be displaced towards the fracture site, the displacement corresponding to one or two, or even more, teeth.

2. In lateral fracture the deformity is more complex. The long fragment inclines towards the fractured side, the median line being diverted in the same direction. Its extremity is usually inside the shorter fragment, which moves forward to compensate for the loss of substance. Owing to the fact that the shorter fragment is practically fixed at the level of the temporomandibular joint, this movement can only be accomplished by elevation of the fractured extremity (figs. 13, 14, 15). This elevation is more or less pronounced according to the number and position of the remaining

PLATE II



Lateral fracture of the mandible. Photographs show the full-face and the profile of the fractured side. Deviation of the chin towards the fractured side. The face on the same side appears shortened. The skin is elevated by overriding of the fragments. There is frequently a cicatrix. The sound side appears prolonged and flattened, without a cicatrix.



teeth of the fractured side. It is particularly marked in certain fractures of the angle.

3. The deformity accompanying fracture of the ramus is characterised by malocclusion of a characteristic type, the teeth of the fractured side meeting while there is still an interval between those of the sound side (figs. 20, 21, 22).

In fracture without loss of substance the displacement of fragments is very slight or nil. Occasionally it appears more marked, but this is only apparent, and is due to the malposition of teeth partially loosened from their sockets, or to alveolar fracture. Where the displacement is real, the teeth of one fragment will be displaced in either the vertical or horizontal plane. In either case correction of the deformity is usually simple.

The symptoms of double fracture are easily recognised by the methods described. There is characteristic displacement of the mobile fragment. It tends to drop downwards and to remain loose, with the result that, in occlusion, when the posterior teeth are in contact the anterior teeth are separated by a gap of two to three millimetres. Fractures of this kind may easily unite in malposition.

Facial Asymmetry.—In the *Presse médicale* (25. X. 1915) we published an account of the facial asymmetry characteristic of different fractures of the mandible. It is most pronounced in lateral fracture. The features of asymmetry are usually sufficiently marked to reveal at a glance the nature of the lesion. This

applies also to cases in which union has long been effected. The characteristic signs of asymmetry are as follows :

1. The median line, with the chin, is deflected towards the fractured side. The deviation is very apparent and has the effect of emphasising the sound



FIG. 28.—Zones of anæsthesia in fracture of the body of the mandible.

side, which, in comparison with the other, appears prolonged and more prominent.

2. The fractured side presents a degree of tumefaction which corresponds to the fracture site and is due to the presence of the callus, displacement of fragments, etc.

3. The prominence of the angle of the jaw of the

fractured side is abolished. Displacement of the smaller fragment causes the posterior border of the bone to slope forward, with the result that in profile it appears flattened and retreating.

4. The skin in the neighbourhood of the fracture is usually disfigured by a cicatrix of varying importance.

Cutaneous Anæsthesia.—We have shown, with Gauthier and Lheureux, that anæsthesia of the chin is a certain sign of fracture of the mandible. It is particularly useful in old cases where union has taken place some time previously and where retrospective diagnosis is difficult.

This anæsthesia is of course due to section of the inferior dental nerve, either in the canal or immediately in its vicinity. It is not observed in median and paramedian fracture, nor in fracture of the ramus when this is situated above the opening of the inferior dental canal. It seems, however, to be constant in lateral fracture. The zone of anæsthesia occupies a practically circular area upon the chin of a diameter of three to four centimetres, and this is prolonged on to the corresponding region of the lower lip. It frequently happens, though this is not a constant sign, that there is anæsthesia of the mucosa of the cheek and of the external gum as far as the fracture site. Insensibility of the inner gum is occasionally observed, but we have found it a very inconstant sign.¹

¹ It should be borne in mind that the continuity of the sensory nerves is sometimes interrupted by cicatrices. Hence irregular areas of anæsthesia arise, and these are liable to be confused with the results produced by section of the mental nerve.

There is of course anæsthesia of the teeth up to the median line. This is readily tested by means of a thermo- or galvano-cautery. Sharp pain results from its application to the teeth of the fractured side, while those of the sound side do not react.

Examination for abnormal mobility is usually accompanied by little pain in mandibular fracture. The explanation lies in the lack of sensibility of the anterior fragment.

II. OLD FRACTURE

Except in regard to modifications brought about by union or by methods of treatment, the signs of old fracture are similar to those of recent fracture.

Where there is pseudo-arthritis, abnormal mobility is usually very marked and may be readily obtained by the methods described.

Malocclusion and facial asymmetry are more or less pronounced according to the results of treatment. In the case of old fractures which have not come under treatment (such are still occasionally met with), the deformity, independently of union, resembles that of recent fracture. In such cases methodical treatment, though it may not effect a union, almost invariably succeeds in getting the larger fragment into good position. Occlusion of the major portion of the dental arch is thus established, and the chin is brought into the median line. The asymmetry affects only the smaller fragment, which retains its oblique and receding attitude, the teeth where present interdigita-

ting more or less imperfectly with those of the upper jaw.

Anæsthesia in the vicinity of the mental nerve seems to be constant. It is present in the oldest fractures independently of union. And it is unaffected by the results of osteo-synthetic intervention. For these reasons it constitutes a reliable retrospective sign in mandibular fracture.

Old fractures are frequently complicated by sinuses. These as a rule are not deep, and lead either to a centre of necrosis, sequestered or not, or to an osteitic cavity. All surgeons know how tenacious and persistent these sinuses are when they occur in connection with fracture of a long bone, especially the femur. To close them requires the most minute and prolonged care. Such is fortunately not the case in sinuses about the mandible. If the passage is well opened up and curetted, healing is certain to follow. The curette frequently brings away fungoid growths, small sequestra, the root of a tooth, or even a tooth itself displaced at the time of injury by the projectile.

Facial paralysis is frequent in both old and recent fracture. We have made no searching investigation, but it is safe to say that spontaneous recovery is frequent.

III. FRACTURE OF THE ANGLE

This variety is closely allied to lateral fracture and presents similar appearances: abnormal mobility, facial asymmetry, malocclusion. Separate classifica-

tion would not be necessary were it not that the condition presents a characteristic therapeutic difficulty. Owing to the fact that the site of fracture passes behind the last molar, the posterior fragment is invariably without teeth. Consequently it is not possible to apply prothetic mechanisms by the usual methods. Hence the classification is therapeutic rather than clinical. Surgical intervention has never in our experience been indicated. Unless there is large loss of bony substance, these fractures unite readily under mechanical treatment.

IV. FRACTURE OF THE RAMUS

The frequency is about the same as in the other classes of fracture, but the principal signs are absent and diagnosis is consequently more difficult. On the other hand the deformity, once its nature is recognised, is very characteristic. On closure of the jaws the teeth of the fractured side come into contact with those above them, while the teeth of the sound side are still separated by an appreciable interval (see p. 27 *et seq.*). The condition can only be accurately diagnosed by means of skiagrams.

V. THE USE OF RADIOGRAPHY IN MANDIBULAR FRACTURE

As in the case of all the curved bones, radiography presents special difficulties. The parts most difficult of observation are the anterior or mental portions, and the highest part of the ramus, namely, the condyle.

It will be seen, however, that in the majority of our skiagrams the ramus, the condyle, and even the coronoid process are all well shown.

Skiagrams of the lateral branches and of the lower portion of the vertical branches give valuable results.

It is of course necessary to take a separate picture of each side. The secret of obtaining successful pictures lies in taking the mandible at a very oblique angle, in such a way that the part of the bone which is not in contact with the plate is pushed as far back as possible and does not obscure the

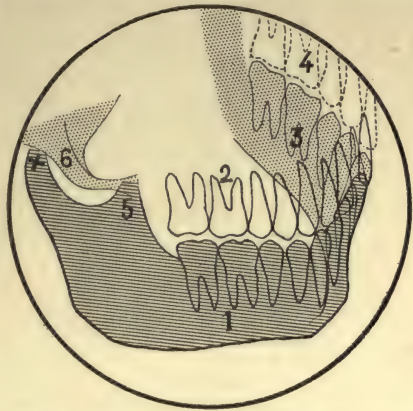


FIG. 29.—Diagram showing the method of interpretation of skiagrams of the mandible. The skiagram is intended to show the left side of the bone. (1 and 2, superior and inferior rows of teeth of the left side; 3 and 4, rows of teeth of the right side—by the obliquity of the rays these latter are removed as far as possible from the image of the left side; 5, left coronoid process; 6, left condyle. The latter is marked with a cross, which is reproduced, and serves as a guide in skiagrams of mandibular fracture.)

image which it is desired to obtain. This result is not always obtainable, the two images sometimes appearing in a certain degree of juxtaposition. Such proofs are very difficult to interpret. For this reason a few hints on the management of skiagrams in mandibular fracture will not be out of place.

Fig. 29 is a reproduction of a drawing from a skiagram obtained under the most favourable conditions. It shows the outline of the left side of the bone. The condyle and its neck, as well as the coronoid process, are clearly seen. But results are by no means always

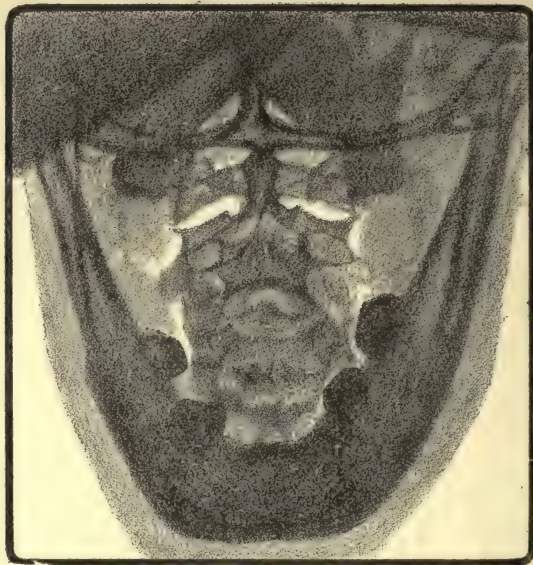


FIG. 30.—Skiagram obtained by application of the full-face to the plate.

so happy. Where there is insufficient obliquity of the rays these parts, as well as the ramus, are more or less confused with the image of the ramus of the opposite side. Or, as sometimes happens, they are obscured by the details of the cervical vertebræ. And it must be borne in mind that, even in cases where a sufficiently clear image is obtained, the

obliquity of the rays sensibly deforms the outline of the upper portions of the bone.

The X-rays successively encounter the dental alignment of the right side and of the left, hence four rows of teeth should appear in the picture. The two lower rows represent the superior and inferior teeth of the side nearest to the plate. This image is the clearer and it is the one which it is desired to obtain. The two upper rows represent the image, or rather the radiographic shadow, of the upper and lower teeth of the side furthest removed from the plate. This is the image which it is not desired to obtain. The obliquity of the rays should correspond exactly to the distance from the field at which it is desired to place the second image. The excellence of the skiagram depends upon the lack of clearness of the second image and its distance from the first. In a bad picture, both images are projected at approximately the same point, the outlines which should be separate thus becoming confused. The difficulties of the method should not be allowed to be a cause of discouragement, for in mandibular, as in other fractures, good skiagrams are valuable diagnostic aids

VI. CLOSURE OF THE JAWS

Closure of the jaws is perhaps the most frequent complication of wounds of the face, but as far as our experience goes it is infrequent in mandibular fracture and particularly so where the fracture is complete.

In another place ¹ we have described a hypermyotonic form which is very common. In our experience it includes four-fifths of cases. Its characteristics are: The comparative insignificance of the wound, which is sometimes unaccompanied by even incomplete fracture; the fact that, by the method described,

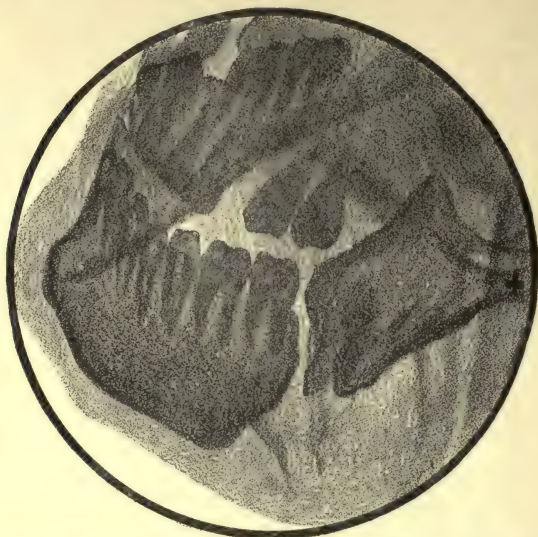


FIG. 31.—Fracture of the angle, right side. Marked obliquity of the posterior fragment.

the mouth may be opened at one sitting; and the precipitate nature of the condition, the mouth shutting immediately upon injury. As a matter of fact this form of closure, though frequently accompanying

¹ La constriction des mâchoires par blessures de guerre, Académie de Médecine, February, 1916. *Presse médicale*, August 24th, 1916. Interallied Dental Congress, 1916. *Presse médicale*, February, 1917.

mandibular fracture, does not seem to be caused by it. The same applies to the cicatricial form, which is the outcome of more or less important destruction of the soft parts.

The presence of fibrous bands in the subcutaneous and submucous structures is another cause of closure

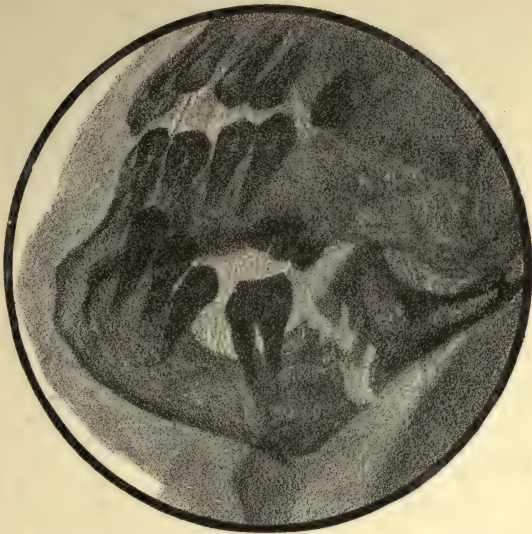


FIG. 32.—Fracture of the ramus, right side.

of the jaws. In some instances these are due to prolonged superficial cicatrices with sclerosis affecting either the temporal muscle or the masseter. More frequently a more or less resistant area, which is sometimes very rigid, is observed beneath the buccal mucosa. This it is which prevents the depression of the mandible.

But all these forms of closure are present in mandibular fracture solely as complications of accessory lesions of the soft parts. In closure arising from ankylosis of the temporo-mandibular joint, however, the case is otherwise. It is readily conceivable that injury to this joint and to the bony masses in its



FIG. 33.—Complete ankylosis of the temporo-mandibular joint. Post-mortem specimen from a man who had suffered violent traumatism many years previously. The dental arch of the same side was bent inwards; the other temporo-mandibular joint, immobilised at the same time, was quite normal.

vicinity may, as in the case of other joints, provoke ankylosis by union of the articulating bony surfaces. Such a condition among patients of war has never been observed by us. One case, however, came under notice, that of a civilian. The patient was a young man of twenty who was brought to the Hôtel-Dieu

at Marseilles with a gunshot wound in the dorso-lumbar region. There was injury to the cord with paraplegia. At the time when he came under observation the injury was several months old and his general condition forbade surgical intervention. Now for several years this man had suffered from absolute constriction of the jaws. The mandible was incapable of performing the slightest movement, either active or passive. Nevertheless long habit, together with the absence of several teeth, had allowed him to assimilate his food, and his general development was absolutely normal. He had even formed one of a gang of Marseilles roughs, and his unlucky star alone was responsible for an "accident" which doubtless made of the aggressor a victim. The photograph shows the condition of the joint after death; ankylosis was complete. From what we could afterwards learn, the lesion was the result of a fall from a height in childhood. It is an interesting fact that the other temporomandibular joint, in spite of its long immobilisation, was entirely normal.

We have had no personal experience in the treatment of this form of closure. For information concerning the operative measures which are indicated in the condition, we cannot do better than refer the reader to the writings of Ombrédanne.

VII. CLINICAL DEVELOPMENT

The details of this subject have been largely dealt with in the chapter on pathological anatomy. Clinical

progress in mandibular fracture terminates normally in union, with more or less malposition according to the amount of substance lost. The question of sinuses has already been discussed.

(a) **Pseudo-arthritis.**—As we have already pointed out, and shall again have occasion to repeat, pseudo-

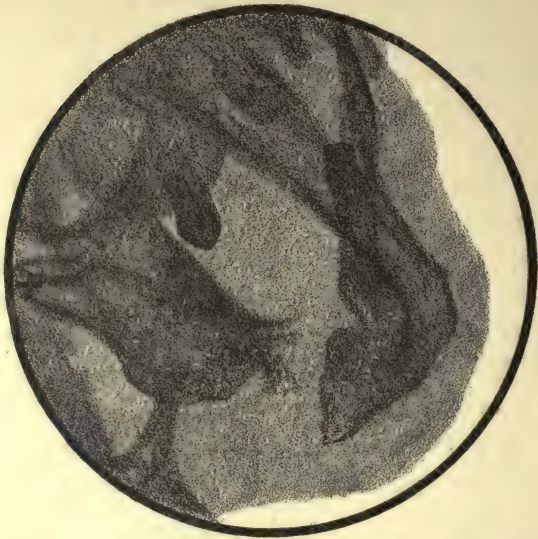


FIG. 34.—Left lateral fracture with large loss of substance. Permanent pseudo-arthritis.

arthrosis is not established until mechanical treatment has been pursued for some considerable time. A period of at least six months should be allowed. Occasionally, however, as in shattering of the mandible with large loss of substance, no known therapeutic measure is able to overcome it and it must be regarded as inevitable.

In the case of the jaw, pseudo-arthritis does not

possess the absolute functional significance only too frequently attaching to it in connection with fracture of the long bones. Nevertheless the degree of incapacity which it is able to produce is frequently considerable. In simple pseudo-arthritis, where the loss of substance is not very extensive, performance of



FIG. 35.—Left lateral fracture with large loss of substance. Mechanical treatment resulted in slight pseudo-arthritis with good occlusion.

function is still possible though it is naturally very imperfect. Mastication of hard substances is impossible, but all soft foods, such as crumb of bread, tender, well-cooked meat, etc., can be consumed. Where, however, a large proportion of the dental arch is missing, and even where only half the mandible is out of play,

mastication is practically impossible. Only food in a condition fit to swallow should be introduced into the mouth. Trituration is a function of the tongue, and, as may be readily imagined, its performance in this direction is very much reduced.

From the functional point of view, then, there are degrees of pseudo-arthritis. That this is also the case in regard to treatment we shall see later.

(b) **Types of Malocclusion observed in United Mandibular Fracture.**—The various types of malocclusion which follow union in mandibular fracture are associated with deformity in varying degree. These deformities reproduce the characteristic bony displacements which, not having been reduced by clinical methods, have become fixed.

Median and paramedian fracture are followed by mandibular [atresia] due to linguo-version of the fragments. Lateral fracture and fracture of the angle are followed by lateral deviation and retraction of the larger fragment, with displacement above, in front of, and outside the posterior fragment. Faulty union of the ramus may be revealed by an interval on closure between the teeth of the sound side, with slight retraction. These are definite anatomical lesions, and correction of the malocclusion associated with them is only possible where the normal shape and orientation of the jaw can be restored by surgical or mechanical means.

Where the callus, as shown by skiagrams, has not undergone complete ossification, mechanical measures

should yield the best results. The mechanisms, to be described later, are similar to those employed in reducing old fractures.

If the callus has undergone ossification, correction of the deviation can be obtained only by surgical means. The most favourable operation is undoubtedly oblique osteotomy, so frequently employed in the surgery of the limbs. We ourselves have never had occasion to employ it, but it ought to be attended by excellent results in cases such as these. It has frequently been employed with satisfactory results by Sébileau. The oblique incision permits the separation of the two fragments, the angular extremities being kept together by means of a plate. The immobilisation thus obtained is reinforced by a mechanism attached to the teeth, which re-establishes the normal occlusion. In addition to the malocclusions due to serious bony lesion, there is yet another form the pathology of which is complex and its symptomatology entirely specific.

This type of malocclusion is seen after fracture of the horizontal portion of the mandible. It is characterised by a more or less marked tendency to lateral deviation of the whole of the mandible of the fractured side, with the result that the dental arches no longer coincide and all functional activity is lost.

This position is maintained even in repose. When the jaws are closed the dental arches are intercrossed, their sole contact-point being in the incisor region. The deviation becomes accentuated when the jaw is

dropped. The deflection of the mandible towards the fractured side produces a similar deformity of the buccal opening, lending to it a very characteristic appearance, rather happily termed *bouche du chanteur de village* (village singer's mouth) (figs. 36 and 37).



FIG. 36.—Lateral deviation known as “*bouche du chanteur de village*” (village singer's mouth).

In extreme cases it is almost impossible, even by the exertion of considerable physical force, to reduce temporarily this deviation. In any case such reduction is accompanied by intense pain in the region of the temporo-mandibular joint.

In most cases normal occlusion can be momentarily re-established by the exercise of more or less extreme pressure in the direction contrary to the deviation. But as soon as pressure is removed, the deviation is instantly reproduced by a lateral movement of the



FIG. 37.—Lateral deviation known as “bouche du chantre de village.” (The lips are held back to show the position of the dental arches.)

mandible, which the patient declares that he is unable to control.

What is the cause of this malposition? All the patients in whom we have observed it appear to have suffered neglect of their maxillo-facial injuries. In

some instances they never came under special treatment. Their jaws united without mechanical aid, the deviation establishing itself by degrees without attracting particular attention. In others, they had received special treatment, immobilisation mechanisms had been fitted to them and they had then been sent to their homes as convalescents. It is probable that, owing to lack of proper supervision, the vicious attitude developed during this leave. In spite of very close observation we have not observed the condition to develop in a patient while under our care. This seems to prove that, like the constriction of the myotonic jaw, *la bouche du chantre de village* is a condition which may be guarded against by means of suitable treatment.

At first sight its pathogenesis seems obscure. The deformity of the mandibular arch cannot be regarded as an etiological factor, for we have frequently observed that, in these cases, there was little or no deformity of the mandible and that the normal concordance of the arches was intact. This was proved by taking plaster models of the two arches which, when superimposed, met in perfectly normal occlusion.

Upon further investigation it became evident that the horizontal portion of the mandible had undergone a slight but distinct reduction in length. The distance from the angle to the chin of the sound side was about one cm. longer than that of the fractured side. This reduction had no influence upon the general outline of the mandibular arch. Such reduction is

nearly constant in all united fractures without malocclusion, and we do not believe, therefore, that the slight shortening of the horizontal portion can be regarded as the ultimate cause of the condition.

The same holds good of the articular modifications. In attempting the reduction of the deformity, a varying degree of stiffness of the joint is encountered. This symptom is of varying constancy. In our opinion this is a secondary condition, consequent upon the displacement of the articular surfaces and of the meniscus and their fixation in abnormal position.

It seems to us that the malposition known as *bouche du chanfre de village* is not due to bony or articular lesion, but is the outcome of functional derangement of the masticatory muscles. As a result of the fracture, the patient adopts an attitude which he at first corrects spontaneously, and which undoubtedly he could completely overcome were he to practise what neurologists term *l'effort inverse*, or if his will-power were reinforced at the psychological moment by a suitable mechanism. The vicious attitude becomes still further ingrained by muscular phenomena of the dynamic kind, very specific to the condition and characterised by hypertonicity and hyperexcitability of the muscles of the fractured side. These dynamic phenomena appear to withdraw the affected muscles from the influence of the will-power. A sort of disequilibrium results, a lack of co-ordination in the movements of mastication, the muscular synergy having disappeared.

It is for this reason that *bouche du chanfre de village* is included in the syndrome which we have termed myotonic constriction of the jaws. This, in its turn, is included in a group of myotonias described by neurologists (Sicard, Babinski)—namely, incurvation of the trunk (*camptocormia*), *main en bénitier*, *main en col de cygne*, etc.

There is moreover another striking analogy between myotonic constriction and *bouche du chanfre de village*. The latter is sometimes seen where no fracture is present, as the result of slight lesions of the cervical region, such as superficial wounds and muscular seton. We have observed a similar etiological peculiarity in the case of myotonic constriction.

Provided that a suitable treatment is instituted at an early stage, the prognosis of this condition is good. Where treatment is deferred for some time after injury, the prognosis is not good. The articular modifications brought about by the malposition are then more difficult of reduction; the muscles undergo structural modification and are less easy to reduce. We have never yet, however, seen an incurable case. Moreover, as in the case of myotonic constriction, we have never observed trophic derangements analogous to those seen in acromyotonia, which so singularly darken the prognosis in this condition.

CHAPTER V

MECHANICAL TREATMENT

I. ELEMENTARY PRINCIPLES

BEFORE entering into the details of the methods advocated in individual cases of mandibular fracture, it is expedient to indicate briefly, for those of our readers who are not specialists, the principal types of apparatus in use in the practice of prosthetic dentistry as well as the results obtainable from each.

These appliances resemble one another in their object, which is to replace teeth which have been lost. They differ from one another in their mode of anchorage. The most simple form may be removed and cleansed by the patient himself; this is termed a *removable* appliance. It consists of a vulcanite or metal plate covering the alveolar ridges or the palate to an extent which varies with the number of teeth to be replaced. The artificial teeth are attached to this plate at the required positions. The retention of this appliance is effected by means of hooks round existing teeth, by sliding posts attached to roots or, where the jaws are totally deprived of teeth, by lateral springs uniting the two artificial rows. Suction

cavities are also employed for upper dentures. These are small cavities on the palatine surface of the plate ; by means of suction the patient creates a void, which immediately brings in the factor of atmospheric pressure, by which the plate becomes firmly applied to the roof of the mouth. Rubber washers of different kinds

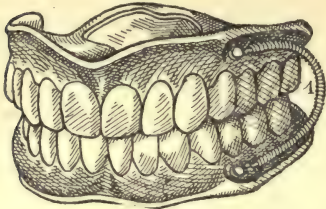


FIG. 38.—Complete set of artificial teeth. Type of removable mechanism. (The stability of this apparatus is assured by the springs on each side, by which the upper and lower dentures are united. On the palatine surface of the upper mechanism a small cavity is shown, known as the sucker. When the mechanism is in place, the patient creates a void by means of a sucking movement which causes the plate to adhere to the palate.)

are sometimes employed to reinforce or facilitate the action of these suckers.

The prototype of fixed mechanism is the bridge. This is a rigid structure to which the artificial teeth are attached and which requires for its support at least two sound teeth. The teeth which serve as pillars must be strong and healthy. The

method of anchorage is by means of metal caps which cover the entire crowns. Where roots are employed as pillars, metal screws are used. These penetrate as far as possible into the root canal, which has previously been enlarged, the free surface of the root being covered by a cap. In addition to these methods of anchorage, which are the ones most in general use, gold screw-blocks, perforated crowns, etc., may be employed. It is not necessary to describe them here.

The platform of the bridge is composed of metal, and sufficient space is left between its lower surface and the gum to permit of the bridge being cleansed *in situ*. The apparatus is permanently attached to its anchorage by an osteo-

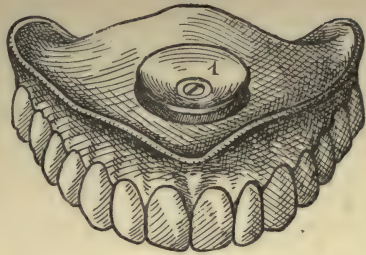


FIG. 39.—Complete appliance for the upper jaw with india-rubber sucker. (To reinforce the action of the sucker as described in fig. 38 a small india-rubber washer (1) is employed. It adheres to the palate in the manner of a cupping-glass.)

plastic cement. Of all mechanisms the bridge is the one which permits of the most perfect restoration of function. The pillars, however, must be very judiciously chosen and prepared, and it is essential that dis-

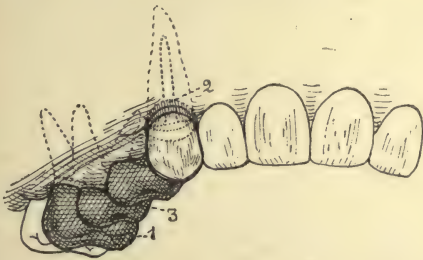


FIG. 40.—Bridge. Type of fixed apparatus. (The first molar is covered by a metal cap (1); the root of the canine serves as support for a screw-cap (2). These two points act as pillars. Between them stretches the platform of the bridge, represented in the drawing by two solid crowns which replace the absent premolars (3). Between the platform of the bridge and the gum a sufficient interval is allowed to permit of the cleansing of the mechanism.)

proportionate demands should not be made upon them. For this reason, small bridges carrying not more than three teeth are the most satisfactory.

There is yet another type of mechanism

which combines the methods of anchorage of the bridge with those of the plate, and this is termed the removable bridge. It is a mechanism designed by us for the treatment of median pseudo-arthritis. It is described in full detail in a later chapter, and to that we refer the reader.

The description of these three types of apparatus shows the extent to which teeth which have been retained may be employed. The principles are well known to stomatologists; they serve as valuable guides in the manufacture of the numerous mechanisms employed in the treatment of fracture of the jaw.

Another important physiological phenomenon, and one which should not be lost sight of, is the extreme mobility of the temporo-mandibular joints and their wonderful capacity for adaptation. Examples are constantly furnished by modern dentistry and orthodontics.

II. THE IMMEDIATE TREATMENT OF LESIONS

What methods should be employed immediately after injury in mandibular fracture?

The large majority of cases might undoubtedly be immediately transferred to special centres at the base for the treatment of maxillo-facial injury. These comprise the less serious lesions, the incomplete fractures, and the complete fractures with little or no loss of substance. Such cases have all passed through a field station. The wounds of exit and of entry have been dressed and drainage of the integumental side,

where necessary, has been effected. At the evacuation hospitals, where there is usually provision for stomatological treatment, the preliminary treatment just referred to can be supplemented by thorough cleansing of the buccal cavity, and by the application of a four-tailed bandage or suitable sling to give temporary rest to the fragments. In lieu of the four-tailed bandage an Angle's arch may when possible be adjusted. This mechanism provides an excellent means of obtaining an emergency immobilisation. It is a kind of general appliance which may be adapted to each particular case, and every evacuation hospital should be well provided with it. To the practised stomatologist its attachment requires half an hour at the most, and the slight fatigue experienced by the patient after the manipulation is completed is amply compensated for by the comfort experienced during the rest of the journey. Such cases arrive at the base in excellent condition. Their diagnosis papers should be marked "evacuation at a centre for facio-maxillary treatment," which greatly facilitates their distribution among the hospitals of the interior.

All cases in which the lesion is at all grave should be kept for a time at the front. It is in these cases, which are too varied and complex for description here, that complications are most likely to arise. Such are: primary and secondary hæmorrhage of the lingual, facial, external carotid, and internal maxillary and its branches; traumatic shock; asphyxia from division of the genio-glossal muscles and consequent

descent of the tongue into the pharynx ; primary infective conditions ; and secondary broncho-pulmonary, gastro-intestinal, and general infective conditions.

We do not propose to enter into the details of either a stimulant medication or its indications.

By surgical drainage of the tract, in accordance with the methods of general surgery, it is possible not only to reduce the local infective conditions, but to discover and to ligature arteries which have been laid bare and which are liable to prove a source of secondary hæmorrhage.

Early resection of the bone should be avoided. Free splinters should be removed, as well as bony fragments, portions of teeth, and projectiles situated in the soft parts: In order to prevent incessant flow of saliva and to facilitate feeding, it is sometimes necessary to perform emergency operations of a plastic nature upon the teeth and lips. This is a resource, however, which should be employed with great discretion and under conditions only which permit of the efficient drainage of the wound.

To guard against asphyxiation, a silk thread should be passed through the tip of the tongue and attached to the dressing by means of an adhesive strap. This method allows the tongue to be drawn forward and kept in position. The performance of trachæotomy cannot be too strongly condemned. Not only is it entirely useless in the circumstances, but it is extremely dangerous, for it creates a port of entry in the near

proximity of an extremely septic area from which infection is very liable to spread.

The stomatologist on his side should see that the buccal cavity is kept scrupulously clean. Only absolutely necessary extractions should be made, however, for it is essential that the state of shock should not be augmented. Temporary treatment should be confined to making the patient comfortable. Sedative dressings should be applied to the surfaces of teeth which have been broken, exposing the dental pulp. The fragments of bone should be

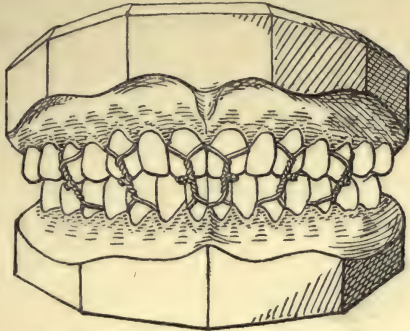


FIG. 41.—Extemporary method of obtaining immobilisation in occlusion. (Ligatures of brass wire are slipped round the necks of a certain number of corresponding teeth of both jaws. The ends are then interunitied, the result being a perfect immobilisation of the mandibular fragments.)

immobilised by means of mechanisms which are easy of adjustment. Angle's arch (fig. 49), interdental and intermaxillary ligature are the measures recommended (fig. 41).

On the recommendation of Pont a simple pocket-case of instruments has been adopted by the medical service, which renders the adjustment of Angle's arch a very simple manœuvre ; one, moreover, which may be employed at a stationary ambulance or at an evacua-

tion hospital. This pocket-case contains three Angle's arches, a pair of flat pliers, a pair of scissors, a file, and a wrench.

It is most important that profuse irrigation by a douche be carried out three or four times a day. Permanganate 1 in 8,000 and nitrate of silver 1 in 20,000 are the best solutions.

It is a wise precaution to feed these patients by a naso-pharyngeal tube. In this class of case, movements of deglutition are invariably both painful and awkward.

Sébileau states that patients have come under his notice upon whom gastrostomy had been performed. This operation is never indicated except where the simple apparatus necessary for œsophageal catheterism is lacking.

III. MECHANICAL TREATMENT OF FRACTURES

The management of mandibular fracture involves two problems: to obtain a good union on the one hand and, on the other, to maintain or to restore the occlusion, for this is essential to good mastication.

In a case of simple contact fracture without loss of substance, this double object is readily fulfilled. Where there is loss of substance the problem is a more delicate one. How is a good union with satisfactory callus to be effected when the fragments are separated by an interval of varying extent? On the other hand, admitting the possibility of effecting a union, how is function to be preserved?

Certain surgeons, in pursuance of the principle advocated formerly by Claude Martin, make their objective the re-establishment of the occlusion of the teeth. Their method consists, whatever the extent of the breach, in immobilising the mandibular fragments in such a way that the inferior teeth preserve their articulation with those above them. . Martinier and Lemerle, in a work which appeared in 1915, describe the method as follows :

“ After a loss of substance sufficient to produce shortening of the mandible, the fragments should be regularised and the case should be handled as in partial resection of the bone. A block of vulcanised india-rubber inserted into the wound prevents cicatricial retraction. When the epidermal covering of the scar is complete, the block is replaced by an ordinary mobile dental apparatus the base of which, by filling the cavity formerly occupied by the lost fragment of bone, assures the continuity of the mandible.”¹

The method of treatment by the immediate employment of mechanical contrivances could not be better described, nor could its advocates more clearly demonstrate their attachment to the principles advocated by Claude Martin.

It is not possible for us to identify ourselves with these views. The regularisation of the fractured surfaces and the removal of splinters, some of which may have retained their periosteum and thus their

¹ Martinier and Lemerle, *Prothèse restauratrice buccofaciale*, J. B. Baillièrre, 1915.

vitality, appears to us contrary to sound surgical principles. Further, how will the patient bear the immediate application of a mechanism, which is bound to retard the cicatrisation of the wound and which must induce septic conditions of the buccal cavity, exposing him over a long period of time to the dangers of broncho-pulmonary, gastro-intestinal, or general infection ?

Even more deplorable in our view is the result aimed at, for all that the method can hope to achieve is a pseudo-arthritis. We know that eventual mechanical treatment is able to effect a certain solidarity between the mandibular fragments and to re-establish, to a certain extent, the masticatory function. But one cannot fail to recognise that the result is a transitory one, the period of usefulness of such mechanisms being dependent upon the preservation of the teeth. The latter, serving as they do as points of anchorage, undergo a supplementary strain which is not calculated to prolong their duration, and irremediable infirmity must sooner or later show itself.

It does not seem that Martinier and Lemerle's technique has been very frequently employed. On the other hand, we know that the re-establishment of normal dental occlusion forms the chief aim of many stomatologists, who are content to immobilise a fractured mandible in good occlusion without troubling about the co-adaptation of the bony fragments.

Where the loss of bony substance is small, the method has much to recommend it, for union under such

conditions almost invariably follows its employment. Even in cases where the loss of bony substance is considerable, namely, 2-3 centimetres, the fragments have been known to unite as the result of simple immobilisation. Whether in these cases some shreds of periosteum remained intact, or whether destruction was not as extensive as it appeared to be, is not known. In spite of these results, it is none the less true that in this class of case, treated in this manner, union is exceptional and can never be safely predicted.

The methods which we ourselves advocate have for their chief object the prevention of pseudo-arthritis. As will be shown later, the object is usually to establish the co-adaptation of the fragments, even at the price of mandibular deformity. It is not essential that the mandible should reacquire its anatomical outline for a satisfactory occlusion with restoration of function to be established. As we have shown in another place¹ it is always possible to correct or to compensate for the deformity.

Restorative mechanisms are employed only to remedy very extensive pseudo-arthroses, and then only when surgical measures have failed.

In view of the conditions peculiar to mandibular fracture and the complex problems associated with

¹ Imbert and Réal, "Les fractures latérales de la mâchoire inférieure avec perte de substance," *Odontologie*, September 30th, 1916.

its treatment, certain authors have found it expedient to treat these lesions on special therapeutic lines.

Cavalié proposes "a general anatomical clinical treatment divided into three periods."

First period.—Restoration of the mandibular arch either by surgical means, by mechanism, or by the simultaneous employment of both methods.

Second period.—Orientation of the arch by surgical or mechanical means or by both.

Third period.—Temporary and permanent adjustment of mechanical appliances.

Frey¹ describes four stages in the treatment of mandibular fracture. The first stage, that of orthognathia, has for its object the re-establishment of the normal relationships between the teeth and the jaw. The second stage, that of contention, consists in the maintenance of the fragments in the conditions of normal intermaxillary and interdental relationship which have already been established. The third stage comprises dynamic exercises, the stomatologist endeavouring to re-establish the synergy of the masticatory muscles and to overcome the retraction of the cicatrices. The fourth stage is that of mechanical replacement or prosthesis (from the Greek, *I replace*).

The physiological method advocated by G. Villain² does not, as a matter of fact, introduce a fresh thera-

¹ Frey, "Un aperçu de la prothèse restauratrice dans les fractures des mâchoires et mutilations de la face," *Paris médical*, August 21st, 1915.

² Geo. Villain, "Traitement physiologique des fractures et des luxations du maxillaire inférieur," *Odontologie*, July and August, 1916.

peutic idea. This author advises, and very justly, the systematic employment of the movements and of the tonicity of the muscles as forces of reduction and contention. In this connection he advocates the crank, an excellent apparatus to which we shall return later.

From our point of view all these authors possess the same fault, namely, that of making the restoration of dental occlusion their primary object, union of the fragments being given a secondary place. Moreover, surgeons who have been disappointed in the results of special technical methods are not likely to accept willingly yet another special therapy and a fresh terminology. For this reason we shall continue to employ the terms "reduction" and "contention," the significance of which is well known and their employment in connection with general surgery universal. By "reduction" we mean, not only the co-adaptation of the fragments with the object of effecting a satisfactory union, but also the establishment of an occlusion which will permit of satisfactory mastication. It is only in extreme cases accompanied by considerable loss of substance, where it is impossible to bring the fractured surfaces together, that "reduction" is confined to the re-establishment of normal dental articulation.

In recent fractures, that is to say, those in which the processes of bony repair are not far advanced, early reduction is readily obtainable. Treatment is confined to the employment of an immobilisation

apparatus, constructed by special methods upon a model of the jaw modified by the form which it is desired to produce.

In old fractures rapid correction of the deviations and deformities of the mandible is not possible. These cases necessitate the employment of mechanisms the action of which is more or less gradual, and which are not replaced by passive appliances for contention until the jaws have recovered their normal relationship. The statement of this general principle is necessary to a complete understanding of the following chapter, in which the methods of reduction and retention to be employed in each type of fracture are described.

The mechanisms described are either those which we ourselves most commonly employ, or those which in the hands of others have given the most satisfactory results. It may seem a little surprising that no mention is made of earlier mechanisms, especially those with extra-buccal attachment employed by Claude Martin, Kingsley, Richet, etc. As a matter of fact, these have practically disappeared from modern maxillo-facial practice. Those of our readers who desire further information concerning them should consult Martinier and Lemerle's book on the subject, to which reference has already been made.

Before passing to a detailed account of our own methods, it is expedient to give the therapeutic classification formulated by Sauvez, the scheme of which is very sound and which we have very largely adopted.

TABLE OF TREATMENT IN MANDIBULAR FRACTURE

FIRST CLASS

Each fragment contains teeth (median or paramedian fracture)

FIRST DIVISION

Without loss of substance

Case 1:

No displacement.

Mechanical treatment. Jaws not ligatured together.

Case 2:

Displacement.

Mechanical treatment. Jaws not ligatured together.

SECOND DIVISION

With loss of substance

Case 1:

Loss slight. Union of fragments effects a tolerable occlusion.

Mechanical treatment. Jaws not ligatured together.

Case 2:

Loss comparatively large. Union does not effect occlusion, but this may be done by means of a fixed bridge in one or three parts.

Mechanical treatment. Jaws not ligatured together.

Case 3:

Loss very extensive. It is impossible to employ a fixed bridge.

1st. Mechanical treatment. Jaws not ligatured together.
2nd. Mechanical treatment. Jaws not ligatured together.
3rd. Surgical treatment. Jaws ligatured together.

SECOND CLASS

One fragment is toothless (retrodental fracture and fracture of the ramus)

FIRST DIVISION

Without loss of substance

Case 1:

No displacement.

Mechanical treatment. Jaws ligatured together.

Case 2:

Displacement.

Combined surgical and mechanical treatment (plate). Jaws ligatured together.

SECOND DIVISION

With loss of substance

Case 1 :

Slight loss. Union effects a tolerable occlusion.

Treatment either surgical or mechanical (plate). Jaws ligatured together.

Case 2 :

Extensive loss. Union is either impossible, or, if effected, would not bring about occlusion.

Surgical treatment. Jaw ligatured together.

Mechanical treatment, temporary or permanent. Jaws not ligatured together.

Preparatory Treatment.—No decision in regard to treatment should be made until a good skiagram of the lesion has been obtained, not only in order to facilitate diagnosis but in order to ascertain the condition of the site of the fracture. It is also absolutely essential that the mouth be carefully prepared before instituting a mechanical therapy.

After the buccal cavity has been minutely cleansed and infected roots have been extracted, the fracture site should be examined with particular care. Fragments of roots of teeth are sometimes present, and these considerably retard union. Some very striking cases of this kind have passed through our hands. Roots included in the region of the fracture are well shown by skiagrams. They are those of teeth adjoining the fracture site, and they appear to plunge down into it. Not only should remains of roots be extracted, but also teeth the denuded roots of which might convey to the site of fracture infection from the buccal area.

Patients frequently come in who are in an emaciated and weakened condition; the way in which they

respond to general treatment is very striking. Our method is to give two Ferrier's cachets¹ a day, to which fifteen drops of adrenalin solution, 1 in 1,000, are added (Sergent, *Presse médicale*, 1913, No. 93).

This recalcifiant (*médication récalcifiante*) treatment is pursued for ten days at a time, with intervals of ten days.

The general condition improves very rapidly under this treatment, which has, presumably, a definite action in promoting the growth of the callus. The work of P. Carnot and C.-L. Slavu (*C. R. de la Société de Biologie*, 1900, vol. lxxviii. p. 832) upon the influence of adrenaline upon bony repair and the growth of the callus is interesting in this connection. These authors are entirely in favour of the method.

Care must be taken during the entire period of treatment to keep the mouth in a state of absolute cleanliness. Every patient should clean his teeth with soap at least twice a day. Irrigation by means of a douche should be performed as frequently as the condition of the lesions demands. Permanganate 1 in 8,000, and nitrate of silver 1 in 20,000, are the best solutions for this purpose.

The problem of feeding is solved in the following manner. Those patients whose jaws are not immobilised, as well as those whose jaws are kept closed,

¹ Ferrier's cachets:

Precipitated calcium phosphate	.	.	0.50 centigr.
Calcium carbonate	.	.	0.30 "
Sodium chloride	.	.	0.15 "
Calcined magnesia	.	.	0.10 "

are given a liquid or semi-liquid diet consisting of minced meat, vegetable *purée*, prepared foods, thick soups, milky foods, and eggs. Neither at the Hôtel Dieu, Marseilles, nor at the Hospice de Sainte Marguerite, where we had the care of 200 to 250 patients, have we ever had any difficulty with this diet. Patients do very well on it. In certain severe cases, which came to the hospital in a very debilitated condition, the increase of weight, namely $8\frac{1}{2}$ lbs. in fourteen days, was really remarkable. The Ferrier cachets were of course administered simultaneously.

As soon as patients are fitted with their retention mechanisms they are usually able to eat the hospital diet.

A. Anterior group: Median and Paramedian Fracture.

—The deformities characteristic of these fractures have already been described.

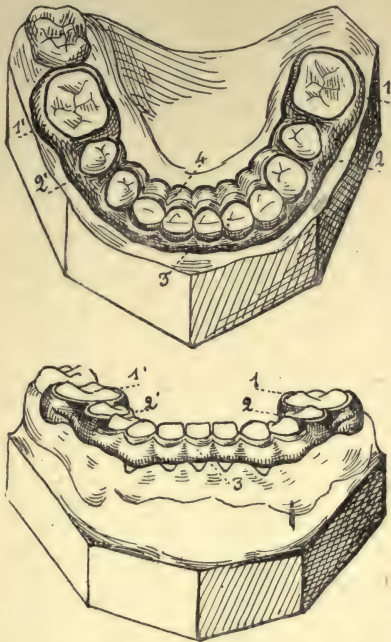
The therapeutic indications vary in accordance with the amount of substance lost. It may be small, 1 to $1\frac{1}{2}$ cm.; medium, $1\frac{1}{2}$ to 3 cm.; or large, $3\frac{1}{2}$ cm. and over. The extent of the loss is revealed by the degree of deformity and by skiagrams.

1. Recent Anterior Fracture.—(a) *Slight loss of substance* (up to $1\frac{1}{2}$ cm.). The method here is, first to restore the mandible to its original form and then to immobilise, the procedure being as follows:

A good model of the jaws is made, preferably in plaster. The model of the lower jaw is sawn in two along the line of fracture. Each portion is then brought into normal occlusion with the teeth of the upper

jaw. To a stomatologist the task is an easy one. Normal occlusion being established, the two portions of the lower jaw are fixed in position by means of plaster. The model of the mandible as it was before

FIGS. 42 and 43.—
Double splint with anchor bands for the immobilisation of median or paramedian fracture with slight loss of substance. (1, 2, 1', 2', are four German silver bands, accurately adapted and attached to the crowns by cement. They form a solid anchorage for the anterior and posterior splints, 3 and 4, which are soldered to them. These splints are of cast silver, and cover only about a third of the crowns, leaving the triturating surfaces and the necks free. The apparatus may be rendered removable by replacing the soldered anchor bands with bands fastened with a screw and nut. See figs. 50 and 51.)



injury is thus obtained, and the mechanism for immobilisation is constructed on the model.

The method which we recommend is the double splint with anchor bands shown in figs. 42 and 43.

The absolute immobility conferred by this mechanism is due not only to the method of anchorage but also to the splints themselves which, where requisite, may be ligatured to the teeth.

The anterior and posterior splints only partially cover the crowns of the teeth, the upper and lower thirds remaining free, thus facilitating both cleansing and control. The splints are easily removed either by cutting the bands or by unsealing the cement.

This mechanism is infinitely superior to the type of cast silver splint shown in fig. 44, which has the

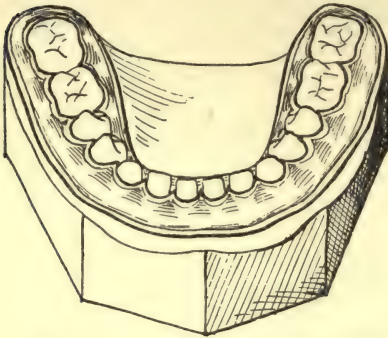


FIG. 44.—Open splint of cast silver for the immobilisation of median or paramedian fracture. This cap splint leaves the occluding surfaces of the teeth free.

drawback of covering practically the whole of the crowns as well as a portion of the muco-perio-
steum.

The cap splint in two pieces is a mechanism designed to facilitate supervision of the fracture without the necessity of removing the mechanism. The two pieces are separated and united at will by means of a special contrivance. The mechanism shown in fig. 45 is a perfect expression of this principle. It is described by Dr. Sauvez and constitutes a very happy modification of the open splint.

Double splints in cast metal, attached posteriorly by means of a hinge and connected at intervals by screw-bolts, may also be used for the purpose.

Figs. 53, 54, and 55 show a mechanism designed to effect this method of anchorage. The principle is that

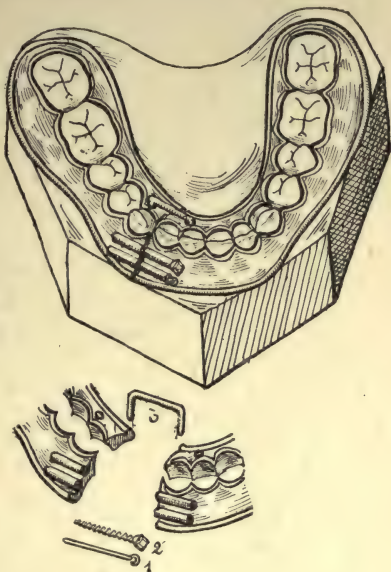
of adjustable bands, a common technical device in dental surgery and one that has been imported into the therapeutics of mandibular fracture. It is unnecessary to enter here into the details of its construction.

The soldered bands shown in fig. 42 may be replaced by adjustable bands similar to those described on a later page in connection with Angle's arch. This method of anchorage renders the splint removable.

(b) *Medium loss of substance* ($1\frac{1}{2}$ cm.).—

In this class of case compensatory contraction must be allowed for and union is more favourable if the fragments are not immobilised in

their position of normal occlusion. The model on which the immobilisation apparatus is constructed should not therefore exactly conform to the normal shape of the jaw, but it should to a certain extent



FIGS. 45 and 46.—Metal splint in two pieces. (This splint is sawn in two at the fracture site. The two portions are firmly united by means of bolts. The two anterior bolts, 1 and 2, of which one is threaded to form a screw, prevent vertical displacement. The posterior U-shaped bolt prevents horizontal separation of the fragments. The mechanism is designed by Dr. Sauvez.)

reproduce the deformity characteristic of the fracture. It should, however, correct the tilting inwards of the occlusal surfaces of the molars, which is sometimes very marked.

An immobilisation apparatus constructed upon such

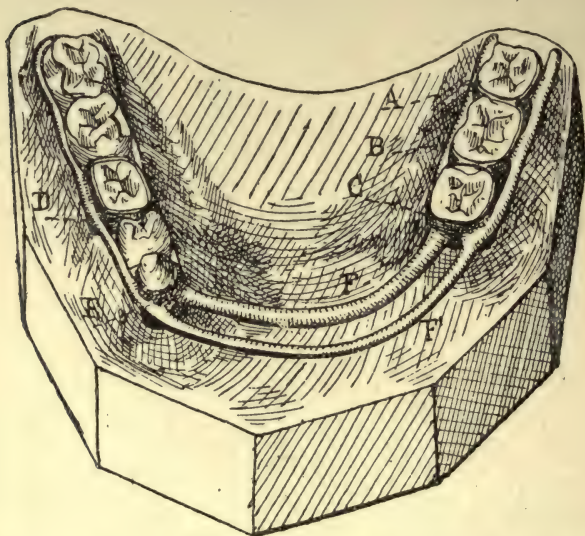


FIG. 47.—Immobilisation of median fracture with large loss of substance. (Anchor bands are cemented to the molars A, B, C, D, E. They are soldered together and rendered stable by two rigid rods F F', thus assuring the immobilisation of the fragments and maintaining them in their normal position.)

a model will result in union with slight contraction. The contraction is readily remedied by various orthodontic measures for obtaining mandibular expansion.

Correction of the contraction should not be deferred until after ossification of the callus. *It should be undertaken at the moment when the mobility of the frag-*

ments appears to be arrested by the resistance of the callus, while skiagrams show that ossification is not as yet very far advanced. Intervention at this moment is attended by results which are positively astounding.

Some years ago Monod published an account of a

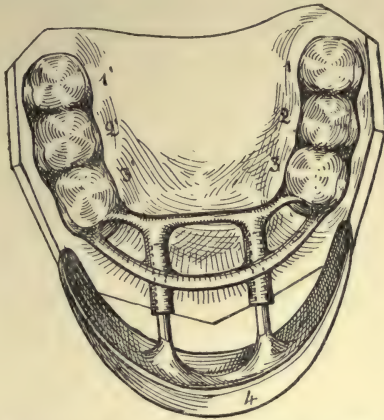


FIG. 48.—Apparatus for the immobilisation of median fracture with large loss of substance. (The lateral fragments are extremely mobile, which necessitates a very firm method of anchorage. The anchor bands are replaced by crowns (1, 2, 3, 1', 2', 3') which are soldered together. The interior surfaces of these crowns are furnished with studs or screws which penetrate the pulp cavities or even the posterior roots. The anchor blocks are united by two transverse bars. The vulcanite piece (4) serves as guide for cheiloplastic operation. It is attached to the principal mechanism by two parallel rods running in two tubes. After cheiloplastic intervention this apparatus may be used as an extensor for the lip.)

case which is very significant in this connection. He effected extension of the callus with the object of reducing a marked contraction of the jaw. The ultimate union was in no way impeded; in fact, it almost seemed as if the extension of the callus had exercised a stimulating effect upon the osteo-genetic processes.

More recently, at the Interallied Dental Congress, Caumartin and Valadier described cases of prolongation of the callus with perfect union. The mechanism which we ourselves employ for this purpose is shown in fig. 52 and will be described later.

It is easy to compensate for slight contraction by the method known as "jumping the bite." This is a manipulation practised by many stomatologists and is carried out by means of a variety of mechanisms into the details of which it is not necessary to enter here.

(c) *Large loss of substance* (3 cm. and over).—The breach is here too large to be compensated for by the union of the fragments. All that can be done is to maintain the fragments in normal position until after the cicatrisation period (figs. 47 and 48). Later they are united by a bony graft, or by a restorative mechanism in the manner of Claude Martin.

2. Old Anterior Fracture.—For the correction of deviations which it is impossible to reduce, we usually employ Angle's alignment wire, a very common appliance in orthodontics.

Angle's apparatus consists of :

1. A German silver alignment wire with threaded ends fitted with nuts.

2. Two anchor bands of the same metal, to the buccal surface of which tubes are attached, into which the extremities of the alignment wire are slipped.

Application of the Mechanism.—The anchor bands are attached to the first, or, if these are missing, the second molars. The arch is placed in front of the

teeth in such a way that the anterior curve is in contact with the incisors. All the teeth in contact with the wire arch are then attached to it by ligatures, which are passed through the interdental spaces and tied. The alignment wire should not be fitted to the

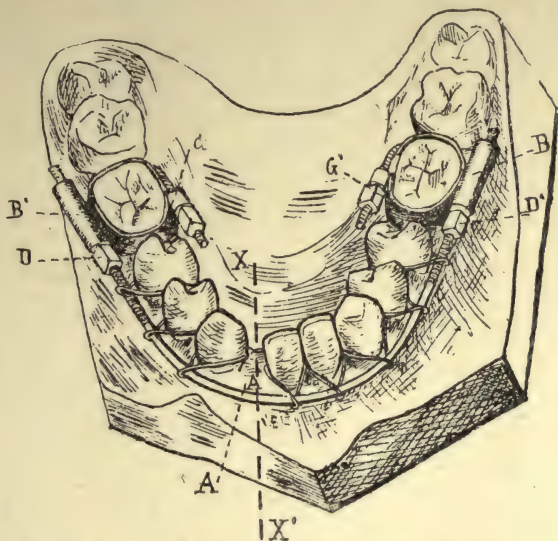
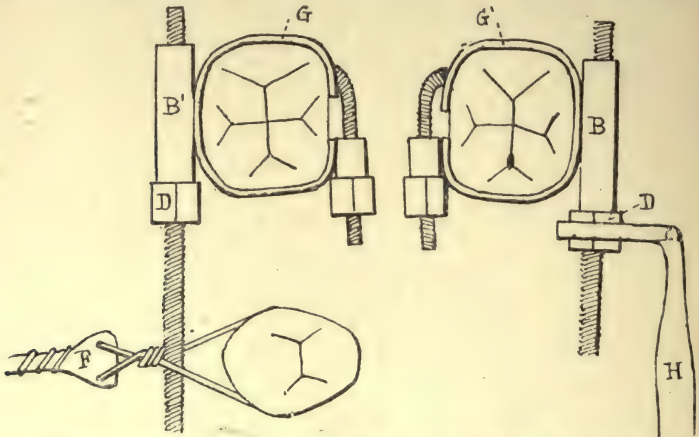


FIG. 49.—Angle's apparatus for paramedian fracture. (The line $X X'$ represents the fracture site. The apparatus consists of a German silver arch A , running in two tubes $B B'$, attached to two screw bands $G G'$. The anchor bands are attached to the first molars. All the teeth in contact with the alignment wire are attached to it by brass wire ligatures passed through the interdental spaces. The extremities of the alignment wire are threaded and furnished with screws placed at the anterior extremities of the tubes.)

lingual surfaces of the teeth. It should be given a parabolic form, which is the ideal mandibular outline, and to which the amended jaw will conform.

The method of action is briefly as follows: In the

first place, the elasticity of the metal tends to straighten out the dental arch and thus to separate the two fragments to which it is attached. In the second, by tightening the brass wire ligaments attached to the teeth implanted in the fragments, it is possible gradually to draw the latter towards the alignment



FIGS. 50 and 51.—Details of the extremities of Angle's arch. (*D D'* nuts; *B B'* tubes containing the extremities of the arch. Fig. 50 shows the method of applying the brass wire ligatures. Fig. 51 shows the manner of tightening the nut by means of the special screw-key)

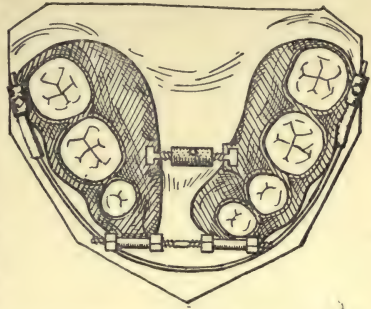
wire, thus restoring the normal dental alignment. Finally, by tightening the nuts against the anterior extremities of the tubes, the diameter of the alignment wire is increased and it is forced in consequence to expand transversely (fig. 49).

The alignment wire is an excellent mechanism in this condition, where it is a question of mobilising two fragments of approximately the same size, subjected

to muscular influences which are approximately equal, and which produce convergent symmetrical displacement.

The principle of the method is the interaction of forces, the one fragment serving as a fulcrum for the mobilisation of the other and vice versa. Where, however, there is marked discrepancy in the size of

FIG. 52.—Apparatus for expansion of the mandible. (Each lateral fragment is enclosed in a splint carefully cemented to the teeth, the base of which descends as low as possible along the entire length of the lingual surface. The posterior jack-screw is placed very low, approximately in the region of the apex. Its two extremities are contained in two cavities in pigeon's-nest form on the lingual face of the splints, where they are secured by means of a pin. A second extension mechanism acts upon the anterior extremities of the fragments. It is fixed as close as possible to the occluding surfaces of the teeth. It consists of a threaded rod running in two tubes which are attached to the anterior extremities of the splints. The screw-rod is furnished with four nuts placed one at each entry and one at each exit of the tubes. By manipulating these screws, expansion and immobilisation may be effected at the same time.)



the fragments, the smaller inevitably tends to become displaced.

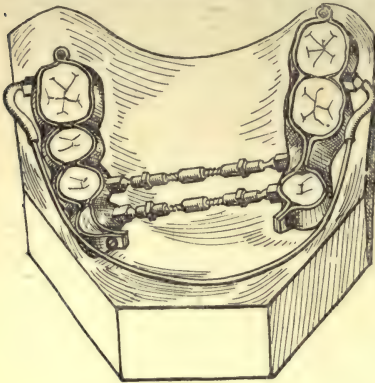
Where greater force is required to overcome the mandibular contraction, the mechanism shown in figs. 52 and 53 is preferable. Here the expansive force is conveyed by means of jack-screws.

In this instance the stress is directly transmitted to the mandibular fragments, owing to the fact that

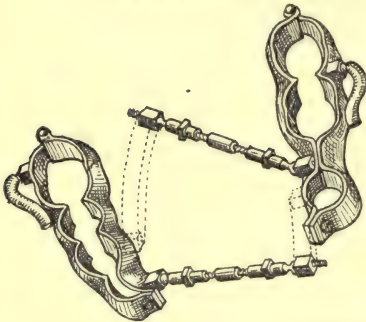
In this instance the stress is directly transmitted to the mandibular fragments, owing to the fact that

102 FRACTURE OF THE LOWER JAW

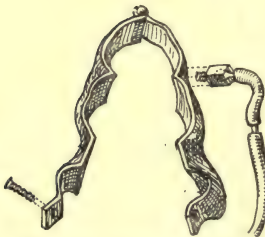
FIGS. 53, 54, and 55.—Extension apparatus for use in mandibular contraction. (This apparatus is described by Dr. Besson, and possesses the following characteristics—in many particulars it



closely resembles an apparatus seen by us at Val-de-Grâce, where it was employed by Dr. Frey: "It consists of two metal cap splints struck in two parts, articulated at the back by means of a hinge and closed in front by means of a screw. The two splints are accurately applied to the fragments, covering the lateral faces of the teeth and the gingival mucosa as far down as possible. They are cemented to the teeth, the occluding surfaces of which are left free. Between the two splints in front two jack-screws are fixed, one above, the other below. The first is placed as close to the teeth as possible. The second is placed as low down as possible between the mesial surfaces of the same teeth. Upon the lingual surface of the splints, as low down as possible, and behind the teeth which erupt at six years, attachments are fixed for an elastic arch of piano wire which surrounds the inferior dental arch. The



attachment of the jack-screws and the vestibular arch is effected by means of knee-joints. This gives an extreme pliability to the entire mechanism. It also facilitates the individual movement of each fragment in response to the forces acting upon it." The extension apparatus shown in fig. 52, which immobilises the fragments while at the same time holding them apart, is chiefly indicated in fracture where union may be anticipated, and which are better



for being kept immobilised during the extension period. Besson's mechanism, on the other hand, owing to its extreme pliability, is more suitable for employment in confirmed pseudo-arthritis.)

the jack-screw is placed very low, very nearly at the point of union of the alveolar and basilar portions of the mandible.

In cases where it is not possible to employ the sub-lingual jack-screw, Duchange's apparatus is indicated. Ingenious appliances with extra-buccal anchorage have been introduced by Guérini of Naples.

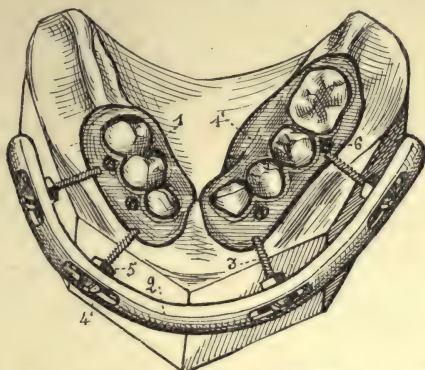


FIG. 56.—Duchange's apparatus for the correction of mandibular contraction. (Each of the two fragments is fitted with a cap splint (1, 1') which is cemented to the teeth; anchorage is reinforced by screws (6) penetrating the interdental spaces. Threaded rods (3) are soldered to the metal caps. The free ends of these rods are passed through eyelet holes arranged at intervals in a rigid metal arch (2). By turning the nut (5) and the counter-screw (4) in the threaded rod, the mandibular fragments are drawn into the required position.

When the mandibular deformity has been corrected, the fragments are immobilised by either retention mechanisms or by the double splint with anchor-bands shown in figs. 42 and 43.

3. Double Fracture.—Similar methods are employed in the reduction of bilateral fracture with median third fragment. Fig. 57 shows such a fracture,

and the instrument for its reduction is shown in figs. 42 and 43.

Occasionally the median fragment shows a tendency to downward and outward displacement, a condition which it is difficult to correct by means of Angle's alignment wire. In cases of this nature intermaxillary anchorage is employed. A mechanism

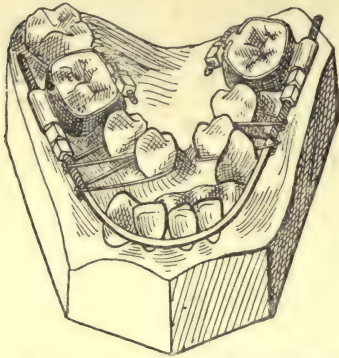


FIG. 57.—Angle's sarch employed to reduce bilateral fracture. The jaw is the same as that shown in figs. 42 and 43, where the fracture is reduced and immobilised by a double splint with anchor bands.

furnished with hooks is attached to the third fragment by means of anchor-bands. The hooks are connected, by means of elastics, with a similar device attached to the anterior teeth of the upper jaw.

Median and paramedian fracture is sometimes complicated by vertical displacement of the fragments. This produces an irregularity in the horizontal plane which must be corrected before immobilisation. This is best done by means of an apparatus similar to that represented in fig. 59. It is composed of cap splints cemented to the lateral fragments. A firm anchorage is essential, and this is assured by screws at the interdental spaces. A spring is attached to the lingual aspect, the action of which is slightly to separate the

two fragments and to lower the elevated fragment. Attached to the labial surfaces are two pierced metal projections. When reduction is complete these exactly face one another. All that remains to be done is to immobilise the fragments by introducing a U-shaped bolt into the holes in the splint previously occupied by the spring, and a straight threaded bolt furnished with nuts into the holes in the metal projections.

Should the vertical displacement not yield to this method, a mechanism with intermaxillary anchorage, such as that shown in fig. 64, should be employed.

In this case elastic bands are stretched between each of the fragments and the upper jaw. Their action tends to separate the fragments and to draw them into contact with the superior dental arch until normal occlusion, that is to say reduction, is obtained.

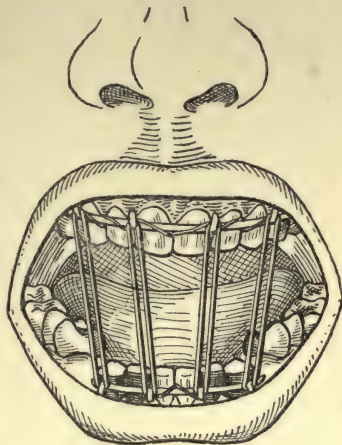


FIG. 58.—Method of intermaxillary anchorage for the purpose of bringing a median fragment displaced downwards and forwards into occlusion. The teeth of the upper jaw are fitted with a rigid metal rod to which hooks are attached. A similar device is attached to the teeth of the loose fragment. Elastic bands of varying number are stretched between the hooks of the two arches, thus correcting the deviation.

It was in cases of this sort that, in former days, Cl. and Fr. Martin practised their "open mouth" treatment.

We have frequently been struck by the facility with which considerable loss of substance in the mental region is made good. The characteristic is quite

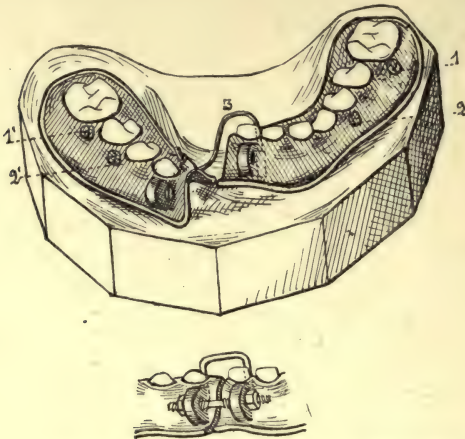


FIG. 59.—Apparatus for the correction of vertical deviation in median or paramedian fracture. The metal splint is divided at the fracture site. Each portion is cemented to the teeth and is also secured by means of screws (1, 2, 1', 2') between the interdental spaces. A spring (3) corrects the deviation. When the reduction is effected the fracture is immobilised by means of bolts which fix the two splints in position.

specific and is not observed in lateral fracture. It may be due to the richer vascularisation of the mental region.

B. Posterior Fracture.—Of all classes of fracture, this is the one most liable to terminate in pseudoarthrosis. Every effort should be made to bring the

fragments into apposition, in the hope of effecting a union.

1. **Recent Lateral Fracture**, with slight or medium loss of substance (up to 3 cm.).—(a) *Posterior fragment containing teeth or roots suitable for purposes of anchorage.*

When the loss of bony substance does not exceed $1\frac{1}{2}$ cm., treatment consists in immobilisation of the

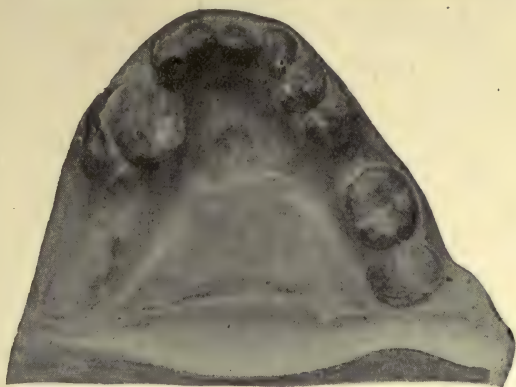


FIG. 60.—Lateral fracture with large loss of substance. Spontaneous union. Compensatory displacement of the posterior fragment.

fragments in normal occlusion by means of either a double splint with anchor bands or a bridge. In the case of the latter it is advisable to strengthen the anchorage of the supporting crowns by screws or bolts penetrating well into the pulp-cavities and canals, the latter having been previously enlarged.

Where the loss of substance is greater (up to about 3 cm.), simple immobilisation should also be employed, provided always that the destruction is not absolute,

and that splinters are present in the fractured area. Skiagrams should be employed for the determination of these factors. It is permissible to count upon the vitality of these bony fragments and of the traces of periosteum by which they are accompanied, which

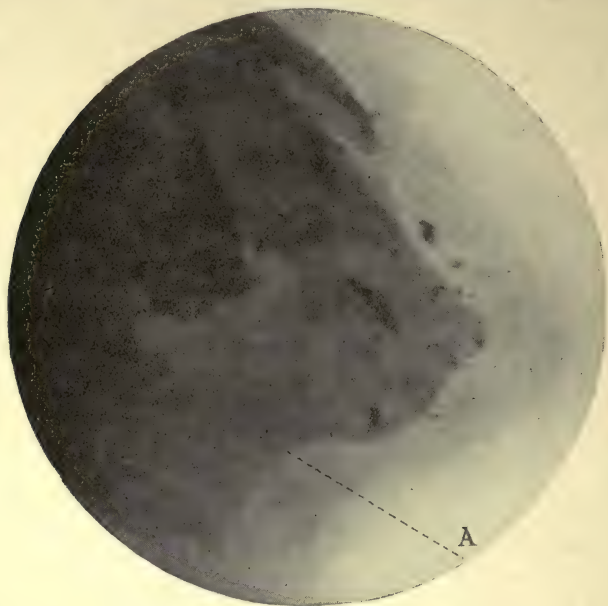


FIG. 61.—Same case as fig. 60. Skiagram of the united fracture.

play a very important part in effecting union. The action of the immobilisation apparatus should be confined to maintaining the principal fragment in good occlusion. No attempt should be made to get the posterior fragment into occlusion; it has already undergone spontaneous displacement by which it has

been brought closer to the principal fragment. To interfere with this displacement is to endanger union. Moreover, is there any decided advantage attaching to its retraction? There is no very great inconvenience in the fact that the last inferior molar articulates with the second superior molar. This represents



FIG. 62.—Same case with prosthetic apparatus.

a very slight degree of malocclusion, and one which is easily remedied later.

For purposes of retention bridges or splints should be employed. We ourselves prefer the apparatus shown in fig. 64, which, in cases of this class, is used solely as an immobilisation agent. It has certain advantages over other immobilisation mechanisms. The posterior fragment is connected with the splint attached to the principal fragment by a double sliding bar, which resists mobility in the transverse and the vertical sense, but permits the spontaneous forward

movement of the posterior fragment, a movement which is very favourable to the co-adaptation of the



FIG. 63.—Photograph of the patient whose fracture is reproduced in the preceding illustrations. The fracture united spontaneously, the posterior fragment coming forward. Flattening of the angle of the fractured side.

fragments and to ultimate union. The double screw is employed solely to fix displacement, never to provoke it.

Where the bony loss is $1\frac{1}{2}$ to 3 cm. in length and is

shown by skiagrams to be absolute, especially where it includes the basilar portion of the bone, distinct advantage is derived from bringing the posterior fragment forward. The interval between the fragments is lessened or may even be filled, and the chance of evading ultimate pseudo-arthritis is increased.

It is important to realise that this compensatory forward movement by mechanical means coincides with a natural impulse on the part of the posterior fragment which may be counted on in the vast majority of lateral fractures. The following clinical history is interesting in this connection.

The patient was wounded in Morocco in July 1914 ; his mandible was fractured but united well. The fracture-site is bounded by the left lateral incisor on the one hand, and by the first or second molar on the other. Hence the amount of substance lost must equal at least three teeth. Although no mechanical measures were employed, perfect union with formation of callus resulted. There is a slight deviation of the mandible towards the fractured side ; occlusion is satisfactory.

It is with the object of obtaining results similar to these that the apparatus shown in **figs. 64 and 65** is designed. By a system of sliding rods and screws the fractured surfaces are drawn together and the fragments are at the same time maintained in rigorous immobility during the entire period of treatment.

By releasing the screw the apparatus may from time to time be sufficiently loosened to permit of examination of the site of fracture. The apparatus is easy

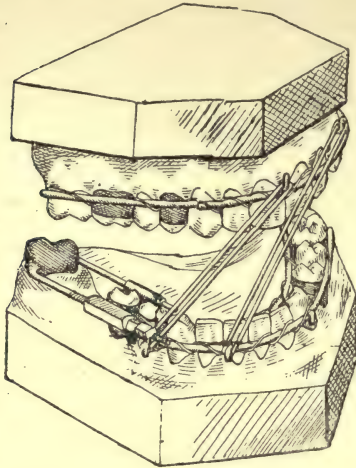


FIG. 64.—Mechanism employed to move the posterior fragment forward, intermaxillary force being exercised at the same time. The mechanism consists of a threaded rod, one end of which is attached to a crown which covers the tooth on the short fragment, the other end runs through a tube soldered to the alignment wire on the principal fragment. By tightening the screw and counter-screw in front of the tube the posterior fragment is drawn forward. On the lingual side a somewhat similar mechanism is placed, but this is not furnished with screw and counter-screw.

of construction and of application; it is clean; and it is very well tolerated by the patient. It should be applied as early as possible, and during the first week of its application the screws should be gradually tightened until the fractured surfaces meet. The results are verified by examination of the fracture site and by skiagrams.

The action of the sliding bars is supplemented by intermaxillary traction by means of elastic bands, whose object it is to prevent lateral deviation of the principal fragment. Both tractions are maintained during the entire period of treatment. Once the fragments have been brought

together, the screws of the sliding bars are not again released.¹

Fraction of the posterior fragment does not demand a very resistant anchor point. A single tooth is suffi-

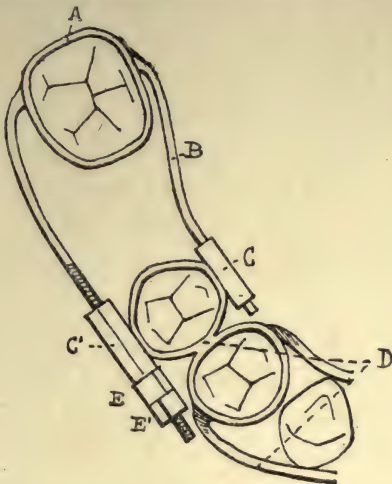


FIG. 65.—Mechanism to bring forward and to immobilise the posterior fragment. The tooth on the posterior fragment is fitted with a band *A* attached by cement. On the lingual face of this band a German silver wire *B* is soldered, which runs through the tube *C*, which is soldered to the anchorage *D* attached to the principal fragment. The mechanism is repeated on the labial face of the band *A*, with this difference, that the extremity of the wire running through the tube *C'* is threaded. A screw *E* and a counter-screw *E'* are fitted to the threaded end of the wire at its exit from the tube. By tightening the screw *E*, the posterior fragment is drawn forward, while at the same time an absolute immobility is maintained.

cient, even though very much loosened or broken. The anchor appliance itself, however, should be very strongly attached. Bands are not sufficiently resis-

¹ Instead of intermaxillary anchorage by means of elastic bands, the apparatus described later under the name of "active crank" may be employed. The method yields excellent results.

tant; crowns should always be used, and it is frequently better to reinforce them by screws going well down into the pulp cavity and the distal root canal.

This mechanism not only reduces the fracture, but it so absolutely immobilises the fragments that to employ a special immobilisation apparatus is unnecessary.

It is a remarkable fact that, where there is large loss of bony substance, the deformity of the mandibular arch is much less than would be supposed. This is due to the tendency of the posterior fragment to move forward and thus to occupy the place of the missing bony portion.

Then again, the establishment of occlusion is greatly aided by the extreme mobility of the temporo-mandibular joints. These movements are determined and fixed by the intermaxillary traction of the elastic bands, and this traction should therefore be very judiciously employed.

By this method we have in some cases effected compensation for loss of bony substance corresponding to two molars (about $2\frac{1}{2}$ cm.) with satisfactory union of the fragments. Owing to the specific adaptive quality of the temporo-mandibular joints, in no case has malocclusion resulted. Naturally, the results are best where the loss of substance is least.

The principle of the method may at first sight seem to be somewhat daring, but it is justified by results. The fact that occlusion is preserved in spite of the shortening of the body of the mandible, removes the

only objection to the method which might have been advanced.

The measures employed by stomatologists for the correction of malocclusion are various. Expansion of the mandible is a common orthodontological procedure. Elongation of the callus, as described in connection with median fracture, may also be employed here, and we are convinced that by this means it is possible to compensate for a bony loss in excess of 3 cm.

Recourse to instruments of prosthesis is necessitated by the nature of certain cases. Where half the lower dental arch closes inside the upper arch, thus losing all contact with the corresponding teeth above it, it is a simple measure to line the upper arcade with triturating surfaces in such a way that they articulate with the teeth of the lower jaw (P. Robin).

A mechanism of this kind, if only on account of its method of equilibrium, is eminently stable, and its efficacy does not depend upon the presence of the teeth.

Moreover it should be borne in mind that the absorption of the bone, consequent upon the loss of the teeth, is always very much more marked in the case of the maxilla than of the mandible. This physiological change has the favourable effect of restoring to a certain extent the harmony between the sound upper jaw and the contracted lower jaw.

We have therefore every right to assert that the future of these cases is as assured as their present. Where there is pseudo-arthrosis, on the other hand, the patient must sooner or later become disabled.

Occasionally the method is unsuccessful and union is not obtained. But even in cases such as these the treatment has certain favourable effects. The forward movement of the posterior fragment permits the employment of osteo-synthetic measures in place of the bony graft, prognosis in the case of the latter

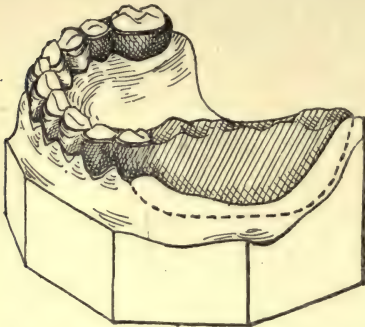


FIG. 66.—Immobilisation apparatus for lateral fracture. There is no anchorage point on the posterior fragment. The cap which encloses the posterior fragment descends very low especially on the lingual side. It is soldered to a double splint with anchor bands which is cemented to the teeth of the principal fragment. This constitutes an efficient method of anchorage.

method being far less favourable than in the case of the former.

(b) *The posterior fragment offers no anchorage point.*—

Where the posterior fragment is accessible, it should be enclosed in a cap which descends very low, particularly on the lingual side. This cap is soldered to a double splint with anchor bands,

which is adjusted and cemented to the larger fragment. The posterior fragment is applied to the cap which covers it by the tonicity and the contractions of the elevator muscles, a satisfactory immobilisation being thus obtained (fig. 66).

Where the mandible shows a tendency to lateral

deviation, intermaxillary anchorage as described above should be employed.

To render the method more efficient, the posterior splint may be attached to that on the principal fragment by means of a device with a double bolt, which permits of the posterior splint being raised for purposes of inspection or cleansing. This instrument is described in detail later.

Where the loss from the posterior fragment is so extensive that immobilisation is not possible, the clinical appearances resemble those of fracture of the angle, and the therapeutic indications are the same.

2. **Old Lateral Fracture** with slight or medium loss of substance ($1\frac{1}{2}$ –3 cm.).—*Where the posterior fragment presents a point of anchorage*, a mechanism should be employed to bring the fragments together. We have observed the union of lateral fracture with large loss of substance in cases where treatment had not been instituted until four months after the date of injury.

In all cases, including those in which union is not obtained, the bringing together of the fragments greatly facilitates surgical intervention. It frequently permits of the substitution of osteo-synthetic methods, which may be regarded as constant, for that of the bony graft, the results of which are always uncertain (see chapter on Surgical Treatment).

Where the posterior fragment is deprived of teeth and, as is usually the case, is displaced forwards and upwards, the first care should be to get it into normal position. This is effected either by a mechanism in

which the force is passive and resides in a spring, or by means of the apparatus shown in fig. 67. In the latter the action of the spring is supplemented by intermittent pressure from a jointed crank, which is brought to bear upon the posterior fragment each time that the elevator muscles contract or under

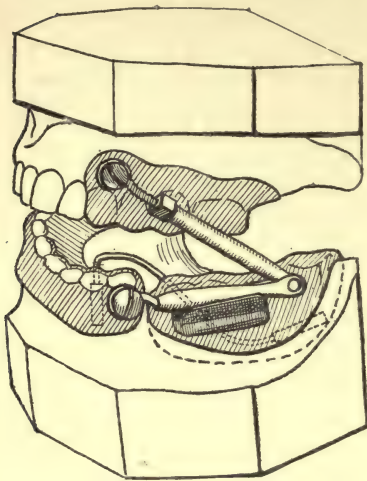


FIG. 67.—Apparatus for the reduction of the posterior fragment when it is displaced upwards and forwards (G. Villain). The posterior fragment is enclosed in a splint the internal face of which descends very low along the whole lingual face of the fragment. This splint is kept in position by a spring of low power on the lingual side. When by the action of the elevator muscles the jaws are brought together, the lower arm of the crank comes to rest in a groove on the vestibular surface of the splint. The rod of the crank is threaded and fitted with a screw, by means of which the action of the crank may be regulated according to need.

the simple influence of their tonicity. The apparatus is designed by G. Villain.

When reduction has been obtained, union between the posterior and anterior splints is established by uniting them with solder and with bolts, as shown in fig. 66.

Where the posterior fragment is inaccessible, the fracture is treated on the lines of fracture of the angle.

3. Old Lateral Fracture with Extensive Loss of Sub-

stance (over 3 cm.).—(a) *Recent fracture*. Where the posterior fragment possesses a tooth or a root suitable for an anchorage point, the fragments are first trained into a position of normal occlusion and then immobilised. By these measures both the deviation of the fragment and cicatricial retraction are avoided and subsequent prosthetic treatment is facilitated. The anchorage upon the posterior fragment should be carried out with extreme care. The best method is by a screw or a stud-crown.

Where the posterior fragment is toothless, immobilisation in occlusion is advised.

(b) *Old fracture*.—Where, as so frequently happens, these fractures have not been previously immobilised, they should be treated in the same way as recent fracture. Until such treatment has been vigorously pursued for at least three mouths, pseudo-arthritis cannot be considered definitive and should not be treated as such.

C. Fracture of the Angle.—The possibility of influencing the posterior fragment is here very limited. The principal fragment, on the other hand, is readily immobilised by attachment to the upper jaw. This measure prevents any movement of the fracture-site which, apart from loss of substance, is one of the chief causes of pseudo-arthritis at the angle and is a far more powerful factor than muscular or tendinous intervention (figs. 69 and 70).

Once again we emphasise the fact that immobilisation in occlusion has always been very well tolerated

by our patients. We have never observed infective phenomena such as those formerly described under

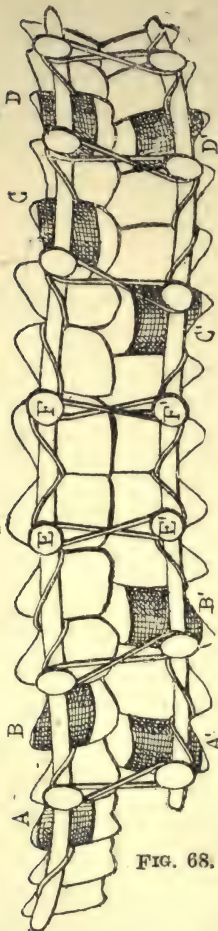


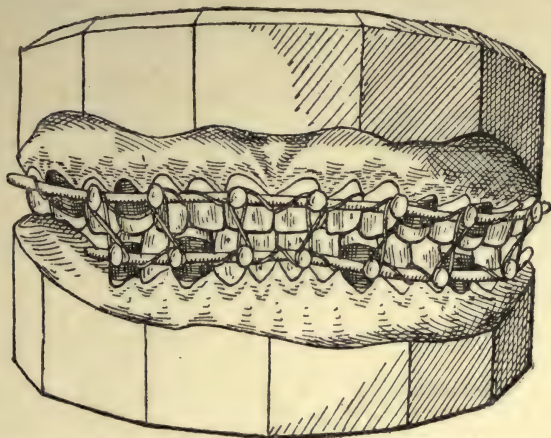
FIG. 68.

the name of buccal cachexia. This may be due to the fact that the instrument permits of scrupulous cleanliness. Moreover, we have never found nutrition seriously affected. A liquid or semi-liquid diet is given which, after a little practice, is readily taken. About every fourteen days the ligatures are removed and the fracture site and the movements of the temporo-mandibular joints are carefully examined. This opportunity for minute cleansing of the buccal cavity is not neglected. Closure of the jaws has never been observed, not even in cases which had been immobilised for several months. The most we have ever seen has been a slight articular stiffness which disappeared after a few days of normal function.

To avoid immobilisation in occlusion a form of retention apparatus has been suggested by certain authors. This consists of a principal splint firmly anchored to the teeth, to which a posterior splint is attached by means of bolts. The

posterior splint encloses the ramus and is fitted to it as exactly as possible. This apparatus is shown in fig. 71.

The construction of an apparatus of this nature is always a delicate matter, and it is especially so where the jaws are constricted. Moreover, the immobilisa-



FIGS. 69 and 70.—Apparatus for immobilising the jaws in occlusion. Metal wires with spurs are attached to the two arches. They are anchored by at least four bands, *A, B, C, D*, which are adjusted and cemented, and by ligatures of brass wire by which all the teeth are attached to the anterior arch. At intervals of about two teeth, spurs (*E, F*) are soldered to the two alignment wires. By means of ligatures of brass wire in figure of eight, the spurs are united and absolute immobility is obtained.

tion of the posterior fragment by this method appears to us very precarious. As a matter of fact, the posterior splint can enclose only the anterior border and a portion of the lingual surface of the ramus. In our opinion there is no guarantee that immobilisation is effected. The apparatus may perhaps be indicated in

angular fracture with slight loss of substance, though these fractures frequently unite without mechanical help. But its use in fracture with large loss of substance is utterly condemned, particularly as an apparatus of this kind has the supreme drawback of opposing the natural compensatory forward movement of the ramus, a movement which is so entirely favourable

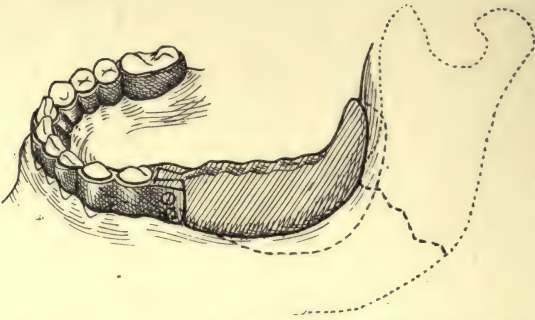


FIG. 71.—Mechanism for the immobilisation of the posterior fragment in fracture of the angle with slight loss of substance. The splint which covers the posterior fragment (ramus) is carried as high as possible up the anterior border of the ramus, and descends as low as possible along its lingual face. It is attached to the principal splint by a dove-tail joint and bolts. It is removable, thus facilitating inspection of the fracture site and cleanliness.

to the co-adaptation of the fragments and, in consequence, to the formation of the callus.

D. Fracture of the Ramus.—*Simple fractures without displacement* frequently unite spontaneously. We have seen a large number of cases in which masticatory movement had been restored without therapeutic intervention. The course of the projectile, however, showed conclusively that fracture of the ramus had

indeed taken place. In cases of simple fracture without displacement we confine ourselves to a "watching treatment." The patients are closely watched; modifications in the articulation of the teeth are especially looked out for; and measures are adopted to guard against closure of the jaws. For the latter purpose we advise, wherever necessary, *mechanico therapeutic dilatation* as employed in the treatment of myotonic constriction. During the intervening periods the jaws should be kept apart by a wooden wedge inserted between the dental arches.

Fracture with displacement demands a twofold treatment: to correct the deformity of the mandible and consequent deviation of the dental arches; and, by immobilisation of the jaws, to maintain this correction. Further, rigidity must be excluded.

These objects are best obtained by the method shown in fig. 72.

Both the upper and lower dental arches are fitted with alignment wires of the kind employed to obtain immobilisation in occlusion. Between the last molars of the fractured side a wedge is introduced which serves to keep the jaws about 2 cm. apart. The jaws are united by ligaturing the two alignment wires together. On the sound side elastic bands are stretched, the number of which varies according to the amount of force which it is desired to employ. This mechanism recalls the "open-mouth" attitude recommended by Claude Martin in fracture with vertical discrepancy of the fragments.

The technique of this apparatus is very simple. The wedge of wood introduced between the molars is the fulcrum upon which the entire body of the mandible moves. Movement is induced by the elastics stretched between the jaws on the sound side, and is continued until the space between the dental arches is eliminated.

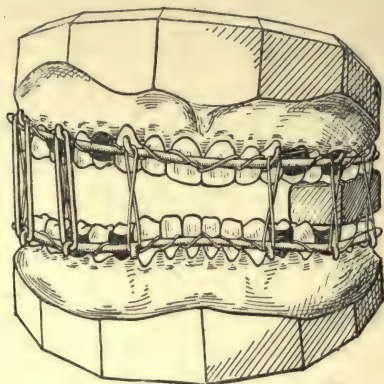


FIG. 72.—Mechanism for reduction of fracture of the ramus with displacement. Immobilisation of the right side is effected by means of simple ligatures, a wedge of wood being inserted between the last molars. On the left side, similar ligatures are reinforced by elastics, the action of which tends to counteract the gap between the teeth in occlusion.

Immobilisation with the open mouth has the further advantage of effectually counteracting osteo-fibrous constriction.

It may possibly be objected that the movement of the mandible might have the effect of shifting one or other of the fractured surfaces and thus imperilling union.

The answer to this objection lies in the fact that

the process of prolongation, to which the callus is subjected during formation, is modified in such a way that slight resistance only is offered to the co-adaptation of the fragments. Moreover, pseudo-arthritis is a far less frequent complication here than in cases where the fracture is situated at the level of the horizontal branch. In the latter case the fracture of the lever results in almost absolute functional incapacity.

Pseudo-arthritis of the ramus, excluding total or partial destruction of the bone, is perfectly compatible with function. As an instance, the case of a man who had lost an entire condyle with its neck and who was perfectly able to masticate his food, may be quoted. He was able to resume his military service.

The apparatus shown in fig. 72 seems to us to be the method *par excellence* of dealing with these cases, for it serves to reduce the fracture while at the same time immobilising the fracture site. We must in fairness, however, record the results obtained with the cranked mechanism (figs. 75 and 76), of which a detailed description will be given later. This mechanism is at first employed to reduce the fracture; later, by blocking the screws of the crank-head it is used as retention apparatus.

Fracture of the condyle with loss of substance, whether complicated or not by destructive lesion of the glenoid cavity, presents a symptom-complex identical with that associated with fracture of the ramus, and is amenable to similar treatment.

We ourselves have never seen a case of fracture of both rami with displacement of fragments, but it is logical to assume that the characteristic attitude of such a fracture would consist in a bilateral interval between the upper and lower teeth. Treatment would consist in a suitable modification of the method just described.

IV. TREATMENT OF PSEUDO-ARTHROSIS

Fracture presents classical pseudo-arthritis when union has not been effected by prosthetic treatment of at least six months' duration. The restorative mechanisms which we are about to describe are designed solely to meet the requirements of such cases. But, as G. Villain has pointed out, this mechanical treatment must be regarded as a step only in the general management of pseudo-arthritis. The condition is amenable to surgical treatment, to which there is a growing tendency to refer it.

Pseudo-arthritis is a frequent, though not a fatal, accompaniment of fractures complicated by large loss of bony substance. As we have shown, a loss of substance up to 3 cm. cannot under suitable treatment be regarded as a bar to union.

In this chapter we propose to deal with pseudo-arthroses due to very large loss of substance (over 3 cm.). These are very varied in character, but they may be classed under five principal headings :

1. Median pseudo-arthritis.

2. Pseudo-arthritis of the body, with posterior fragment suitable for purposes of anchorage.

3. Pseudo-arthritis of the body, with no posterior fragment or one useless for mechanical purposes.

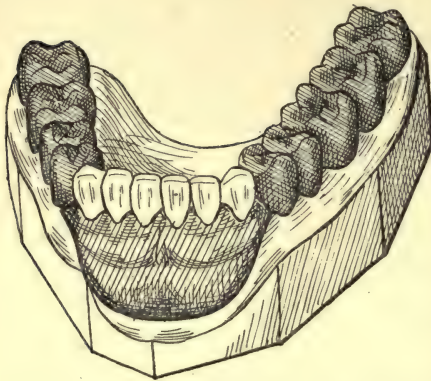
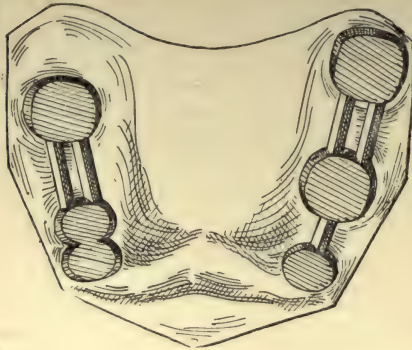
4. Pseudo-arthritis of the ramus, with loss of substance at the temporo-mandibular joint.

5. Extreme cases, with loss of substance corresponding to the entire body of the mandible with all its teeth. These are cases where the comminution is extreme and which are outside classification.

All these classes of lesion are accompanied by static and dynamic modifications, by which function is very much disturbed or even destroyed.

In median and paramedian pseudo-arthritis the fragments are equal or approximately so, and are separated by a considerable interval. They tend to approach the median line in such a way that the teeth lose all contact with the corresponding teeth above them. The free extremity of each fragment has lost all elevator power and to so marked an extent that, even where dental occlusion is re-established, masticatory movements are accompanied by the mechanical depression of the fragment. Hence the derangement of function is considerable; it is no exaggeration to say that it is diminished in the proportion of 50 per cent.

Very similar conditions prevail in the case of lateral pseudo-arthritis. The principal fragment, being markedly displaced to the fractured side, is useless for mastication, while the posterior fragment, being



FIGS. 73 and 74.—
An apparatus for use in median pseudo-arthrosis, the lateral fragments possessing teeth. The teeth are covered by cylindrical crowns, attached to them by cement and united to one another in such a way as to form two solid anchorage blocks. These anchor blocks are carefully adjusted and are then enclosed very exactly in two telescopic gutters. The latter depend largely for their support upon the lingual face of the bone, where they are prolonged as far as possible both backwards and downwards. They are united by a rigid median base of great resistancy, upon which the prosthetic instrument, which is intended to fill the gap left by the substance and teeth lost, is fixed. In our view this mechanism is infinitely the best for the treatment of this class of

case. Its stability is greater than that of simple removable apparatuses. On the other hand, it does not shorten the life of the teeth as does the bridge. Its anchorage is comparatively free, and the strain to which it is subjected is distributed over a large area of the mandible.

displaced either inwards or outwards, is in no better condition.

Pseudo-arthrosis of the ramus has a somewhat better prognosis, the reason for which will appear later.

The greater number of the mechanisms for the

treatment of these conditions are dependent for their application upon the presence of a certain number of teeth. Where there are no teeth, the infirmity is almost irremediable. For this reason mechanisms should be chosen, the anchorage of which excludes traumatic conditions such as must inevitably hasten the loss of the teeth.

Median Pseudo-arthritis.—A mechanism intended to remedy median pseudo-arthritis should fulfil two requirements: it should maintain the lateral fragments in occlusion, and it should derive from them a support sufficient to assure the stability of the replacement mechanism.

The first qualification is fulfilled by mechanisms constructed on a model presenting normal occlusion. We assume that the fragments have undergone preliminary orthognathic treatment, and that they may be readily got into positions of normal occlusion.

The question of anchorage is a debatable one. Some authors connect the two fragments by means of a bridge, strongly cemented to the teeth by means of crowns, which are soldered together. Others prefer to cap the teeth of each fragment and then strongly to unite the caps, thus creating two resistant anchor blocks, to which a removable median piece is attached by various methods.

At first sight the bridge appears the better method of the two, for it effects perfect immobilisation while at the same time conveying the subjective impression of restored function. Experience shows, however,

that the abnormal mobility of the fragments leads to increased activity of the alveolo-dental articulations, which inevitably terminates in the loss of the teeth.

For this reason we prefer a removable mechanism or, better still, a mechanism part of which is fixed and part of which is removable. By this means the strain upon the dental supports is reduced to a minimum. The most effective apparatus is that shown in figs. 73 and 74. The method of anchorage is entirely satisfactory. Further, owing to the fact that its internal margin descends very low on the lingual side, the base of support is broadened and the natural movement of lingual deviation of the fragments is utilised as the method of fixation.

Where one fragment is toothless, the results of mechanical treatment are obviously more precarious. In such cases the defective anchorage may be assisted by broadening the base of support and by employing an intermaxillary spring such as that shown in fig. 38.

Where both fragments are toothless, the base of the plate should enclose the fragments very exactly and should extend as far back as possible upon the lingual side. The springs may be strengthened by a fragment of piano-wire slipped into the lumen. They should be placed with their convexity forward.

Lateral Pseudo-arthritis.—Where the posterior fragment bears one or more teeth, there is always the temptation to effect connection with the principal fragment by means of a fixed bridge. This method may be employed with advantage where temporary immobilisa-

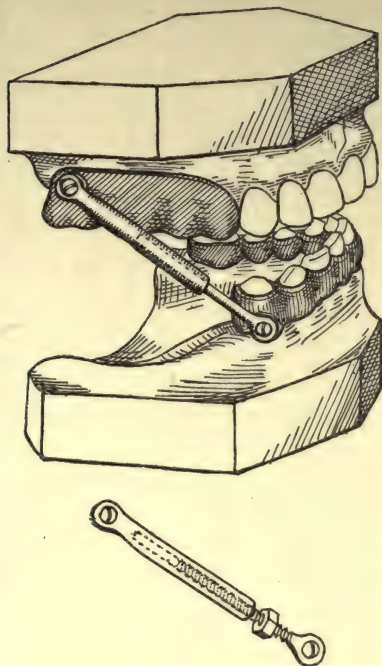
tion is required with a view to obtaining union. But in lateral pseudo-arthritis, where the mechanism employed should have the character of a definitive restorative measure, it is not advisable.

The posterior pillars of a fixed bridge are unlikely to resist for long the very considerable strain which is put upon them during mastication. Hence it is advisable in cases of this sort to have recourse to a type of mechanism which is partly fixed and partly removable.

The apparatus should be designed upon lines similar to that shown in fig. 73. The posterior fragment is very exactly covered by a splint which covers not only the teeth, but also the lingual face of what remains of the body, angle, and ramus. G. Villain advises the incision of the vestibular cul-de-sac in the retro-molar region, performed in such a way that a cul-de-sac is formed on the external surface of the angular region of the mandible. A prolongation of the base of the plate is slipped into this cul-de-sac, which gives an excellent support. By this means a very large area of support is obtained. The sound teeth of the principal fragment should be treated similarly to those of the lateral fragment (fig. 73).

The stability of a mechanism on these lines is usually entirely satisfactory. It may, however, be reinforced by pins inserted at intervals in the dental spaces, or by supplementary hooks which hold the teeth together.

Lateral Pseudo-arthritis, with total loss of the Posterior Fragment or its disability for mechanical purposes.—The



FIGS. 75 and 76.—Active and passive cranks.

FIG. 75.—Passive crank for use in lateral pseudoarthrosis, the posterior fragment being absent or useless for prosthetic purposes. The four last teeth of the right maxilla are covered by a cast silver cap splint which is firmly cemented to them. To the posterior portion of this splint on the labial side, the cylinder of the crank is attached. The attachment is by means of a joint permitting movements of circumduction. All the teeth of the mandibular fragment are enclosed in an open cap splint to the extremity of which, corresponding with the site of pseudoarthrosis, the piston rod of the crank is attached. This crank-head is able to perform movements of circumduction identical with those of the crank-head on the upper splint. As the jaws are closed, the rod telescopes into the tube. Its length

is calculated in such a way that the end of the rod reaches the bottom of the tube at the moment when the jaws are in occlusion.

FIG. 76.—Active crank. This crank differs from the one shown in fig. 75 in the fact that its rod is threaded and is furnished with a screw which, in movements of occlusion, touches the orifice of the tube. By altering the position of the screw, the crank may be brought into action before the end of the rod reaches the bottom of the cylinder. By this means it is possible to determine empirically the length which the rod should have in order to produce a given effect. A passive crank may then be constructed which will present the maximum of efficiency.

therapeutic problems presented by pseudoarthrosis of this nature are very complex.

In each of the preceding classes of case it has been possible to re-establish a certain solidarity between

the fragments, and by this means to obtain a sufficiently satisfactory mandibular function. Here, on the other hand, we are faced with a single fragment, which has lost all connection with one temporo-mandibular articulation, and which, in consequence, possesses an irreducible tendency to lateral deviation, thus losing all functional ability.

It has been held by some that an apparatus maintaining the normal occlusion of the teeth during functional activity would meet the requirements of the case. Other authors have believed that such a therapy represented the minimum of treatment, and have sought to remedy the fracture of the mandibular lever, either by the creation of an artificial temporo-mandibular joint to which the free end of the fragment is connected, or, by transmitting to the fractured extremity sufficient elevator force (flexible cables) for the performance of movements of mastication, equal to those performed by the rest of the mandibular fragment.

Up to now sufficient evidence in regard to the latter method has not been forthcoming. There is, however, a well-proved method of reduction in these cases which has been described by G. Villain,¹ who calls it a "crank."

The crank is an apparatus which depends on intermaxillary force. It is anchored to the fixed bony mass of the upper jaw, and reacts upon the mandible or one of its fragments (figs. 75 and 76).

¹ G. Villain, "Traitement physiologique des fractures et des luxations de la mâchoire," *Odontologie*, August 30th, 1916.

The mechanism consists of a rod which telescopes into a tube. Rod and tube are attached by means of removable splints, the tube to the upper jaw, the rod to the lower, or inversely according to the requirements of the case. The heads of the crank are attached to the splints by joints, which permit of movements of circumduction upon the attachment screws, in such a way that elevator and depressor movements are not interfered with. If a little play is allowed to the heads of the crank, movements of circumduction may also be performed.

The mechanism of the apparatus is best understood by studying its action in a given case.

The mandibular fragment bears a splint, to the free end of which the rod of the crank is attached. The tube is attached either to a fixed splint or to a removable apparatus upon the maxilla.

During depression of the mandible there is a tendency on the part of the fragment to lateral deviation, but this is possible only within the very narrow limits permitted by the laxity of the crank heads. When the jaw is elevated, the rod plunges into the tube, and the length of the rod is so calculated that its extremity touches the bottom of the tube at the moment when the jaws are in occlusion. The effect is to force the teeth of the lower jaw into occlusion, and to maintain them in that position.

This is the passive crank employed for the reduction of deviations which are readily amenable to treatment. Where correction of the deviation is more difficult, the

active crank is preferable. This differs from the passive crank only in the fact that the rod is threaded and furnished with a nut. By screwing the nut towards the orifice of the tube the latter is arrested before the position of occlusion is reached. Thus, at each elevation of the mandible a degree of pressure, which varies in accordance with the position of the screw, is exercised, the effect of which is to propel the mandibular fragment into good position.

As soon as the displacement becomes amenable the threaded rod is replaced by a smooth one.

In certain special cases it is necessary to increase the length of the piston stroke, and for this purpose the elbow-crank (fig. 77), the jointed crank (fig. 78), the crank with horizontal attachments (fig. 79), are all employed. Where it is desired to modify the centre of rotation, the crank is mounted on vertical prolongations.

The crank is usually well tolerated and its therapeutic value is incontestable. It appears to act as something more than a simple guide; the connection thus established between the jaws on the fractured side serves as a kind of support to the free extremity of the mandibular fracture.

The action of the crank is intermittent and is exercised only at the moment of muscular activity. In such cases as the one under discussion, the crank is infinitely superior to the old method of guides or of intermaxillary elastics.

Such is the apparatus usually employed to remedy this grave form of pseudo-arthritis.

The apparatus reproduced in fig. 81 was designed by M. Bosano, a surgeon dentist and one of our clinical assistants. In our view it represents a very happy modification of the crank. It is, in fact, a jointed crank, the cylinder being replaced by a metal splint the upper surface of which is furnished with articulations which interdigitate with the teeth of the upper

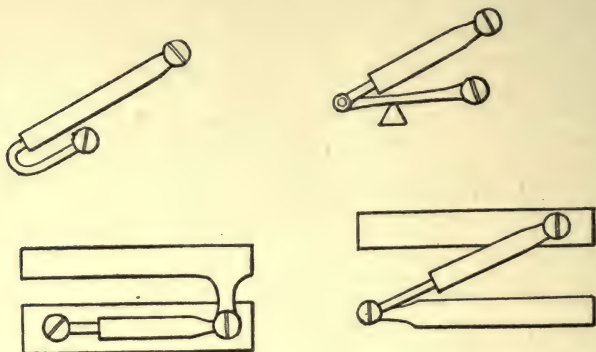


FIG. 77.—Elbow crank.

FIG. 78.—Jointed crank.

FIG. 79.—Crank mounted on horizontal prolongations.

FIG. 80.—Crank mounted on vertical prolongations.

jaw. This arrangement possesses all the advantages of the crank while at the same time re-establishing mastication upon the fractured side.

Among other apparatuses designed to the same end some, of which one is described by G. Villain, provide an intrabuccal artificial joint with which a rigid arm attached to the free extremity of the fragment articulates (see article in *Odontologie*).

We ourselves have designed an instrument upon

similar lines, the artificial fulcrum being fixed externally in the region of the absent temporo-maxillary joint. The bony lever is replaced by a rigid rod, which articulates with the artificial fulcrum and is firmly attached to the mandibular fragment.

Such an instrument as this should, in our opinion, be worn only during a meal.

At our suggestion MM. Granier, Bosano, and Audibert constructed several appliances conforming to a different principle. Here the elevator power which, owing to the break in mandibular continuity, had been lost, is reconveyed to the free extremity of the fragment.

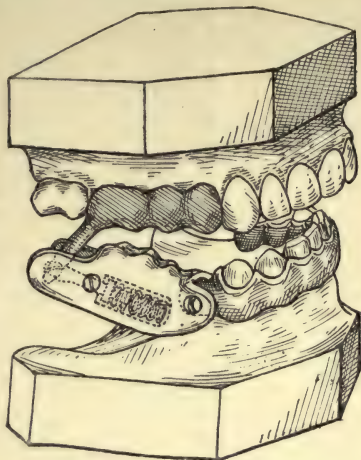


FIG. 81.—Jointed crank with articulated surfaces. The lower arm of this crank is a bar of cast silver with articulated surfaces which assist in mastication and serve to fix occlusion.

Fig. 82 represents an apparatus of this type. When the muscles contract, the flexible cable is extended; it draws upwards and into good occlusion the free extremity of the fragment, which is thus enabled to perform masticatory movements along its entire length.

These mechanisms are still very new and investiga-

tion concerning them is not complete. They are mentioned here only with reservation.

Pseudo-arthritis of the Ramus; Loss of Substance at the Temporo-mandibular Joint.—These pseudo-arthroses are consequent upon fracture of the ramus



FIG. 82.—Apparatus for use in lateral pseudo-arthritis. The chief feature of this apparatus is a flexible cable attached to the sound side which, at each movement of occlusion, is extended and transmits to the extremity of the fragment an appreciable force. Extension is effected by means of a system of pulleys. The apparatus may be rendered removable if desired.

with large loss of substance. They are characterised by malocclusion of a very specific type, which has been described in an earlier chapter (figs. 21 and 21*a*).

The malposition resembles that seen in extensive traumatic lesion of the temporo-mandibular joint

(destruction of the condyle and of the glenoid cavity). The method of treatment is equally applicable to both classes of case.

In pseudo-arthritis of the ramus, when the elevator muscles are contracted the elevation of the mandible is not equal on both sides, in spite of the fact that muscular action is equal.

The fractured ramus drops in such a way that the fragments are brought together along the entire length of the breach. This movement is shared by the horizontal branch, with the result that the dental arches of the fractured side meet prematurely, the teeth of the sound side being separated by a varying interval. The elevator muscles of the sound side continue to contract, and occlusion is eventually effected upon this side also.

This occlusion in two parts is characteristic of the lesion. It may be associated with retraction and lateral deviation of the fractured side, but these displacements are secondary and always little marked.

The apparatus designed to remedy this pseudo-arthritis should, in the first place, limit the action of the elevator muscles and the elevation of the mandible upon the fractured side. It should also, where necessary, force it into occlusion.

The crank with jointed arms and double stops, as described by Villain, corresponds to these therapeutic indications (fig. 83).

In elevator movements of the mandible the posterior arm encounters the superior stop, which conveys a

propulsive movement and thus corrects the lateral deviation and the retraction. The distal prolongation of the lower arm comes into contact with the inferior stop, thus preventing abnormal elevation of the mandible. Finally, when the mandible is in occlusion, the extremity of the rod of the crank comes to rest at the bottom of the cylinder and thus completes the action of the stops.

This description applies to the crank in its definitive form. It is frequently possible to employ this form from the first. It is, however, sometimes necessary, for purposes of examination and regulation, to employ the form shown in fig. 84.

In the latter, crank, arms, and stops may be modified in every kind of way to produce elongation or curtailment. The operator is thus enabled to alter the dimensions and relationships of the different pieces experimentally, and by this means to adjust the apparatus to the necessary requirements.

A "stop-guide" is also recommended by G. Villain. As, however, we have had no opportunity of testing it, we shall not describe it here.

We have already had occasion to mention a case in which complete disappearance of the condyle with its neck was not attended by functional derangement of any description. It is hardly probable that in a case of this kind the missing portion of bone could have been reconstituted. We must therefore assume a species of muscular adaptation to compensate for the missing bony substance. It is reasonable to assume

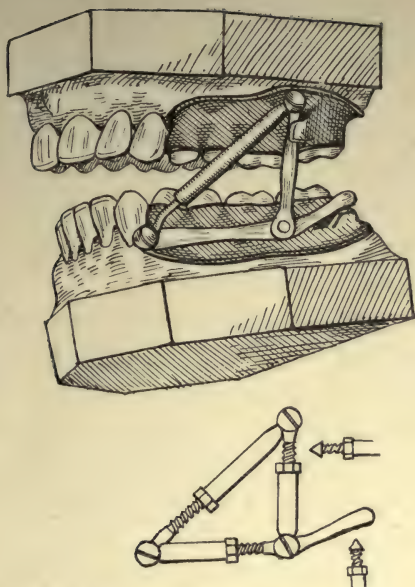


FIG. 83.—Crank with lever and two stops for the treatment of pseudo-arthritis of the ramus or loss of substance at the temporo-mandibular joint. This is a passive crank (fig. 75) attached to two rigid arms, one vertical the other horizontal, which are jointed at the crank heads and jointed together. To the upper splint a stop is attached which, in movements of occlusion, bears on the vertical arm of the lever and produces a forward movement of propulsion. To the lower splint a stop is also attached which, in movements of occlusion, bears on the extremity of the horizontal arm of the lever, thus limiting abnormal tendency of the mandible to rise. The latter movement is due to loss of substance of the ramus or of the temporo-mandibular joint, and produces premature contact of the dental arches of the fractured side. The play of the lower arm of the lever counteracts this movement and regulates it in such a way that interdental contact is simultaneous along the entire length of the dental arches.

FIG. 84.—Active crank with lever and stops. This is a kind of preliminary to the form shown in fig. 83. The rods of the crank, lever arms, and stops are threaded and fitted with nuts. By this means the dimensions are varied and the form most suitable to the individual case is obtained experimentally. From the design obtained in this manner the definitive apparatus, as shown in fig. 83, is constructed.

that, after a given time, muscular adaptation of this kind may develop under the influence of the crank, and that the crank would then become superfluous. Hence the prognosis in these pseudo-arthroses would be more favourable than in the lateral and median forms. This, be it understood, is hypothesis; experience in these cases is too recent for a categorical statement to be permissible.

Loss of Substance amounting to almost the entire Mandible.—It is cases of this class which make the greatest demand upon the ingenuity of the practitioner. We can only give the general lines upon which treatment should be conducted. Each case demands special mechanisms, and we give the results of our experience with a certain number of these.

To obtain an impression of the mandibular fragments is frequently a very complicated proceeding and one that requires several sittings. The chief endeavour should be to obtain as faithful a reproduction as possible of all fibrous bands and bony projections likely to favour retention.

The base of the mechanism should be in cast metal. It should take advantage of the slightest bony or fibrous elevation for purposes of anchorage. The artificial teeth are attached to it later by vulcanized india-rubber. Retention may be aided by springs attached to the upper jaw in the manner described above. In certain cases the crank with springs described by G. Villain (Interallied Dental Congress, 1916) is indicated.

A badly shattered jaw is sometimes accompanied by marked constriction of the buccal opening. This constitutes a serious obstacle to the taking of impressions and the application of mechanisms. In these cases the impression should be taken in several portions and the apparatus should be constructed in several pieces, in the manner described formerly by Claude Martin and Delair, and more recently by Martinier and Roy (*L'Odontologie*, 1916).

V. TREATMENT OF MALOCCLUSION

Where malocclusion is due to vicious union as the result of large loss of substance, surgical intervention is indicated. Oblique osteotomy would appear to be the best method. It has frequently been practised by Sébilleau with satisfactory results.

In other cases, notably the deviation known as *bouche de chancre de village*, the best method is by early prosthetic treatment.

The apparatus employed for the treatment of lateral fracture should always permit of intermaxillary anchorage, in order that any tendency to lateral deviation may be counteracted. The mechanism shown in fig. 64 fulfils this requirement.

Where the vicious position is already established, treatment is more complicated and is bound to take a long time.

The apparatus which most nearly corresponds to the indications is the crank.

It is not always indicated in the earlier stages of treatment. In certain extreme cases, where deviation is not readily remediable, the jaws should at first be immobilised by the apparatus shown in figs. 69 and 70. By this means the vicious position is partially corrected from the start. Later on the ligatures are tightened every eight days, in such a way that the dental arches are gradually brought into occlusion. Occlusion is maintained during a varying period, the ligatures being removed from time to time to ascertain the results of treatment.

The crank is not employed until the movements have become more supple and the reduction of the vicious attitude can be effected with slight manual effort.

The crank is intended to counteract the lateral deviation, which is more pronounced when the mouth is open. It should at the same time effect normal occlusion when the jaws are closed. Thus its function is that of a guide.

A passive guide (fig. 75) generally fulfils all requirements. It is attached to the fractured side in the usual manner, and as little play as possible is allowed to the articulations at the crank-heads as well as to the telescope. The latter is regulated in such a way that when normal occlusion is obtained the rod comes to rest at the bottom of the tube.

Occasionally two cranks are necessary, one at each side. By this means it is possible to counteract

strong muscular opposition, as well as to obtain a better occlusion (fig. 85).

In cases of this sort the lever-crank is very useful. It is a more resistant guide than the simple crank and is, for that reason, frequently indicated here.

The methods described give excellent results in this sense, that they rapidly reduce deviations which are sometimes very marked, while at the same time they permit of a practically normal diet. But it must not be supposed that a malposition corrected is always a malposition cured. Before an absolute cure is obtained, the muscular hyper-tonicity must be

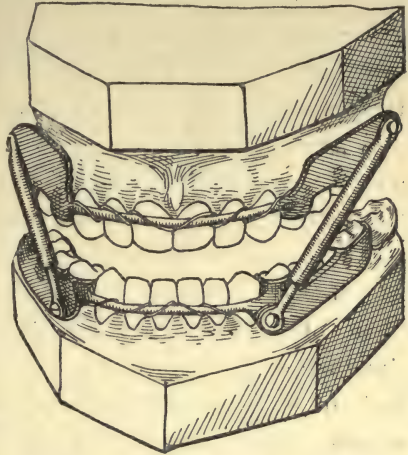


FIG. 85.—Double crank for the treatment of the deviation known as “*bouche du chantre de village*.” These are passive cranks similar to those shown in fig. 75 *et seq.* They work as two active guides which counteract the lateral deviation.

counteracted for a long time by the influence of the crank. Every now and then the apparatus is removed for the purpose of testing whether the patient is able to correct the vicious attitude spontaneously. Not until he has acquired the faculty of contracting his masticatory muscles synergically can he be regarded as cured and relieved of his crank.

After cure the patient should still be under supervision for a time, for his condition, similarly to that of mandibular constriction, is essentially prone to relapse. Moreover, the co-operation of the patient is not always to be depended upon.

On the slightest sign of relapse the crank is replaced. Lateral deviation may be prevented by using a lateral guide, supported by a bridge attached to the sound side.

The malocclusion consequent upon mandibular fracture is referable to two primary causes.

In some cases it is associated with very marked anatomical lesions of the mandible, deformities which are amenable to prosthetic treatment where union is not far advanced, or which demand surgical intervention if the ossification of the callus is definitive.

In other cases malocclusion is the outcome of dynamic derangement of the masticatory muscles, the lack of co-ordination in their action producing the specific distortion known as *bouche du chantre de village*. The length of time required for treatment depends upon the length of time the condition has lasted. Treatment should be purely prosthetic, and the most efficacious mechanism is the crank.

VI. MECHANICO-THERAPEUTIC TREATMENT OF MYOTONIC CONSTRICTION OF THE MAXILLÆ

The method of treatment now to be described is more particularly indicated in the form of closure of the jaws most commonly observed, namely, the myo-

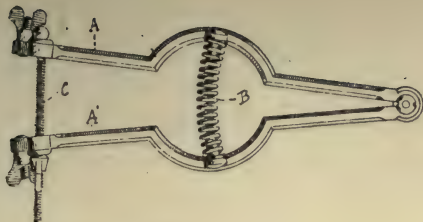


FIG. 86.

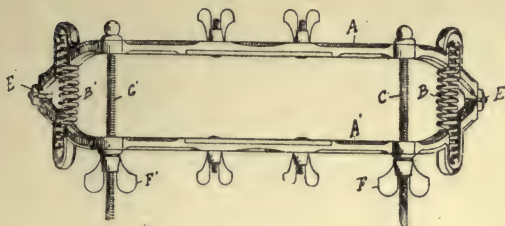


FIG. 87.

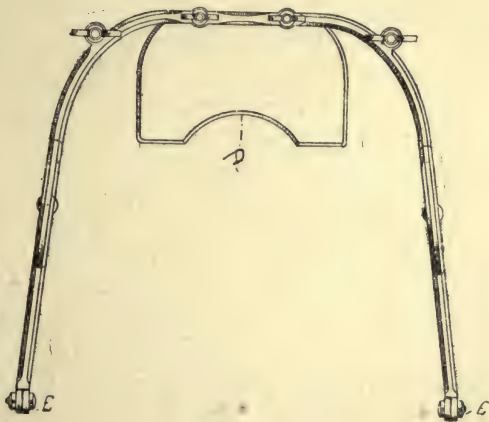


FIG. 88.

FIGS. 86, 87, 88.—*AA'*, metallic arches jointed at *EE'* and furnished with splints *DD'*, by which the power of the springs *BB'* is transmitted to the dental arches. *CC'*, threaded and graduated rods with flanged screw-nuts *FF'*, by which the action of the springs is modified. Their graduation shows the progress made.

tonic. If undertaken early, before sclerotic or cicatricial lesions have become definitely established, it is very efficacious in constriction due to myositis of the masticatory muscles and to lesions of the temporo-mandibular joint.

Our patients always receive mechanico-therapeutic



FIG. 88a.—Automatic mouth-opener, for the treatment of closure of the jaws.

treatment twice a day. Each sitting lasts for about half an hour, and the apparatus employed is one which we have had in use for some time and which is shown in figs. 87 and 88. Its qualifications are as follows :

The base of support is distributed over the entire length of both dental arches by means of special adjustable splints.

The springs which convey the expansive force are regulated by flanged screw nuts.

Each day's progress is registered by means of a graduated rod.

In our view it is essential, especially in myotonic cases, that the gap between the jaws effected at each sitting shall be maintained by means of a wooden wedge introduced between the teeth and kept there until the next sitting. This measure effectually counteracts the hypertonicity of the elevator muscles. It produces the "inverse attitude," a therapeutic principle regarded as of extreme importance by neurologists interested in acromyotonia.

CHAPTER VI

SURGICAL TREATMENT

IN the last chapter the technique and the clinical results of prosthetic treatment were described. In mandibular, as in the majority of other fractures, operative treatment should not be resorted to until treatment by mechanical apparatus has failed. It is in fact indicated in pseudo-arthritis alone.

For the last eighteen months we have been in charge of a maxillo-facial department with a minimum of 150 patients. During this period eighteen patients only have received surgical treatment. This is proof positive that we ourselves have carried out the principle which we advocate, namely, never to operate except in definitive pseudo-arthritis.

Two forms of surgical intervention are indicated. Where it is advisable to draw the two fragments of bone together, osteo-synthesis should be practised. Where the loss of substance is very extensive, however, osteo-synthesis is either not attended by results or it yields results which are functionally imperfect. In such cases the method should be reinforced by the bony graft. The object of this book, however, is to describe the positive results of the treatment of war

wounds, and the number of bony grafts performed upon the mandible is too few to permit of definitive conclusions. For this reason the subject will be only briefly dealt with here.

Those of our cases in which osteo-synthetic methods have been employed have all been lateral fractures. This is due, not to special suitability of the condition, but to the fact that the method has not been indicated in the cases of median and retromolar fracture which have come under our notice.

Union is undoubtedly more frequent in median fracture than in other types. This is attributable to the fact that the equal length of the fragments facilitates their inclination towards one another. It is true that vicious union may result, but pseudoarthrosis is excluded. It may be, too, that the tendency to intervention on the part of the muscular masses in the immediate neighbourhood is slighter. However that may be, one thing is certain, namely, that pseudoarthrosis in median fracture is invariably associated with grave loss of substance, such as cannot be remedied by osteo-synthetic methods.

Similar reasons hold good in the case of fracture of the angle and of the ramus. These fractures either unite or the loss of substance is so extensive that osteo-synthesis is impracticable.

I. OSTEO-SYNTHESIS

In the case of fracture of the limbs the bony extremities may be brought together in various ways: by

flexible ligature, metal ligature, bolts, etc. In fracture of the mandible several of these methods are excluded. The only permissible methods are ligature with metal wire, and the application of a screw-plate. The latter is preferable, because it procures a greater rigidity and a better co-adaptation of the fragments. We recognise, however, that after the fragments have been brought together, the maintenance of the jaws in occlusion by methods which we shall describe later, contributes very favourably to the contention of the fracture site, and for this reason we do not entirely reject the wire ligature.¹

It must be understood that the indications for surgical treatment are exceptional. The special methods described in the previous chapter result in the union in good position of 90 per cent. of fractures with loss of substance, and 100 per cent. of fractures with no loss of substance. The results obtained in the maxillo-facial department of the medical centre at Marseilles are such that the proportion of patients returned to the army has never been less than 90 per cent., and has frequently reached 95 per cent.

OPERATIVE TECHNIQUE

Here, as elsewhere, asepsis is essential, and the technique we are about to describe is formulated with the object of attaining it. But it must not be for-

¹ L. Imbert and P. Real, "Traitement des Pseudo-arthroses du maxillaire inférieur par l'ostéo-synthèse." *Soc. de Chir.*, March 29th, 1916, and Interallied Dental Congress, November, 1916.

gotten that union is obtainable even at an infected fracture site. Good results in the case of the humerus have been published by Dujarier, and we ourselves have effected union where a sinus existed at the site of operation. On the other hand, union by first intention is not invariably a therapeutic success. In the case of the mandible, the infective complications of osteo-synthetic operation are never serious. We have never lost a patient nor have we ever had cause for serious anxiety. Hence, where local infection is present it is rarely necessary to remove the metal plate; it is usually sufficient to remove the sutures.

Age of the Fracture.—At what stage is operation indicated? As we have shown, the surgeon should not intervene until pseudo-arthritis is established. This condition depends either upon the amount of substance lost, which is not less than 2–3 cm., or upon the failure of prosthetic measures. The latter should have been employed under suitable conditions and should have succeeded in bringing the fragments together. A fracture in which the fragments are permanently separated may unite by the agency of bony projections, but the conditions are not favourable to union. To obtain union in obstinate cases an apparatus should be employed which will bring the fragments together. It should, moreover, be worn for a sufficient length of time. In our opinion the minimum is three months, dating from the moment when the lesions of the soft parts have so far progressed that complications on their part are no longer to be

anticipated. Thus, pseudo-arthritis is not presented until after a period of at least six months. Intervention before this date does not expose the patient to any serious danger, but the results of such intervention must be regarded as surgically facile, seeing that union could have been obtained by means of mechanisms.

Should operation be postponed until infection is abolished? Our answer is emphatically in the affirmative. Not that good results are not obtainable, but it appears to us purposeless to act in the presence of a suppuration which, to say the least, must prove inconvenient. Moreover, it is always easy to dry up the suppuration from a fracture, and the conditions presented by the mandible are more favourable than those of the majority of bones. A sinus in connection with a fracture is due to two causes, namely, the presence of dental caries or of a sequestrum. The mouth should be minutely examined by the stomatologist, and all fractured roots as well as those suspected of infirmity should be removed. Where, in spite of minute attention, the sinus does not close up, surgical intervention is indicated. Simple curetting, so frequently without effect in sinuses of the bones of the limbs, usually gives excellent results here. The channel is opened up, a small sequestrum, the root of a tooth, a tooth itself, removed, and the sinus closes in a few days. It is exceptional for a second curetting to be necessary.

Occasionally there is a hampering discharge, salivary

rather than purulent. This is remedied as follows. The little orifice is localised by watching the patient during mastication. The fine point of a galvanocautery is introduced as far as possible into the passage and is heated when the point is in position. If well cauterised in this manner, the fistula closes in a few days.

These minor interventions may with advantage be carried out during the prosthetic period of treatment. Where the rare opportunity occurs of taking over a patient from the first, by careful attention to these details the period of treatment may sometimes be reduced to four months. On the other hand, it must obviously be lengthened by the amount of time spent under less favourable conditions.

Preparation for Operation.—It is important that the buccal cavity should not be opened up by operative manipulation, for this is certain to lead to infection of the wound. It is difficult to prevent, however, where the root of a tooth is implanted in the extreme border of a fragment. For this reason we make a preliminary exploration of the fracture site. Roots at the extreme edge of fragments are carefully removed and the gum is allowed to heal, usually a matter of about fourteen days. In the first two operations which we performed, we opened the mucosa, but since taking these precautions such an accident has not occurred, not even where the denudation of the fractured surfaces was very extensive.

A second essential condition is the possibility of

bringing the fragments together. A reasonable loss of substance is presupposed; it should not exceed one or two teeth, in rare cases three. From this point of view prosthetic treatment, even where unsuccessful, is of extreme utility. In a previous chapter we have expressed the view that union is more important than occlusion, and that an efficient retention apparatus should bring the fragments together, thus effacing the loss of substance. It should prepare the ground for surgical intervention, for, as we shall show later, the success of osteo-synthetic methods in mandibular as in other fracture, depends upon the bringing together of the fractured surfaces. The superiority of osteo-synthesis does not depend upon the fact that it is applicable where there is large loss of substance. From this point of view its indications do not differ from those of prosthetic appliances. But the latter sometimes fail to effect union even where they have succeeded in abolishing the interfragmentary gap. The primary causes of this failure are not always appreciable, but the immediate causes appear to lie in the pointed configuration of the broken ends and the presence of a more or less thickened fibrous obstruction. The objects of operation are: to remove this obstruction, to make a fresh-cut surface to the broken ends, and to bring them into contact. It is evident that these results are more easily obtainable where the preliminary prosthetic treatment has fulfilled its purpose.

Anæsthesia.—In a former chapter we showed that mandibular fracture presents a mental zone of anæ-

thesia affecting the gum and mucous membrane of mouth, as well as the teeth of the anterior fragment and the anterior fragment itself. Thus anæsthesia of the posterior fragment and of the soft parts is all that is required. This result might undoubtedly be obtained by local anæsthesia, though the method is one which we have never employed. In one case we combined local and regional anæsthesia by direct action upon the mandibular nerve. With Sicard's able assistance the operation was successfully completed. The method is, however, only practicable in the case of very vigorous subjects. With this one exception we have always employed general anæsthesia.

Ether or chloroform? The abundant salivation almost invariably provoked by ether seems to us a definite contra-indication to its employment. For this reason we have always used chloroform, but even with this anæsthetic, the near presence of the anæsthetist constitutes a serious embarrassment. To reduce the inconvenience as far as possible we employ Ricard's old-fashioned apparatus, which obviates the necessity for constantly pouring chloroform on the compress. The anæsthetist is instructed to keep his hand and fingers well within the limits of the mask. By observing these precautions, the number of the possible channels of infection arising from the vicinity of the mouth and the anæsthetic manipulations is certainly reduced.

Incision.—The position of the incision is obviously dependent upon that of the fracture-site. We em-

ployed at first a rectilinear incision corresponding to the inferior border of the maxilla, but the method presented certain drawbacks, and we have since abandoned it. Sutures in this position are immediately over the plate and screws, a condition very unfavour-



FIG. 89.—Diagram showing the usual position of the fragments; falling of the posterior fragment; extremities in irregular points. The figure shows the line of incision; curved and with the concavity uppermost; extending from the vicinity of the symphysis to that of the angle.

able to good cicatrization. Moreover, in spite of all precautions, the secretions from the mouth tend to soil the dressings. The further the incision is removed from the mouth, the better the chance of avoiding such a contingency. We prefer a curved incision (fig. 89), with the anterior extremity at the median line or the inferior border of the

bone, and the posterior extremity at the angle of the jaw.

By this means a flap is raised which should be well freed to facilitate suture after operation.

Cicatrices should be avoided, especially those extending under the curve of the incision. We have occasionally seen complete mortification of the flap,

the circulation having been arrested by the cicatrix. The curved incision completes the anæmia, and the entire flap is thus deprived of nutrition. Where a cicatrix occupies this disadvantageous position, a band of healthy skin should be left intact between it and the incision in order to effectuate circulation.

Exposure of the Fracture Site.—The flap is raised by large strokes of the bistoury until the fracture site is well exposed. A thread is passed through it, the extremities of which are attached to a rather heavy forceps, which forms the counter-weight and acts as an automatic retractor (fig. 90).

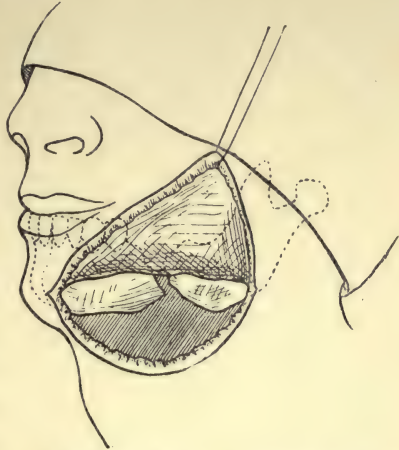


FIG. 90.—Diagram showing the flap turned back and the fracture site exposed.

Denudation of the fragments follows. A stroke of the bistoury, penetrating well down, is carried along the inferior border of the bone, and separation is effected by means of the scraper. It goes without saying that hæmorrhage is abundant. Unless the facial has been destroyed by the injury, it bleeds very freely. Moreover, regions which have formed the seat of prolonged inflammatory trouble remain very vascular.

The hæmorrhage is easily arrested ; we usually ligature only the facial.

The scraper should be employed for denudation of the fragments. As always, Farabeuf's curved scraper is a valuable instrument. It is advisable to begin with the posterior fragment, which is usually more easily decorticated. The external surface is first exposed, then the end of the fragment, which is usually pointed and irregular, and then the internal surface is denuded. Finally the superior border is exposed, taking care not to expose too much in order to avoid making a passage into the buccal cavity.

In the case of the anterior fragment, the inequalities of the external face are patiently followed with the tip of the scraper. The point, the internal face, and the superior border are all successively treated in the same manner. The anterior fragment after scraping rarely presents the neat and satisfactory appearance of the posterior fragment.

When the two fragments are denuded and an attempt is made to bring them together, it will be found that the fibrous obstruction by which they are separated has a pronounced tendency to interpose. This must be cut away with the scissors until nothing remains to hinder the contact of the fractured surfaces.

Fresh cutting of the Fractured Surfaces.—A further difficulty now presents itself. The surfaces of fragments are habitually irregular, and are usually pointed. Merely to cut away these surfaces would leave two bony points in contact. The sole method is to bring

down the point, and this must be executed with extreme discretion or the breach will be irretrievably widened. The removal of about 1 cm. should suffice.

With an electric lathe and some dentist's burrs the manœuvre is a simple one ; with the ordinary surgical outfit it is really

difficult, and is usually imperfectly performed. In good hands, a burr such as that shown in fig. 91 gives rapid and satisfactory results. The arm of the electric lathe is of course covered with a piece of sterile linen, and the hand-piece and burrs are sterilised with the other instruments.

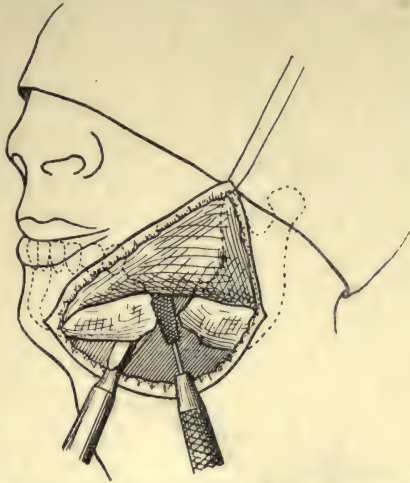


FIG. 91.—Diagram showing the manner of freshening the fractured surfaces by means of a burr on an electric lathe. The fragment to be cut is held with the curved scraper.

Application of the Plate.—The plates which we prefer are of gilt German silver. It is true that they are not as resistant as Lambotte's plate, but the bone with which we have to deal is not uniform in its curve. It is almost flat in places, and becomes more convex as it approaches the median line. Hence a plate must be employed the curve of which may be modified by

means of strong pliers. After operation the mandible is immobilised by attachment to the upper jaw, hence the maintenance of reduction is not entirely thrown upon the plate, and its lack of absolute rigidity is not an insuperable drawback. It is usually fixed in place by means of four screws, two in front and two at the back. A point of paramount importance is to avoid the roots of the teeth. A root which has been injured by a screw may easily prove a source of infection to the fracture site. For this reason the plate is not applied to the centre of the external face of the fragments, but along their inferior border, the screws being inserted about 1 cm. above the edge. The precautionary measure of removing the marginal teeth still further limits the danger.

Before applying the plate the surgeon should assure himself that the two fragments may be easily brought together. Contact is essential, and an interval, though only of a millimetre, must almost inevitably compromise the results. Where there is difficulty in bringing the fragments together, a hole should be bored in each fragment, through which a strong wire is passed. The latter must permit of powerful traction, and must maintain contact until the plate is screwed into position.

These precautions having been taken, and the plate bent into shape with a pair of strong pliers, it is applied. A hole corresponding to the posterior screw-hole of the plate is bored in the posterior fragment. The hole is made with a burr on an electric lathe, its

size conforming to the diameter of the screw. The latter is immediately screwed into place. A hole corresponding to one of the anterior screws is bored in the anterior fragment and this is screwed into place. The application of the two remaining screws is a simple matter (fig. 92).

One of the great difficulties associated with pseudo-arthrosis of the bones of the limbs is the poor consistency of the extremities of the bony fragments. Only too frequently the screws fail to bite, and their hold is very precarious. Occasionally their use is impossible and ligatures must be employed, always an unsatisfactory method. This complication does not arise in the case of the mandible. We have always found the bony extremities to consist of a compact and resistant tissue which gives the screws a good hold.

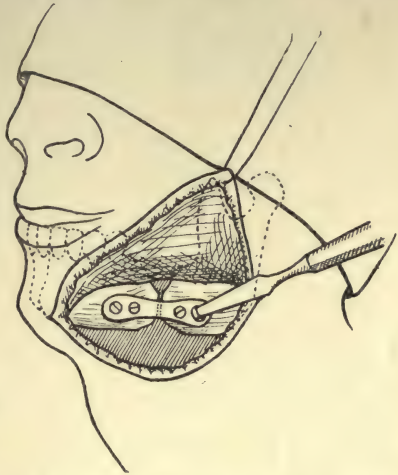


FIG. 92.—Diagram showing the plate attached by four screws, two upon each fragment.

Once the four screws are in position, the operation is terminated. A gap corresponding to the inferior border of the bone, and due to the shape of the fractured extremities, is frequently observed. We have

endeavoured to fill it with a chip taken from the posterior fragment, but we are not convinced that the results of this little operation are entirely satisfactory.

Sutures.—All that now remains is to put back the flap. Most frequently it is thin and traversed by cicatrices. Nevertheless it should be sutured along two planes, using catgut for the deeper plane, which brings the soft parts together, and silk or horsehair for the surface stitches. Unless the buccal cavity has been opened, drainage is not required.

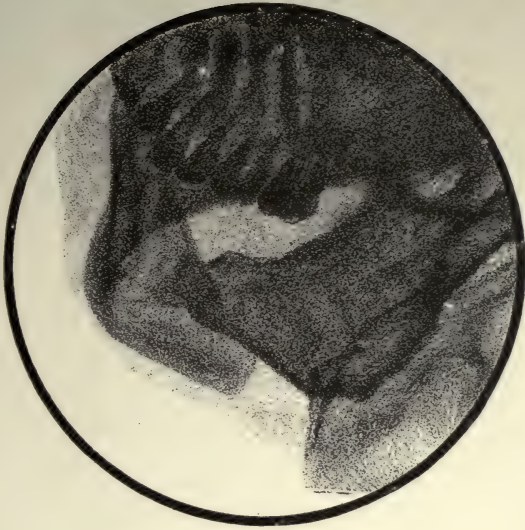
This is the moment for dental intervention and the immobilisation of the teeth in occlusion. Two alignment wires with spurs having been previously attached to the upper and lower dental arches, to unite them at the end of operation by brass wire ligatures is a simple matter.

The wound is dressed with gauze kept in place by bands of adhesive plaster. The latter are arranged in such a way that they form a sort of barrier at the side of the mouth. Before coming round the patient is put in charge of a nurse, who sees that the dressings are not soiled by the buccal secretions.

Results of Osteo-Synthesis

Up to the present we have had 18 cases under observation. Of these 7 were successful, 8 unsuccessful, and 3 are so recent that the results of operation are still uncertain. Those cases only are regarded as successful in which union is definitive. As in the case

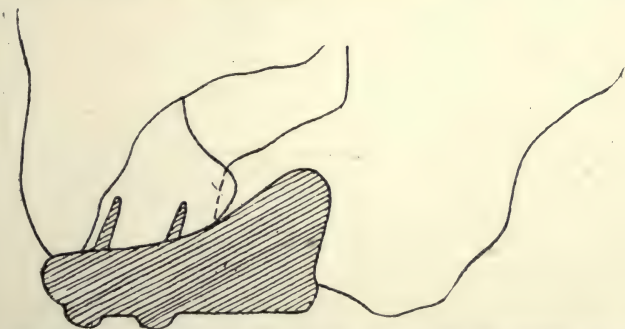
PLATE III



Patient T. Skiagram and explanatory diagram. Pseudoarthrosis of the mandible with loss of substance. Overriding of the fragments.



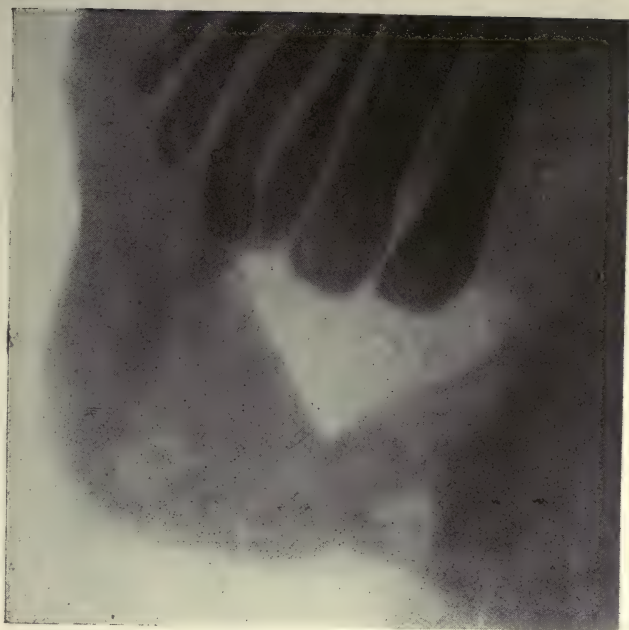
PLATE IV



Patient T. Skiagram after osteo-synthesis; reduction of the fragments; application of a metal screw-plate. Skiagram and explanatory diagram.



PLATE V



Patient T. Skiagram after union and removal of the plate.
Skiagram and explanatory diagram.



of pseudo-arthroses of the limbs, failure is fairly frequent, but it must be borne in mind that in all our cases the pseudo-arthrosis was confirmed.

Union is very protracted, and this is in line with the observations of others of osteo-synthesis in fracture



FIG. 93.—Left lateral fracture; pseudo-arthrosis in spite of prolonged immobilisation; the skiagram shows the plate by means of which union is obtained.

of the long bones. Cases in which union is effected in two months may be regarded as exceptionally favourable. The average varies from three to four months, and we have known union delayed for five.

It is easy to judge of the progress made. We make a rule of removing the mechanism which effects occlusion at the end of two months. By that time the

screws have acquired sufficient play for it to be possible to judge whether mobility is still present. The apparatus is immediately replaced, and is removed every month for purposes of investigation.

In hospitals accustomed to the management of these



FIG. 94.—Left lateral fracture with large loss of substance; pseudo-arthritis in spite of prolonged immobilisation; union by osteo-synthesis.

patients diet offers no difficulties. It should consist of liquid or semi-liquid foods; many patients are sufficiently adroit to manage minced meat.

Where infection is present we always remove the plate. We recommend removal of the plate in aseptic cases also, a course to which the greater number of patients consent. They are as anxious to rid them-

selves of this foreign body as if it were a fragment of projectile. Naturally, removal of the plate does not take place until after union, or until after proved failure at the end of five or six months.

Plates III, IV, and V show the position of the fragments in one of our cases before and after osteosynthesis, as well as their union after removal of the plate.

II. BONY AND CARTILAGINOUS GRAFTS.¹ ACTUAL RESULTS

The question of the bony graft in connection with pseudo-arthritis of all kinds is still in course of study.

We propose to describe definitive results only. If little is known of the ultimate outcome of bone-grafting in pseudo-arthritis of the bones of the limbs, still less is known of its results in pseudo-arthritis of the mandible. This is due, not to any inherent unsuitability of the method, but to the extreme scarcity of the literature of the subject. We shall describe, first, the results obtained by other surgeons, and second, the results which we ourselves have obtained.

Briefly stated, the situation is as follows :

The term "bone-grafting" has a certain biological significance which is comparatively definite and precise,

¹ Autografts are those taken from the subject; homografts those taken from another subject of the same species (man); heterografts those taken from a subject of different species (animal). We do not know of a specific term for grafts taken from the fracture site. They might very well be termed autografts *in situ*.

but from the surgical point of view this is not the case. Surgically, the graft is employed to fulfil a double purpose, and it is improbable that the conditions incidental to success are the same in both cases.

Sometimes the graft is employed as a simple agent

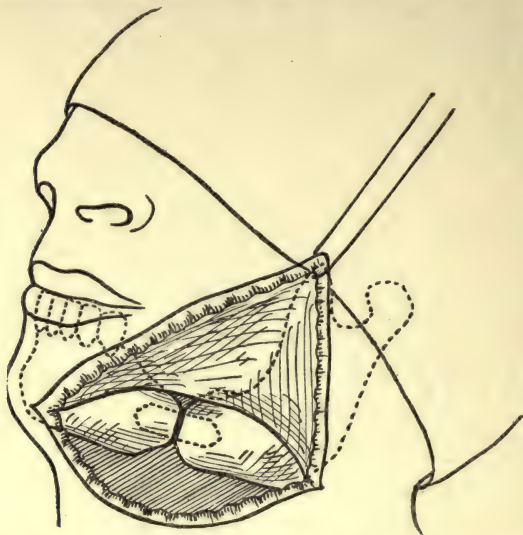


FIG. 95.—Bone graft. In this case the graft acts as an agent of union, the method being that of osteo-synthesis in which the metal plate is replaced by a segment of bone. The callus will be formed as in ordinary fracture by the two fragments, the graft will not take part in its constitution.

of union (fig. 95), when it plays the part of a bolt. In such a case the surfaces of the fragments are in contact and there is no loss of substance to be replaced. The typical indications for this use of the graft are supplied by fracture of the neck of the femur. Some surgeons introduce a long bony pin into the neck

with the object of immobilising the fragments and favouring union. The same method appears practicable in the case of the mandible, the graft taking the form sometimes of a pin and sometimes that of an osteo-synthetic plate attached, or even screwed, to both fragments. It is evident that success by these

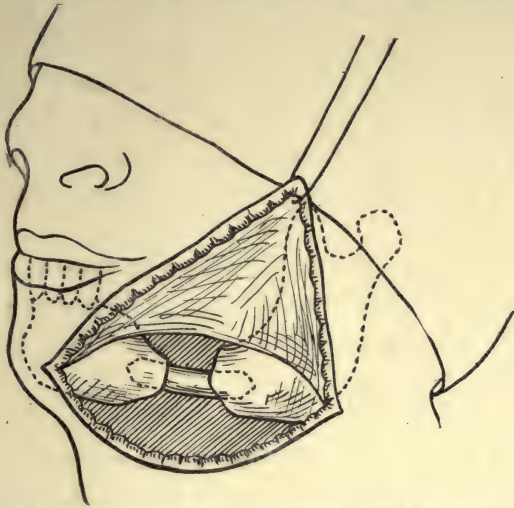


FIG. 96.—Bone graft. Here the graft does not act only as an agent of union. The space between the fragments is so considerable that union is not possible through their agency. The graft should take an active part in the formation of the callus. It is not certain that it will do so.

methods should be comparatively easy. There is no reason to doubt that a splint of this nature may effect immobilisation and ultimate union as well as or better than a metal plate.

Where the graft is intended to replace and to fulfil the functions of a missing portion of bone, the con-

ditions are entirely different. In the case of the first method it is a matter of indifference whether the transplanted fragment is eventually resorbed or not. Such is not the case here. The graft is expected not only to live, not only to preserve its essential qualities, and especially its solidity, but to participate actively in the processes of reparation and to play a structural part in the formation of the callus. In our view, no proof is forthcoming that such results may be anticipated with certainty, even in pseudo-arthroses of bones other than the mandible. The solution of the problem would be of inestimable value to the therapeutics of surgery.

That this point should be cleared up is essential, and it seems to us indispensable that all histories of cases should furnish very precise and explicit details in this direction.

There is yet another factor which appears to us to have a primary importance in its bearing upon the definitive results of bone-grafting.

Every one knows, and we have more than once recalled the fact, that a breach in the mandible of 2 cm., or even more, especially when situated anteriorly, may perfectly well unite without surgical intervention by the simple application of prosthetic mechanisms, or it may unite spontaneously. We have seen cases where union has been effected with a loss of 3 cm. and over.

The fact must not be lost sight of that, as the

majority of recent fractures unite without difficulty, the bony graft is indicated only in confirmed pseudoarthrosis. Hence, except where loss of substance is very extensive, grafting should always be preceded by prolonged prosthetic treatment, and proof of the negative results of such treatment should be forthcoming.

It is superfluous to add that, the object of grafting being union, it cannot be regarded as successful unless union is obtained.

Histories of cases in which grafts have been employed should then elucidate two points: that a sufficiently long prosthetic treatment has been employed; and that there is clinical, and where necessary radiographic, proof of union.

We have stated that osteo-synthesis does not necessarily fail when the wound becomes infected. Many surgeons have observed this fact in connection with pseudoarthroses of the limbs; we can offer confirmatory evidence in regard to the mandible.

Does the same hold good in the case of the bony graft? We think not. There is no doubt that a transplanted fragment of bone may recover its vitality, provided that it acquires intimate contact with the tissues by which it is surrounded. But if it is bathed in pus, it seems to us that it must inevitably become a sequestrum. It is essential to the future of bone-grafting that this point should be cleared up, and we take this opportunity of appealing to those

of our confrères who have experience of the method, to publish detailed particulars of their findings in regard to this all-important matter.

Morestin has applied his general method of cartilaginous graft to mandibular pseudo-arthritis. In a case described before the Société de Chirurgie (May 31st, 1916), the angle, together with the ramus, had been totally destroyed. The missing portion was replaced by a graft taken from the 6th and 7th costal cartilages. From the æsthetic point of view the result was perfect, but the union of the graft with the bone was incomplete, the graft continuing to present an obscure mobility. More recently other similar cases have been published by this author.

Morestin also proposed (*Soc. Anat.* 1902, p. 183) to treat pseudo-arthritis of the mandible by the mobilisation of a bony bridge obtained from the posterior fragment, care being taken to preserve all the periosteal attachments. Unfortunately he has not been able to employ his method upon the living subject.

Cavalié (of Bordeaux) has employed a somewhat specialised technique in bone-grafting (*L'Odontologie*, June 30th, 1916).

According to whether the gap is more or less than 2 cm., he cuts from one or both fragments a bony strip, the length of which is greater than that of the space to be bridged. This bony strip is covered by its periosteum and by connective tissue; its lower face

is covered by spongy tissue. It is either pushed or turned backwards to the breach. From the author's description it seems better to leave a peduncle of periosteum. Where two grafts are employed, they are fastened together in the centre of the fracture site. The grafts are kept in place by a catgut suture.

Cavalié does not give a detailed description of his cases. He merely states that, in 15 cases out of 21, the grafts either united or were in process of union with the fragments.

Independently of any knowledge of Cavalié's researches, we have on several occasions made use of fragments detached from the fractured extremities. We must confess that our results were not entirely satisfactory. The *a priori* cause lies probably in the fact that the graft is insufficient to replace extensive loss of substance, and yet it is just this class of case with which the graft is required to deal.

At the Interallied Dental Congress, and before the Société de Chirurgie, Sébilleau gave an account of eight operations with bony grafts taken from the tibia. In only three cases has a sufficient period elapsed for results to be demonstrable. Of these, union was effected in one case, amelioration in the two others (see his communication to the Société de Chirurgie, November 8th, 1916). Interesting observations have also been published by Pont.

Delagenière has adopted a different method. His autografts are osteo-periosteal, and are obtained from

another part of the body. His observations were described before the Société de Chirurgie, May 3rd, 1916.

His method consists in taking a shaving of periosteum lined with more or less bony substance from the tibia. The method has been employed to replace loss of substance from the skull, the long bones, etc., and it has been applied to two cases of mandibular pseudoarthrosis.

In one case pseudoarthrosis was due to loss of substance from the body of the jaw. The two fragments were maintained in good position by means of a little metal plate with two holes. The interval of 15 mm. was filled by an osteo-periosteal graft from the tibia. In spite of somewhat profuse suppuration a voluminous bony callus was formed. At the time of publication the metal plate had not been removed.

The second case presented pseudoarthrosis of the horizontal branch, with trapezoid loss of substance amounting to 2 cm. at the alveolar border and $3\frac{1}{2}$ cm. at the inferior border. An aluminium plate with two screws at the posterior end and one at the anterior end was applied. The osteo-periosteal graft was introduced under the plate between the two fragments. There were suppuration and expulsion by the mouth of the bony portion of the graft. The author states that new bone seemed to form.¹

¹ Since these lines were written, Delagenière has announced that union has been effected in both his cases under satisfactory conditions. Other successful cases of his were described by Lebedinsky at the Interallied Dental Congress.

Our own researches have been conducted upon somewhat different lines.

Our first endeavour is to maintain the vitality of the graft, for it is certain that a bone completely detached from its connections may continue to live. With this object in view we have thought it preferable to perform the operation in two parts, with a long interval between them.

The first part of the operation consists in the removal of a fragment of bone, generally from one of the patient's ribs, and its introduction, with the minimum of operative manipulation, under the integuments of the region of operation in the vicinity of the pseudoarthrosis. Simple puncture with the bistoury and separation of the soft parts are sufficient. The costal fragment is then slipped into the opening, which is closed with a stitch. The manœuvre is one of extreme simplicity. The graft is always tolerated, but our investigations do not permit us to conclude that it lives a normal life. In some of our cases a small secondary fistula, corresponding to a centre of necrosis of the graft, appeared after a few days. But this centre of necrosis was limited and was never accompanied by elimination. The greater number of cases healed by first intention.

As soon as the graft has, presumably, acquired means of nutrition, which is not until two or three months have elapsed, it is put into place by operation. In moving the fragment, its new vascular connections are interfered with as little as possible.

In only three cases were we able to accomplish the second part of the operation in a satisfactory manner. In the first case there was loose pseudo-arthritis with loss of the entire left portion of the mandible including the ramus. With the object of achieving a physio-



FIG. 97.—Left lateral fracture with large loss of substance. Pseudo-arthritis in spite of prolonged immobilisation. This case has been treated by means of a bone graft. Result as yet uncertain.

logical substitute for the temporo-mandibular joint, we grafted a bony fragment from the ribs together with the adjacent costal cartilage. The bony portion of the graft was secured to the extremity of the mandibular fragment by two screws. The result was excellent in the sense that union by first intention was

obtained. But to-day, eight months after the second operation, the graft is absolutely mobile on the mandible. There is no visible sign of a callus, and the functional gain is nil.

In a second case we adopted similar measures for a loss of substance of the left ramus measuring about 3 cm., which had been unsuccessfully treated for several months by means of mechanisms. We first introduced under the skin a costal fragment measuring about 5 cm. taken from the patient. The graft was tolerated. At the end of two months we moved the costal fragment and shaped each end to a point. These were inserted into two cavities cut in the mandibular fragments. The retention of the graft by this means was satisfactory. But the operation is of too recent a date for the definitive results to be apparent.

The third case is more recent still. A large part of the dental arch was missing. The graft was fixed by means of a metal plate screwed to the fragments in another place.¹

In accordance with the suggestion of M. Lequeux, we have employed as grafts bones from a new-born infant. Through the kindness of the staff of La Maternité, Marseilles, we were able to obtain the body of a still-born infant under suitable conditions. We removed the principal bones of the skeleton and pre-

¹ These operations are now no longer recent. In no case was union obtained.

served them in vaseline in a refrigerator at $+4^{\circ}$. We found that fragments of these bones were perfectly tolerated in the tissues of patients not wounded in the face. We then decided to use them as true bony grafts in two cases of mandibular fracture. We followed the method of operation in two parts. The fragments were first introduced under the skin, where they were tolerated without ill effects. The one fragment consisted of the inferior extremity of the femur with the cartilaginous nucleus of growth, the other of the superior extremity of the humerus in the same condition. The future will show the value of these experiments.

To sum up : we believe we are justified in concluding that, at the present moment, the results of bone-grafting in mandibular pseudo-arthritis are not as yet demonstrated. As Sébilleau has said, they are encouraging—no more. It is to be expected, however, that the efforts made in many directions to obtain the cure of pseudo-arthritis by bony transplantation will result in an improvement of general knowledge which must react to the benefit of mandibular lesion.

CHAPTER VII

ASSESSMENT OF THE DISABLEMENTS CONSEQUENT UPON FRACTURE OF THE MANDIBLE

IN an article which appeared in the *Archives de médecine et de pharmacie militaires* (April 1916), we showed what we believe to be the best method of assessing incapacity arising out of mandibular fracture.

Briefly, compensation for disablement comes under five headings :

1. Discharge with pension.
2. Definitive discharge No. 1 with or without a grant.
3. Temporary discharge with or without a grant.
4. Return to an auxiliary branch of the service.
5. Return to active service.

The difference between definitive retirement No. 1 and temporary retirement No. 3 is appreciable only to the patient. In the case of the first, he can never again be taken for the army, his dismissal being definitive. In the case of the second, the patient's condition is assumed to be amenable to a degree of amelioration, which will render him liable at some future time for auxiliary or even for active service. Apart from incurability, a retirement pension pre-

supposes the existence of incapacity assessed at at least 60 per cent. Except where there is extensive loss of substance of the soft parts, fracture of the mandible, even with loss of bony substance, is not associated with so high a degree of functional incapacity. It follows that discharge with pension is granted only very occasionally. Nevertheless, the inclusion of this class in the scale of disabilities provides for certain isolated cases.

To the best of our knowledge, the degree of disablement which renders a man liable to be returned for auxiliary service is not fixed. There is a tendency to regard as eligible a maximum incapacity of 10 to 20 per cent.

With regard to grants, the military regulations have established a certain fixed scale which does not exist under civilian conditions. Disablements are calculated in tens per cent., and there is no recognition of intermediary figures.

We shall successively consider :

1. Loss of teeth, generally complicated by more or less important fracture of the alveolar border.

2. Fracture of the mandible, with its principal terminations, thus :

(a) Union in good position with preservation of occlusion.

(b) Union in malposition.

(c) Pseudo-arthritis.

3. Closure of the jaws, so frequently associated with wounds of the face.

I. LOSS OF TEETH, COMPLICATED BY FRACTURE OF THE ALVEOLAR BORDER BUT WITHOUT COMPLETE FRACTURE

Loss of teeth is remedied by the employment of various prosthetic mechanisms, of which the best is the bridge. This is a fixed apparatus, the essential feature of which is a platform corresponding to the missing teeth and attached to at least two pillars. The pillars are metal caps, screw-crowns, etc., by which the teeth at each extremity of the dental breach are covered. This apparatus is cemented to the teeth, and it affords the nearest approach to the normal state. It is durable, and it completely re-establishes function.

Unfortunately the employment of the bridge is advisable only where the loss of teeth is minimal (four at the most). But wherever its employment is permissible we do not think that there are justifiable grounds for indemnity.

Larger gaps are filled by means of removable mechanisms, the base of which is composed of vulcanised india-rubber. These are fitted with good quality artificial teeth, and their attachment is by hooks of German silver. A partial apparatus of this kind, even of considerable size, perfectly re-establishes function so long as the remaining teeth assure a good anchorage; two sound teeth in each fragment, for example, a premolar on one side and molar on the other, are ample for the purpose providing they are

sufficiently apart. Here again we cannot admit any functional incapacity.

Where a complete apparatus is required, a judicial estimation of incapacity is dependent upon two entirely different factors. In the majority of cases these mechanisms are well tolerated and permit of almost normal mastication. But there are a certain number of patients who, through lack of perseverance, are unable to accustom themselves to the use of the apparatus. On the other hand, it must be remembered that the loss of all the teeth is not entirely the result of the traumatism. As a general rule the dental condition previous to injury was precarious, and for this the State cannot be responsible. We think that, on the grounds of intolerance, an indemnity is justified, but on account of loss of teeth we think that it should not be high. An average of 10 per cent. seems to us to be fair.

It is understood that the State bears the cost of replacing and repairing these mechanisms. For they are liable to wear out. The alveolar processes undergo involution, and an apparatus which was perfect at the time of its application may, after a certain time, become defective or break. The State might reasonably entrust this matter at a uniform tariff either to stomatologists appointed by the State, to the stomatological department of hospitals, or to dental schools.

II. FRACTURES

These fractures terminate in various ways, all of which do not present disturbance of function in the same degree.

(a) *Fracture with union in good position.*—This does not require an indemnity, but the State undertakes to replace the teeth destroyed by the traumatism.

(b) *Fracture with union in malposition.*—Malocclusion should not be taken into account unless it affects at least half of the dental arch and is of such a nature that, whatever the position of the mandible, the patient is always unable to use the teeth of both sides simultaneously. This state is realised when deviation of half of the arch is so pronounced that its *ensemble* passes either within or without the corresponding teeth of the upper jaw. In such a case as this we estimate the incapacity at 20 per cent.

The infirmity is necessarily greater where the mandible is united but contracted, and closes entirely within the superior maxilla, the inferior teeth presenting no point of contact with the corresponding superior teeth. It is true that an attempt may be made to remedy this deformity by an apparatus attached in front of the remaining inferior teeth; a supplementary dental arch, repeating the main arch and articulating with the superior teeth. It is obvious that the anchorage of an apparatus such as this will last only as long as the teeth are sound. Its stability and consequent utility disappear with them. In any case,

an apparatus of this kind is able to restore function only very imperfectly. Under such circumstances the indemnity should not be less than 30 per cent.

(c) *Fracture without union ; pseudo-arthritis.*—Functional troubles arising from non-consolidation of fracture of the mandible are modified by the seat of fracture on the one hand and on the other by the degree of laxity of the pseudo-arthritis—in other words, by the amount of substance lost.

A very loose pseudo-arthritis with large loss of substance (a finger-width and over) should be largely indemnified. Wherever situated, it is accompanied by almost total suppression of function, and we estimate the indemnity at 40 per cent. We are aware that prosthetic apparatuses may be employed in cases of this class, but, owing to the extreme mobility of the fragments, such mechanisms are of minimal value. Their application does not appreciably lower the coefficient of incapacity, especially as their employment is dependent in part upon the dental conditions. As soon as the remaining teeth disappear, the functional value of the mechanism is reduced in a notable proportion which may fall to zero. There is one mechanism only which is able appreciably to re-establish function, and that is the bridge, extending as it does between the fragments and, by the agency of the teeth which serve as pillars, giving them solidarity. It is evident that such an apparatus is not applicable except where a sufficient number of teeth suitable for anchorage are present. In our view, two teeth on

each side of the gap is the minimum. In such a case the functional incapacity equals 20 per cent. But in view of the fact that the pillars of the bridge may fail and the patient be compelled to resort to a removable mechanism, we feel that the functional incapacity should not be estimated at less than 40 per cent.

Where the pseudo-arthritis is less lax (a finger-width or two teeth and less), patients may under certain conditions almost entirely recover their functional capacity, though under others it remains considerably impaired. Here the coefficient of incapacity is indeterminate and ranges from 10 to 40 per cent.

Contrary to what one would suppose, the nearer the pseudo-arthritis is situated to the temporomandibular joint, the less as a rule is the derangement of function. We were able to send a man back to the front who had lost a condyle with its neck as the result of fracture by a bullet. In these lesions, and in all those affecting the ramus as far down as the angle, there is no derangement of occlusion, and the movements of the mandible are unimpaired.

Where the pseudo-arthritis is rather more forward and is situated in the molar region, it is almost invariably accompanied by deviation of the fragments, by which the articulation of the dental arches is destroyed. Here it is necessary for the patient to wear a guiding mechanism which will correct the deviation and restore normal occlusion. This is usually an easy matter, provided always that the patient possesses a certain number of sound teeth.

On the other hand, it must be admitted that even under these circumstances mastication is very imperfect. In consequence of the fracture of the mandible, which normally forms the rigid lever to which their action is directed, the power of the masticatory muscles is very much reduced. Such patients are practically incapable of chewing solid food and it is easy to foresee the troublesome sequelæ inevitable to imperfect mastication. In such circumstances, to estimate functional incapacity at 20 per cent. does not seem excessive. Where, however, the pseudo-arthritis is narrower and tends to act as a fibrous callus, the indemnity may be reduced to 10 per cent. It is certain that the narrower the pseudo-arthritis, the easier it is to provide a suitable mechanism, whether fixed or removable, and the more efficient the services which it is able to render. The question is one of degree, and can be decided only by careful examination of each patient.

It is in pseudo-arthritis in the vicinity of the symphysis that prosthetic mechanisms attain their maximum of usefulness, for their chief function is to maintain normal occlusion by separating the fragments, which have an inherent tendency to approach one another. Experience shows that these apparatuses, having approximately equal points of support, provided in each case by half the dental arch and acted on by muscular synergic forces which are approximately equal, are more efficacious than lateral mechanisms. The bridge is particularly indicated in these pseudo-

arthroses with slight loss of substance, provided always that the points of anchorage are solid in character and sufficient in number (four teeth is the minimum).

Thus, in our view, median and paramedian pseudoarthroses are those which, functionally speaking, are the least discouraging. An indemnity of 10 to 20 per cent. seems just. As we have shown in an earlier chapter, these cases are the least frequent.¹

III. CLOSURE OF THE JAWS

Cases of mandibular constriction should be recommended for indemnity only under extreme reservation. Nevertheless it is regrettable, to say the least, that these cases should become permanent chronics in our special or general hospitals.

We have already had occasion to describe our experiences in this direction, which may be briefly summarised as follows :

It is certain that a proportion of these cases are those of pure simulation or of gross exaggeration. Proof is usually easy to obtain.

But we believe that the majority of closures are due to a simple muscular contraction. These are

¹ As we have shown, we do not believe that mandibular pseudoarthrosis should be included among the cases eligible for pension with discharge. But the following must be regarded as incurable :

1. Pseudo-arthrosis resulting from very extensive loss of bony substance.
2. Pseudo-arthrosis which, having been operated upon either by osteo-synthesis or by grafting, has failed to unite.

These are the only classes of case where fracture of the mandible might possibly be compensated by discharge with pension.

cases of hypertonicity similar to those observed by neurologists. By employing an automatic mouth-opener (*ouvre-bouche*) and exercising moderate pressure, the resistance is found gradually to diminish in the same way that a tired muscle "gives," and the mouth may eventually be opened with ease. These patients should receive regular treatment continued over several weeks, and there is no question of indemnity.

Last of all, there are closures due to cicatrices, to muscular sclerosis, or to bony fusion. The first of these is undoubtedly amenable to surgical intervention. So also is the third, but it is rare. Out of more than 150 constructions arising from wounds of war, among which temporo-maxillary wounds were not infrequent, we have never seen a case. Fibrous retractions are very obstinate, and might in some cases provide grounds for indemnity. This is a matter which can only be decided, however, after surgical intervention. It is incontestable that section of the tendon of the temporal or operation of the *Le Dentu* is sometimes attended by good results. But this is by no means invariably the case, and some of our patients have relapsed in spite of every effort.

That absolute occlusion constitutes a serious condition seems to us incontestable, and an indemnity of 40 per cent. does not seem to us excessive. Such an instance has never come under our notice, and it must in any case be very exceptional.

Where the mouth may be opened as much as 2 cm. alimentation is perfectly possible.

In the very rare cases which occupy a place between absolute occlusion and an opening of 2 cm., we are of opinion that an indemnity of 10 to 20 per cent. should suffice. It must be repeated that such cases are quite exceptional.

Finally, we desire to emphasise the fact that our personal experience does not countenance definitive conclusions upon all these points. This brief summary does not pretend to do more than furnish a classification of the different types of disablement, such as may be employed as a basis of discussion.

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