INJURIES OF
THE FACE AND JAW
AND THEIR REPAIR

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AND THEIR REPAIR

AND THE TREATMENT OF FRACTURED JAWS

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TRANSLATOR'S FOREWORD

It may be justly claimed that during the war no branch of surgery has emerged from oblivion and neglect to a position of insistent importance to a greater extent than facial restoration. The reasons for the former indifference are not far to seek. First, traumatic facial deformities were rare. Among non-traumatic causes, epithelioma is chiefly confined to the lips; syphilitic stigmata to the nasal bridge, and usually treated by paraffin. The ravages made by rodent ulcer and lupus are suitable rarely for plastic, although sometimes for prosthetic, correction. Thus the field for plastic facial surgery was limited. And, secondly, the profession in Great Britain availed itself but little of such opportunities as offered. Anyone frankly adopting this branch as a speciality would likely have been classed with beauty specialists and other quacks. It would have been urged (and still is by inexperienced critics) that large facial gaps could only be treated by prosthesis, and should be passed on to the surgical instrument maker; that, as regards smaller wounds, anyone with the most modest surgical skill can sew up a face; and that since this is so, and the work neither involves serious surgical emergencies nor depends on a pathological basis, this branch can hardly be called true surgery—still less major surgery.

I submit that, at any rate for gunshot injuries, this view is wrong. To undertake the correction of smashed faces and jaws, from the moment of their arrival from the firing-line until they are fully restored, will satiate even an ambitious surgical appetite with a diet of science flavoured with art. On any day the operator may be confronted with an emergency tracheotomy, a bullet to be removed from the prevertebral space, a carotid artery to be ligatured, accessory nasal sinuses (including frontal and sphenoidal) to be opened. The next day he may be busy with such delicate manipulations as raising the angle of a mouth, or with undertakings which must appeal to the spirit of a pioneer—for instance, moving large flaps, and grafting fat, cartilage, or bone. On the scientific side the facial surgeon is brought into contact with the modern scientific product of dental education, the oral surgeon; and with the physician and bacteriologist, witness the (alas! too frequent) lung infections from septic mouths. And on the mechanical side he is in constant collaboration with expert dental mechanics, the admirable workmen who construct ingenious splints to build out lips, shape noses, and so on. Truly, there is much interesting country in this surgical no-man's-land, the face.

The importance of temporary prosthesis is paramount. Without its aid, it would be quite impossible to get the results we do. As to permanent prosthesis, we at No. 83 General Hospital use it as little as possible. In a totally new nose (made from a rib cartilage and a forehead flap), invisible dilators may have to be worn in the nostrils, and removed daily for cleansing; a loss of tissue in a mandible, if unsuitable for a bone graft, requires a prosthesis; and often a gap in an alveolar margin has to be closed by a vulcanite denture bearing teeth. But—as is shown by our cases published elsewhere—we aim at building up the face from the patient's own tissues. The patient naturally prefers this. Only one has elected to go to England for a permanent mask prosthesis, rather than undergo a series of operations.

Perhaps a few brief criticisms of the authors' views may be allowed. In my experience, secondary hæmorrhage is not so pleasantly rare as in theirs; but, as they say (p. 158), irrigation cannot be held responsible. Very frequent lavage is certainly necessary; at No. 83 it is performed hourly (p. 188). Boiled water (p. 323) is sufficient in many cases; but it should be under pressure, a forcible stream. Major Valadier devised an excellent apparatus in constant use here. A five-gallon petrol drum, movable on wheels, is fitted with an exit tube controlled by a stop-cock, and ending in a plated cannula. An entrance tube connects the drum with a bicycle pump, which provides the pressure.

To prevent retrocession of the tongue (pp. 168, 191), I have never seen the necessity or advisability of the patient wearing a wire (attached to the jaw appliance and passing through the tongue). Any such arrangement is a constant source of slight pain, and encourages sepsis. Apropos of wiring the teeth of upper and lower jaws together, it is pointed out (p. 260) that this makes it difficult to feed the patient. I would add to this that, if he is to be shipped to England, it is also difficult for him to vomit if he feels seasick—an important detail. We share the authors' respect for teeth in the line of a fracture (p. 282). It is noticeable that they do not discuss grafts, either for nose or jaw.

The suggestion that artificial substances should be used for filling the hollows left by frontal sinus operations (p. 229) is not likely to find general favour among rhinologists. It will hardly be believed that the results are as good as those of, for instance, the radical method of Killian, whose " bridge " operation avoids any deformity.

It will please many readers that the method of paraffin injection is damned with faint praise (p. 227). Indeed, for reasons familiar to rhinologists, this practice is, in Great Britain at any rate, not much followed now. Its dangers are out of all proportion to the probability of a permanent good result.

The authors' comments on total rhinoplasty (p. 234) seem unduly harsh; we have had very happy results. The section on prosthesis for the ear (p. 141) is scanty, which accords with the lack of progress in this direction. The part devoted to laryngeal prosthesis (p. 107) is valuable as a lesson in mechanical ingenuity. But few surgeons of to-day feel any enthusiasm on the subject of artificial larynxes. After a total extirpation of the larynx the patient's mental condition is truly miserable. The keynote in the treatment of that ghastly affliction, laryngeal carcinoma, is earlier diagnosis. Then, if operation be indicated, thyrotomy and submucous removal, or partial resection of the laryngeal box—with or without extirpation of lymphatic glands—is to-day admitted to be the procedure of choice. After operation, or in cases where this is contra-indicated, diathermy and radium are valuable allies.

The section on fractures of the upper jaw (p. 330) is particularly clear and concise.

In their introduction, the authors are to be congratulated on their frank admission that in the text they repeat themselves, and that they do not apologize for so doing. Such fundamental truths as, for instance, that an anatomically restored jaw is useless if physiologically damaged by malapposition of corresponding teeth well bear repetition.

In conclusion, I should like to emphasize that facial work amply repays the trouble spent on it. Many of those maimed in this war will require, on their discharge, to canvass for civil employment. Human nature always finds physical deformity repugnant, facial disfigurement especially so. And the sufferers are likely to be handicapped if their appearance is revolting. Their recognition of this fact largely accounts for their extraordinary patience in undergoing the repeated operations which are necessary. Their gratitude afterwards is good to see. It gives the surgeon real pleasure to note the pride with which, let us say, a man, who had lost his original nose, sneezes through a new one made out of his own flesh and bone.

Any who wish to verify this sensation of surgical satisfaction by undertaking similar work will find this book most useful.

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AUTHORS' PREFACE

THE manual which we issue to-day has no pretensions to being a technical treatise on prosthetic restoration. We have merely endeavoured to systematize the innumerable efforts at prosthetic restoration which have been made, especially during the last fifty years. Our principal aim, then, has been to point out the limitations of each of these, and to classify them. In fulfilling this object, we feel no misgivings on the score of having repeated ourselves. Any insistent repetitions will be forgiven us if we have succeeded in diminishing the regrettable confusion (which the practitioner too often encounters) between methods sometimes strongly similar in appearance, but depending upon principles and general ideas which are essentially different.

At the beginning of this manual it is our pleasant duty to salute the memory of our master, Claude Martin, who has always helped us in our written researches with a kindly and untiring supervision. The name of this genius among prosthesists dominates the restorative art which he practised. For out of fragmentary methods he has pieced together schemes such as that of immediate prosthesis. And he has helped to make surgical prosthesis an essentially French branch of our profession, and a branch of which the brilliance flashes through our land. We thank our confrères Fr. Martin, Pont, and Delair, from whom we have often received contributions, and who have allowed us to borrow extensively from their work.

P. MARTINIER.
G. LEMERLE.

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SECTION I.—FRACTURES OF THE MANDIBLE

CLASSIFICATION
OF THE DIFFERENT METHODS OF RESTORATION BY PROSTHESIS

THE art of making artificial substitutes for any organs cut off, whether by an accident or by surgical procedures, constitutes the art of prosthesis.

Ambroise Paré defined it more succinctly, in writing that it comprised all "methods and devices for supplying that which, from natural or accidental causes, is lacking."*

The prosthetic method propounded by A. Paré is the oldest. It holds good to-day; and if in its technique it has risen to an extraordinary perfection, nevertheless it still remains governed by the same general principles.

The advent of the era of asepsis has allowed us to think out new prosthetic methods. These are still, at this day, in full growth; none of them has become final, but the unison which they have called forth between surgeon and prosthesist promises fair to be fertile of results. In the vast majority of cases the intervention of the prosthesist occurs a long time

* Ambroise Paré, "Œuvres complètes," Lyon, 1646, 23e livre, p. 572.

after that of the surgeon. Nevertheless there are instances where the two procedures emerge into one single operation; and from this fact is derived a division which may serve as the basis of a classification of the various prosthetic methods.

These latter may be drawn up into two great groups:

External Prosthesis, when we are dealing with apparatus which remains in communication with space.

Internal Prosthesis, when, allowing for the tolerance which the tissues, under certain conditions, display towards foreign bodies, we make use of apparatus which has no communication with space. External prosthesis comprises remote and immediate prosthesis.

External Prosthesis.

1. **Remote or Late Prosthesis** occurs a certain time later than the operation or accident which has cut off the organ which it is proposed to replace, when the wound which was the outcome is entirely cicatrized. This process of cicatrization generally involves the formation of contractile fibrous bands which resist the application of a prosthetic apparatus. The reduction of the vicious scars constitutes the first step in any attempt at prosthetic restoration.

Thus, the study of remote prosthesis includes the study of (1) methods for reducing scar tissue, (2) remote prosthetic methods proper.

2. **Immediate Prosthesis** has as its object the prevention, at the outset, of cicatricial contraction by

the introduction into the tissues of an apparatus intended to replace the part of the skeleton which has been removed. This apparatus is essentially temporary; when, thanks to it, a correct healing has been obtained, it should be removed and give place to an apparatus which is late, final, and removable.

Another plan of immediate prosthesis consists in introducing into the depth of the tissues apparatus intended as a temporary substitute for part of the skeleton after subperiosteal resection. This apparatus acts as a prop for periosteal flaps until these latter have given rise to an adequate regeneration of bone.

Thus, immediate prosthesis comprises two methods quite distinct:

(*a*) Immediate prosthesis intended to resist cicatricial contraction (Cl. Martin).

(*b*) Immediate prosthesis intended to hold up periosteal flaps after subperiosteal resection (Michaëls).

Internal Prosthesis.

Internal Prosthesis is designed to replace pieces of bony framework, or certain organs, by means of apparatus buried (in a final sense) in the depth of living tissues. It comprises two methods:

1. Internal prosthesis intended to guide bony regeneration. This regeneration may occur because the resection was subperiosteal, or it may originate from a bone graft. In this case, contrary to what occurred in the above method—*supra*, 2 (*b*)—the

prop for the osseous formation is finally left in the organism.

2. Internal prosthesis properly so called, consisting of an apparatus buried in the tissues and intended to be tolerated there permanently, wholly replacing in function the absent organ.

In relation to the surgical procedures first taken, internal prosthesis falls into the subdivisions of immediate and remote prosthesis.

Such are the divisions which it seems to us logical to introduce into the study of the various prosthetic methods which we propose to examine according to this classification.

We are, as a matter of fact, not discussing certain varieties of late prosthesis which are of interest to commercial circles. Internal prosthesis by injections of paraffin is a restoratory method which, since it does not belong to the dental speciality, we shall remove from our scheme of study.

Let us, then, resume in the following way the classification of existing prosthetic methods.*

* For everything concerning dental prosthesis, properly so called, the reader can refer to the " Manuel de Clinique de Prothèse dentaire " of P. Martinier and G. Villain.

Injuries of the Face and Jaw and their Repair

FIRST PART
EXTERNAL PROSTHESIS

SECTION I
REMOTE PROSTHESIS

THIS is the oldest method. The type of this which is the simplest, and which, moreover, seems never to have emerged from the province of orthopædic and surgical instrument makers, is the artificial limb fitted to a stump after an amputation. But, as applied to losses of tissue involving the face, remote prosthesis demands a special technique. This is connected with the technique of dental prosthesis, was evolved by dentists, and belongs exclusively to their department. Remote prosthesis of the lower jaw in particular constitutes a problem of singular complexity. In fact, after the removal of a part of the lower jaw, cicatricial contraction involves such extensive displacements that, until these latter have been reduced, one must not dream of making a prosthetic apparatus.

PROSTHETIC RESTORATION.

External.		Internal.	
Remote.	*Immediate.*	*By Plastic Substances (Paraffin).*	*By Apparatus.*
	I.		I.
1. Correction of cicatricial tissue.	1. Prophylaxis of cicatricial contraction by an immediate temporary apparatus.		1. Guide apparatus for periosteal flaps or for pieces of cartilage.
2. Final apparatus of restoration.	2. Restoration proper, by a secondary and final apparatus.		2. The bony regeneration having been obtained, the apparatus is not lifted out, but is left in the tissues.
	II.		II.
	1. Prophylaxis of cicatricial deformity by an apparatus to guide periosteal flaps.		1. An immediate or remote apparatus to restore a part of the skeleton or an organ.
	2. The bone having reformed, the temporary guide is lifted out.		2. No regeneration is expected; indefinite tolerance of the foreign body is anticipated.

Remote prosthesis of the face often falls into clearly cut steps:

1. Stage of reduction of scar tissue.
2. Stage of prosthesis proper.

Dentists, well prepared for this task by their familiarity with the general principles of orthodontia which they apply every day, have managed to excel in this method of bucco-facial prosthetic restoration.

CHAPTER I

CHARACTER OF CICATRICIAL TISSUE

THE term "cicatrization" is given to the organic process tending to the production of a new tissue destined to close accidental or surgical solutions of continuity produced in the body. This tissue formed in this way is called a "cicatrix."

The histological elements of a scar arise from the proliferation of histological elements which were there previously, and the two are always similar. The repair is usually provided by the connective tissue, but in the case of skin and mucous membranes epithelial tissue shares in the constitution of the cicatrix.

We will consider cicatrization by first and by second intention.

"Although the essential phenomena in the two cases are identical, the intervention of a new factor, suppuration, gives to the cicatrization of an infected wound some special characteristics."*

* Francisque Martin, "Bloodless Treatment of Vicious Scars," Thèse de Lyon, 1901.

1. **Cicatrization by First Intention.**—When the lips of the wound are approximated, they are soon glued together, first by the blood poured out, later by serum which, exuded from neighbouring vessels, contains embryonic connective-tissue cells. This embryonic tissue is soon invaded by newly formed capillaries. According to Masse,* "The vessels of neighbouring parts of the new scar tissue produced show at first, at one point of their walls, some tiny bosses, which become changed into little processes, pointed at their end and enlarged at their base.

"The parent vessel is usually a capillary with structureless walls, with some fusiform cells at regular intervals. The new vessels which are produced are of the same nature; tapering in shape, their walls are hyaline, the cells more numerous and especially more crowded. At first of a very small calibre, they cannot allow of the passage of corpuscles; only the blood-plasma can course through them. These tapering vessels become more and more prominent in the cicatricial tissue. Their increase in height goes hand in hand with an increase in width; meanwhile they anastomose one with the other, and form loops which are at first permeable only to the plasma, later to blood-corpuscles. The first-formed loops soon give rise to other pointed branches, which in turn join to form secondary loops; then a third, and so on."

The capillaries emerging from one lip of the wound meet those of the opposite lip, and form an anasto-

* Masse, "Cicatrization in Different Tissues," Montpellier, 1866.

mosis which re-establishes the circulation from one edge of the wound to the other.

These embryonic vessels take on progressively the characters of adult vessels; the same applies to the embryonic cells, which become adult connective-tissue cells. Later the cicatrix undergoes further modification, and at the end of its evolution it will consist of fibrous tissue.

2. **Cicatrization by Second Intention.**—When the lips of a wound have not been approximated, cicatrization is produced by means of a layer of fleshy buds covering the bottom of the wound. These fleshy buds form the granulation layer, of which the characters have been carefully described by the old-time surgeons. In fact, they represent the method of cicatrization natural to all infected wounds.

It is on the surface of this granulation layer that the secretions are produced which constitute pus. This very surface is absorbent, witness the poisoning by sprinkling ulcerations with iodoform. Lastly, these fleshy buds have a power of contraction which gradually approximates the edges of the wound.

"This approximation occurs especially when the wound is cleansed. At this time one observes the occurrence of a series of changes at the surface. The suppuration dries up, the fleshy buds take on a rich red colour, the edges of the wound contract and approach each other under the influence of the contraction of the granular layer. On these edges appears a bluish border, originating in the healthy surrounding skin. This border approaches little by little the centre of the solution of continuity, the surface of which it gradually diminishes. This japan or varnish of epidermis gains ground from the periphery towards the centre incessantly, and soon the surface of the buds is epithelialized. The cicatrization of the wound is complete.

"In certain cases, the slight exudate which a wound in the process of cicatrization incessantly secretes hardens on the surface, and covers it with a dry scab, beneath which epithelialization proceeds just as when exposed to the air. This mode of healing, of which it has been proposed to make a separate variety termed 'cicatrization beneath a scab,' differs in no way in nature from cicatrization by second intention."*

The granulation layer to which we just now referred is a soft tissue composed of round cells. Among these, certain cells are multinuclear; they are destined to die and form pus. In the neighbourhood of these multinuclear cells, which will be destroyed, are found numerous mononuclear cells, of which some are large and resemble epithelial cells. It is these epithelioid cells, according to Ziègler,† which give rise to granulation tissue. They are called "fibroblasts" or "fibroblastic cells," because they have the power of forming connective tissue.

"The fibroblasts of most recent origin occur as round cells, but their shape is altered very soon; they put out processes which become gradually

* Francisque Martin, "Bloodless Treatment of Vicious Scars," Thèse de Lyon, 1901.

† Ziègler, "Treatise of Pathological Anatomy," translated by Augier and Von Ermengen, 1892.

lengthened. Thus cells are formed, some club-shaped, some fusiform; others, again, branched and united very irregularly by their branches. At the same time the number of large formative cells increases in such wise that at last they get the better of their small round neighbours, and group themselves here and there in crowded masses; this occurs especially in the deeper parts of the fleshy buds.

"A sufficient massing together of the formative cells inaugurates the development of the connective tissue, or intermediary fibrous tissue. This latter is formed partly at the immediate expense of the protoplasm of the formative cells, partly at the expense of the homogeneous matrix, which, again, has previously been formed by the fibroblasts or formative cells.

"In the former case [where the connective tissue is formed at the direct expense of the cell protoplasm—TR.] one can note the appearance, on the sides as well as at the ends of the formative cells, of fine fibrillar processes arising from neighbouring cells. The direction and mass of the bundles thus formed are independent of the original shape and situation of the cells which gave them origin; usually the direction of the bundles is that of the greater diameter of these cells. When a sufficient number of fibrils has been produced, their formation ceases. The remains of nucleated protoplasm in the original cells become the fixed cells of the connective tissue, which remain attached to the surface of the bundles of fibrils. It is thus that the process comes to an end, and granulation tissue becomes a cicatrix."*

* Francisque Martin, "Bloodless Treatment of Vicious Scars," Thèse de Lyon, 1901.

3. **Epithelialization.**—The newly formed epithelium which covers the superficial stratum of fleshy buds never arises from these; it is always traceable to neighbouring epidermal cells. This epithelialization can take place in three ways:

(*a*) By sliding of epithelial cells from the periphery towards the centre.

(*b*) By grafting of epithelial islands detached from the edges.

(*c*) By cellular proliferation along the edges of the wound, thus tending to a progressive centripetal epithelialization.

When the cicatrix is fully formed, it undergoes an evolution which may last from eighteen months to two years,* and during which the new tissue of which it is formed suffers a series of changes. This cicatrix, now adult, will contain fibrous tissue and show a new structure and new physical properties.

According to Francisque Martin, if one dissects and carefully examines a fully formed scar, one sees that it consists of—

1. A thin superficial membrane, sometimes rugous, more usually uniform and glossy; this, which is the newly formed epidermis, is dry, because no secretion appears to moisten it.

2. Deep to this epidermis is a special sort of tissue, of fibrous appearance, dense, resistant, pearly white, creaking under the scalpel. This is the fundamental part of the scar, or " inodular " tissue, which results from the cicatrization of the dermis.

3. In this dense non-porous tissue are formed

* Dupuytren, " Cliniques Chirurgicales," iv.

arterioles and venules in very small number and tightly bound down. "Inodular" tissue constitutes the fundamental element of adult scar tissue. Delpech has given it this name in contradistinction to young cicatricial tissue, which is, on the other hand, "nodular" tissue.

"In the skin, a cicatrix consists of fibrous tissue, where fat-vesicles soon appear in the deep layers; but there are never as many fat-vesicles as in the normal condition, and the fibrous tissue found is always very dense. The dermis is produced in fibrous and elastic tissue, but glands are not reproduced. The papillæ are re-formed in the cases where they had, by their hypertrophy, made up the fleshy buds of the cicatricial tissue. In such a case the normal papillæ of the skin, transformed into fleshy buds, return to their primitive condition; then some of the buds sink down, and the embryonic tissue becomes connective tissue.

"But when the fleshy buds spring up from the deeper parts, and the papillæ have been destroyed to a marked extent, they do not become entirely re-formed; and the cutaneous scar which results remains flat and depressed, or, on the other hand, prominent, if the exuberant granulations have not been restrained.* Our knowledge of the structure of the retractile scars which follow on union by second intention is less exact. On this point Francisque Martin quotes in his thesis the following interesting remark of Paviot: 'It is easy to demonstrate that in the depth of connective tissue in

* Cornil et Ranvier, "Manuel d'Histologie."

general elastic fibres and elastic granules are very rare if the tissue be a young one containing many round cells. And, on the other hand, when the number of round cells is less, when the connective-tissue fibres, increasingly full-grown and thick, appear in a similar kind of tissue, the elastic fibres and granules (as to the origin of which no one has been able to lay down anything beyond theories) increase proportionately in number. This is demonstrated daily by all histologists; but the rôle of these elastic fibres, under the circumstances which we are studying, has never been laid down accurately.'

"May we not suppose that it is to the transformation of the tissue to the inodular type, when the elastic elements appear, that a cicatrix owes the loss of its retractility? Perhaps one may also infer that the extensibility of an inodular scar depends on the presence of the elastic elements. In support of the probable truth of this argument, one may cite a histological contrast easy to make, between a keloid scar which is still to a large extent nodular, and a linear fibrous scar robbed of all round cells and already rich in elastic elements."

4. **Physical Characters of Cicatricial Tissue.**—When it has lost its suppleness, cicatricial tissue possesses a good deal of toughness; its elasticity is nil, but it is noticeably extensible and capable of elongation under a slow and continuous pressure. It has no real retractility. Minervini* has shown experimentally that only the cellular tissue of a cicatrix

* Minervini, "On the Retractile Power of Cutaneous Scars" (13e Congrès Internat. de Médecine, Paris, 1910).

is retractile. A scar, once formed, does not retract. "Thus, we should speak, not of a retractile cicatrix, but of cicatricial retraction."* Francisque Martin thinks that the retractility of a cicatrix undergoing evolution depends upon the inflammatory process which accompanies cicatrization, and according to him there is a correlation between the duration of suppuration and the retractile power of a scar.

A scar fully formed may be made supple and lengthened when it is made to undergo long and continuous pressure. "This relaxation and lengthening of scars is not invariable unless certain nutritional changes occur. But the exact nature of these changes, clinically obvious, are not known to us; and to arrive at final conclusions on this point a series of histological examinations bearing on scars before and after their lengthening will be required."† Be this property what it may, it is thanks to it that vicious cicatrices may be corrected by the help of prosthetic treatment. In fact, consequent upon a prolonged suppuration, the scarring of a wound often produces bands and adhesions more or less extensive, which in turn entail a varying degree of functional incapacity of the affected part. These vicious scars necessitate surgical intervention, of which the results are often unreliable. Side by side with the surgical treatment, on the other hand, the bloodless treatment of the scars by prosthesis should have a place.

* Francisque Martin, "Bloodless Treatment of Vicious Scars," Thèse de Lyon, 1901.

† *Ibid.*

CHAPTER II

THE BLOODLESS TREATMENT OF VICIOUS SCARS

THE bloodless treatment of vicious scars is wholly due to Cl. Martin of Lyons. In 1900 he laid down the general principles of his method, as follows:

"All patients on whom any part of the lower jaw has been resected, and to whom an immediate prosthesis has either not been applied or has remained an insufficient time, are as a rule invalids. The æsthetic changes and the functional troubles which they have to endure depend on one and the same cause—that is, the projection inwards of one or more bony fragments. These troubles comprise facial asymmetry, the sagging of skin not supported by a bony plate, the atresia of the mouth or forward projection of the tongue and the flow of saliva outside, the lack of apposition of the dental arches, and the difficulties in mastication which result therefrom. In the presence of such infirmities, I have asked myself if it is not possible to alleviate these patients. And therefore I have sought to correct the underlying lesion, on which the other evils depend—that is, the cicatricial retraction which produces the deviation of the bony fragments and the flattening of the cheek on the side operated on.

"In my earlier researches I had established an arrangement of apparatus which allows one to drag the bony extensions to their normal positions and keep them there, all the while leaving them free to resume their functions. But, despite this correction, I had never been able to restore the buccal cavity to its original dimensions. I had, in fact, constantly to combat this unceasing and considerable force—the cicatricial retraction, which perpetually tends to spoil the result obtained.

"These comparative failures had made it clear to me that I should not be able to achieve any unalterable result without dealing with the scar itself. Thus, I have striven to alter it, to soften it, to make it extensible—in a word, to stretch it in such wise that the fragments could occupy their former position.

"I have achieved this result by means of special apparatus to which I have given the name of heavy appliances or appliances for continuous pressure. The application of the method which I have just shown is not limited to the correction of deformities due to scars after resection of the jaw; it is a more general plan to which all deformities due to scar tissue are amenable. The essential principles are frequent massage and continuous pressure applied to the inodular tissue. But if, for resections of the jaw, the position of parts allows us to take advantage of gravity, this does not apply for other scars—for example, on the neck. One can then obtain continuous pressure by means of elastic traction apparatus, of which one can at will graduate the pressure."*

"To sum up, the fundamental principle of the

* Cl. Martin, "Methods of correcting Deformities due to Vicious Scars by Heavy Appliances or Appliances for Continuous Pressure" (Cong. de Chir., Paris, 1900).

method which we advocate is the following: Bring to bear on the cicatricial tissue a slow and continuous action, which will coax it in the direction opposite to that of its retractility, and which can undo what this retractile force has done."*

The means to which one can resort differ according to the form of the scar and the region affected. Annular scars can be stretched either by means of apparatus of soft elastic rubber or by spring apparatus. Linear scars may be stretched by continuous pressure of heavy appliances or under the influence of traction apparatus. Traction and pressure are all the means generally used, whether we adopt heavy appliances, or elastic force as shown in the well-known plan of Fr. Martin (Figs. 1 and 2).

But the mechanical treatment of vicious scars is governed by the following general rule: *The reduction apparatus should act on the scars very gently, and never cause the patient the least pain.* These appliances are as various as the deformities which they are destined to correct; so we shall limit ourselves, in this book, to describe only those which have been employed most often by Cl. Martin at the level of the jaws.

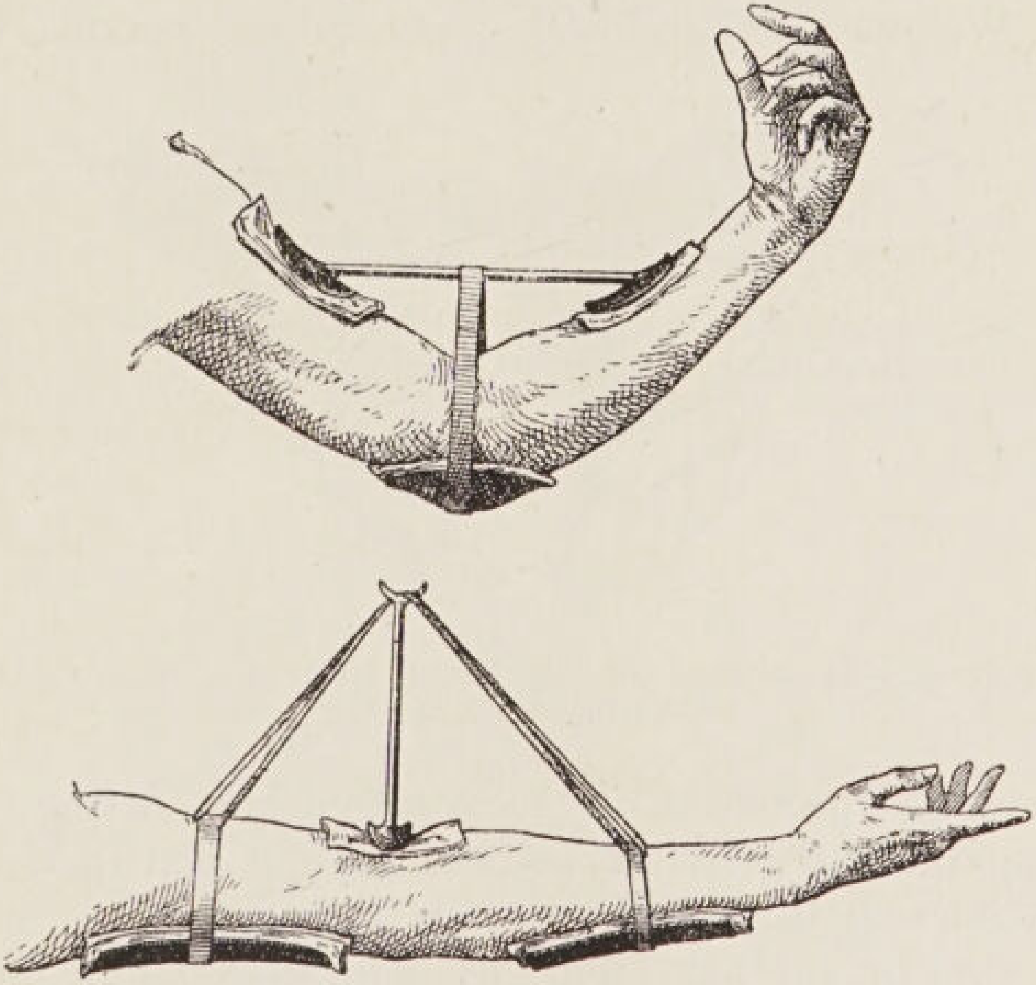
I. Upper Jaw.

Resections of the maxilla often cause but little deformity in the region of the face. Nevertheless, the soft parts of the cheek may form deep adhesions which become irksome for the application of an

* Fr. Martin, "Bloodless Treatment of Vicious Scars," Thèse de Lyon, 1901.

appliance for remote prosthesis. In such cases Cl. Martin has used the following apparatus:

A palatine piece covers the roof of the mouth, including the loss of substance left by the surgical intervention. It is fixed to the teeth of the left maxilla, and on the right it is kept up, supported



FIGS. 1 AND 2.—Traction Apparatus of Fr. Martin.

by a spring taking its *point d'appui* from the lower jaw, like a denture. This principal piece bears two other accessory pieces. One is fixed without a joint on its upper surface near its posterior edge, and passes up to the top of the cavity to fit which it has been cast. The other is attached to the front part of the upper surface, by a hinge joint placed a little lower than the anterior border of the cavity. A spring placed horizontally on the former (posterior) of these accessory pieces plays on to the latter (anterior), which moves like a hinged shutter. This spring by its continuous pressure on the scar tissue gradually stretches it (Fig. 3).*

We may equally well apply to the maxilla the

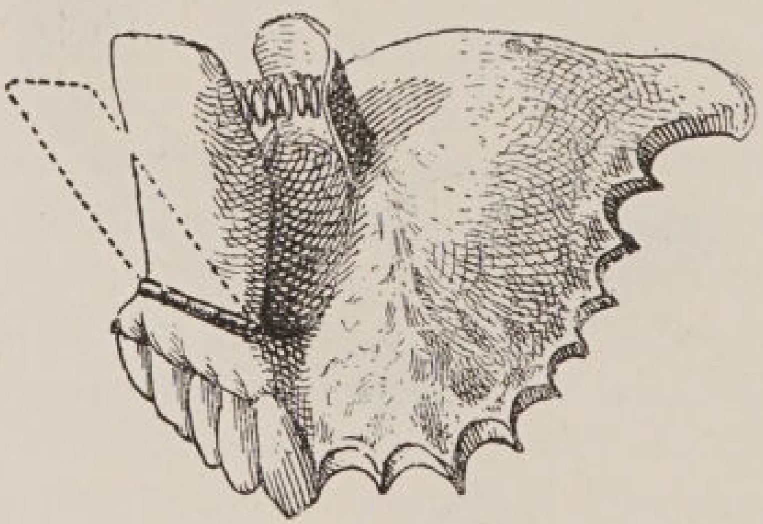


Fig. 3.—Apparatus for stretching after Resection of the Maxilla. (Cl. Martin.)

pressure produced in mastication, by fitting an apparatus of gradually increasing volume at the level of the scar tissue to be stretched.

One of us† has used this plan successfully on a patient who had undergone resection of the left upper jaw. It was expedient, before fixing a final prosthesis on this patient, to force back the scar

* Cl. Martin, "Methods of correcting Deformities due to Vicious Scars by Heavy Appliances or Appliances for Continuous Pressure" (Cong. de Chir., Paris, 1900).

† Martinier, "Two Typical Cases of Restoration of the Maxillæ" (*Odontologie*, 15 Mars, 1903, p. 225).

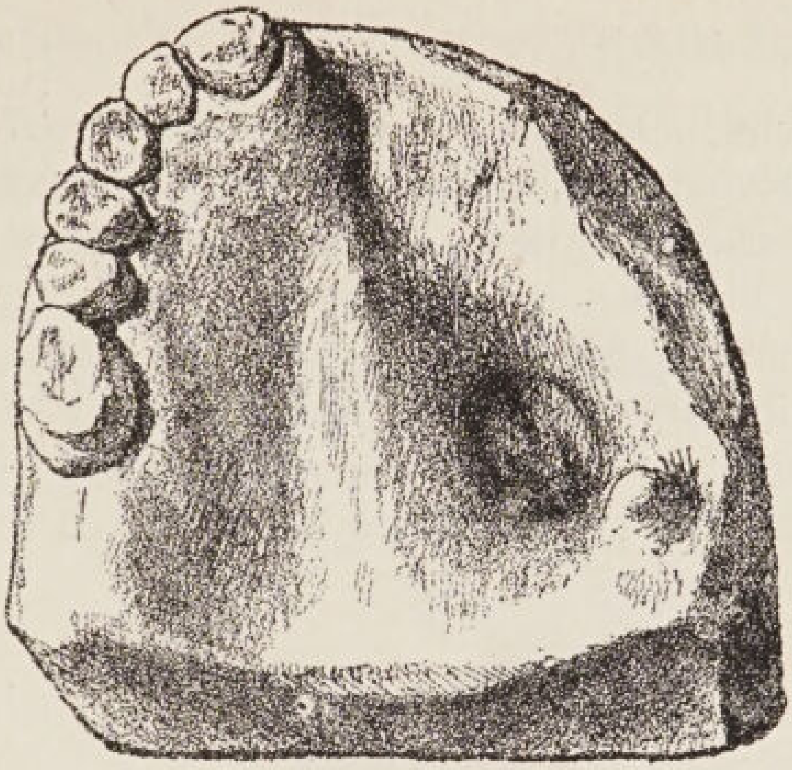


FIG. 4.—Model in Plaster Cast of the First Impression. To the right of the figure, the perforation which makes the mouth communicate with the antrum and nasal fossæ. (Martinier.)

FIG. 5.—Model in Plaster Cast of the Last Impression, after the Cicatrization of the Soft Parts and the Dilatation of the Scar Tissue. (Martinier.)

tissue which, in producing the classical deformities consecutive to total ablation of the maxilla, had invaded the operation cavity. The treatment is as follows: The plaster mould of the remaining moiety of the maxilla is taken, as well as of the mandible, and to initiate the slow stretching of the cicatricial bands one makes a provisional correcting appliance consisting of a metal framework composed thus:

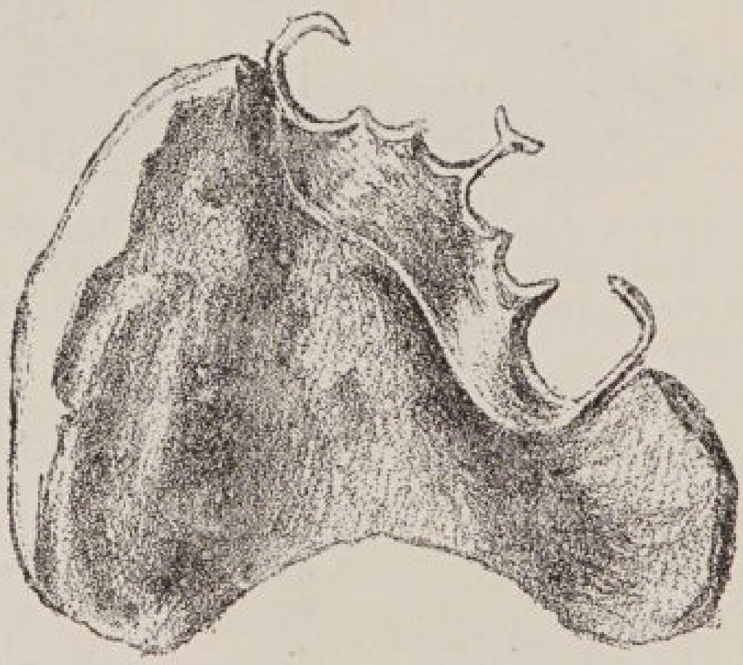


FIG. 6.—The First or Provisional Appliance seen from its Upper Aspect. To the right of the figure the original skeletal part, to the left of the figure the part made of hard rubber destined to cover the palatal vault and close in the perforation. The outer part of the appliance may be fitted with a bed of gutta-percha to increase its size.

1. An external band encircling the dental arch and fitting the gum.

2. A beaten plate on what remains of the palate, to which are soldered metal prolongations intended to give support to a piece of vulcanized rubber. This piece, forming a bridge above the hole in the

palate, is an exact replica of a block of wax which has previously been fixed to the prolongations and tried in the mouth, with the idea of moulding the

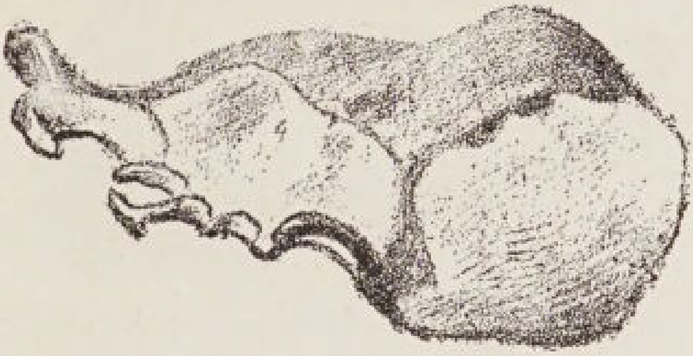


FIG. 7.—The Same Appliance: Lateral View of Anterior Surface. The white part shows the added gutta-percha.

scar tissue of that region which the apparatus is meant to stretch (Figs. 4 to 10).

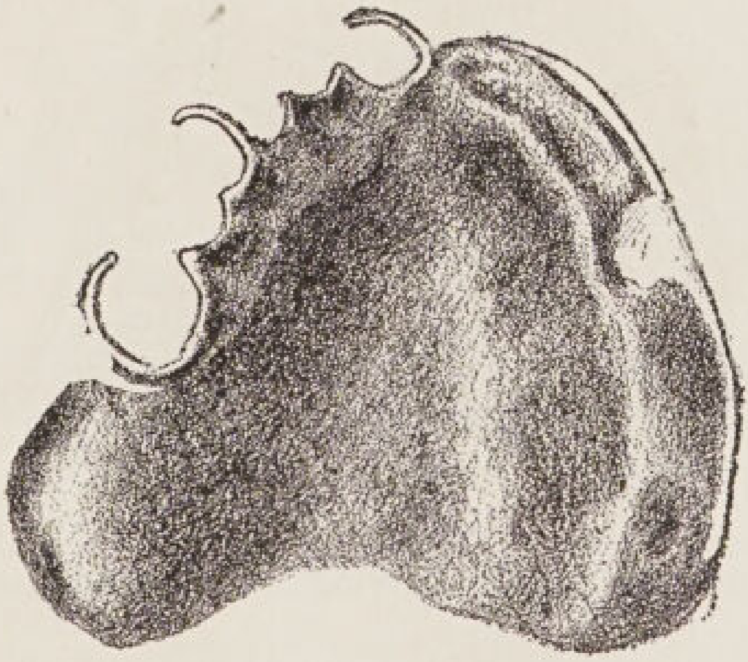


FIG. 8.—The First or Provisional Appliance, Lower Surface, with its Articulating Edge which will link up the Two Jaws.

It has on its lower part an articulating border destined to re-establish the relations of the two jaws in the movements of occlusion and articulation (Fig. 8).

The external band and palatine plate are joined

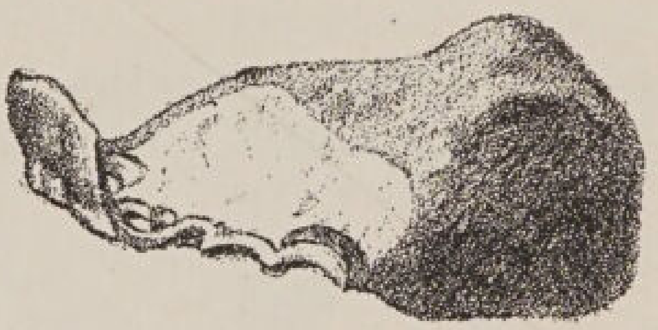


FIG. 9.—The Same: Lateral View of Anterior Surface.

one to the other by a series of hooks of platinized gold applied to the internal and external aspects of the teeth, and soldered only on the central side

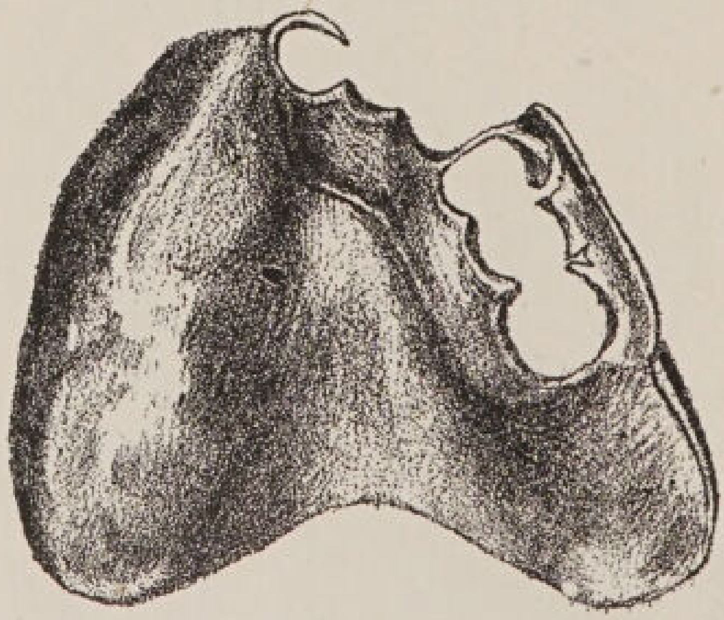


FIG. 10.—The Second Appliance with its Final Metallic Skeletal Part, External Wing, and Special Hooks.

through a very small part of their extent, so as to give them a very great elasticity (Fig. 10).

The volume of the whole is increased by applying gutta-percha. If it be desired, one can eschew the use of gutta-percha, which has the disadvantage of gradually softening in the mouth. The process consists in vulcanizing, at the time of making the apparatus, a series of small rubber plates, taking the external shape of the appliance at that part intended to stretch the cicatricial tissues. The superposition, one after the other, of the small plates in this way increases the pressure on the tissues to be stretched.

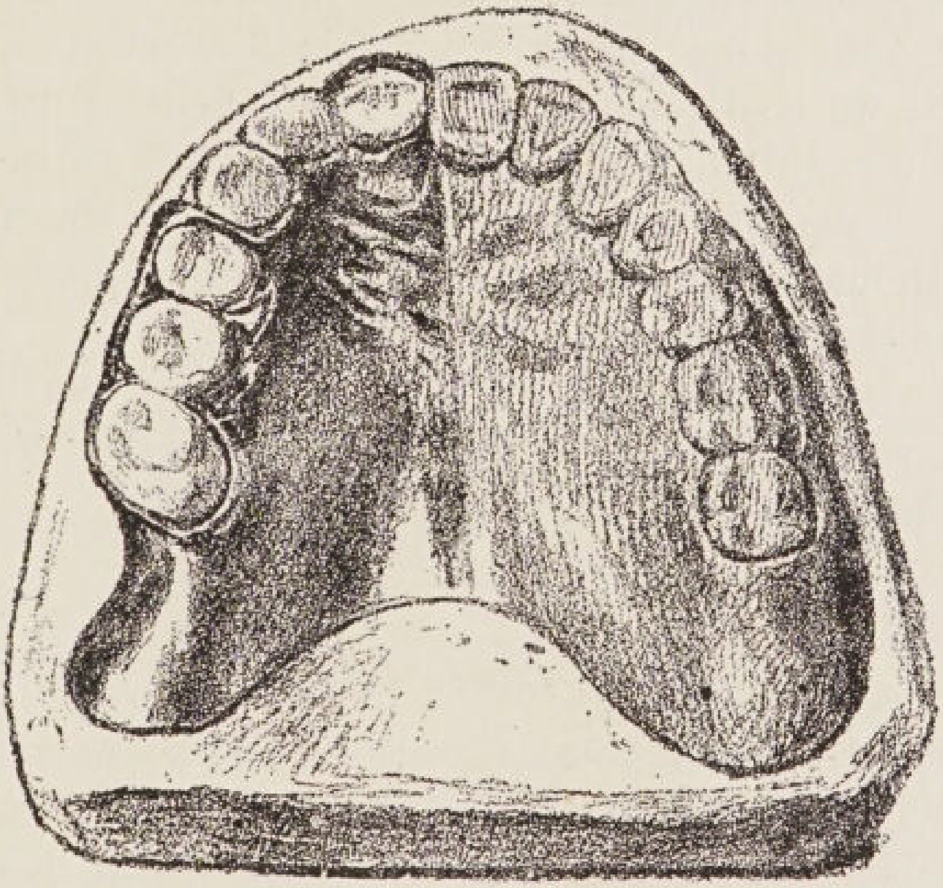


FIG. 11.—Lower Lingual Aspect of Final Appliance.

These small plates may be fixed to the appliance by screws. One will take care beforehand to prevent the saliva soaking in, by plastering the inner side of the platelet and the corresponding part of the appliance with a solution of rubber in chloroform. Having obtained complete dilatation of the cicatricial mass, it only remains to make a final appliance carrying teeth articulating with those of the lower jaw. The arrangement with hooks which we have just described constitutes, in our opinion, the method of choice for fixing this sort of apparatus. The springs so constantly employed are very irksome to the patient, besides which, applied as they are and placed in contact with the surrounding tissues, they cannot fail to irritate these and retard a favourable result.

At this stage certain considerations crop up on which we shall enlarge later. In a general way, it may be said that the primary apparatus to restore large losses of substance in the region of the upper jaw should be the lightest possible (hollow apparatus), to facilitate their retention.

The same does not apply round about the lower jaw, where, on the contrary, heavy apparatus are indicated for the same reason.

II. Lower Jaw.

The partial or total resections of the horizontal ramus of the lower jaw produce cicatricial deformities and displacements from contraction, which in most cases entail serious functional disabilities.

Following on a partial resection of the jaw, one notices, in fact, that the cicatricial tissue forms a linear band between the ends of the two bones, and carries the remaining fragments inwards and backwards. Mastication is impossible, since the teeth no longer articulate; the lips, lacking the support of the skeleton, allow the saliva to trickle out.

For a long while we have sought to remedy these serious troubles resulting from resection of the lower jaw. Mursinna in Germany and Verhuylen at Antwerp made the first efforts.

The appliance of Mursinna was an external one, and consisted simply of a sling, which hid the deformity fairly well. A sponge placed inside absorbed the saliva.

Verhuylen's apparatus replaced the whole jaw; it was actuated by a spring which kept the lower dental arch against the upper. To use it, the patient lowered with his hand the chin band containing the jaw, introduced his food, and released the catch. Afterwards Préterre constructed divers appliances which have already brought about excellent progress.

Results of Resections performed upon the Lower Jaw.—Following on the resection, the jaw fragments become displaced, irresistibly pulled by the cicatricial retraction and the contraction of the muscles there inserted. The dental arches no longer correspond, and their movements sideways are very considerable. For instance, we often observe the front teeth of the left lower fragment articulating with the upper right molar teeth, the upper left teeth biting on the gums and on the lower part of the left cheek, thus giving rise to ulcerations intractable to all treatment. The cavity of the mouth is narrowed; the tongue, lacking its place in the mouth, is projected forwards. Under these conditions mastication is quite impossible, swallowing much hampered, and pronunciation unintelligible.

Préterre, who during the Italian War had been able to observe these deformities in numerous cases, was anxious to remedy them so far as possible. So he waited until cicatrization was complete, and when he judged the time opportune, because there was no more deformity to fear from retraction of scar tissue, he took an impression and applied his apparatus. This apparatus consisted of a second artificial dental arch placed in front of the natural deviated arch, which it ensheathed, and from which it derived its support. The artificial denture articulated with the teeth of the upper jaw. The patient then had a lower jaw in two tiers, reminding one of a shark's. Préterre's appliance greatly facilitated mastication by giving a comparatively sturdy *point d'appui* to the teeth of the upper jaw, which thus could not impinge on the lower lips. But by its volume it still further narrows the buccal cavity, the tongue is still more cramped than before, pronunciation yet more faulty, swallowing nearly impossible.

We can well realize what risky results late prosthesis of the lower jaw gave, up to the time that the apparatus of Cl. Martin—when he created his admirable method for bloodless correction of vicious scars—allowed of late corrections which it had been impossible to achieve before his time. To place an apparatus for late prosthesis of the lower jaw, it is necessary to reduce the cicatricial band in two directions. We must first carry the remaining fragments forwards and outwards until we re-establish the interdental articulation; and then depress the cicatrix from above downwards, to hollow out of it in some way a bed receiving the prosthetic apparatus which shall re-establish the continuity of the mandibular arch.

Appliances to pull on the Mandibular Fragments.—The aim of these is to carry the remaining segments of the jaws into a position of abduction until the interdental articulation is re-established. The majority of these appliances take their purchase from outside the mouth by the interposition of a

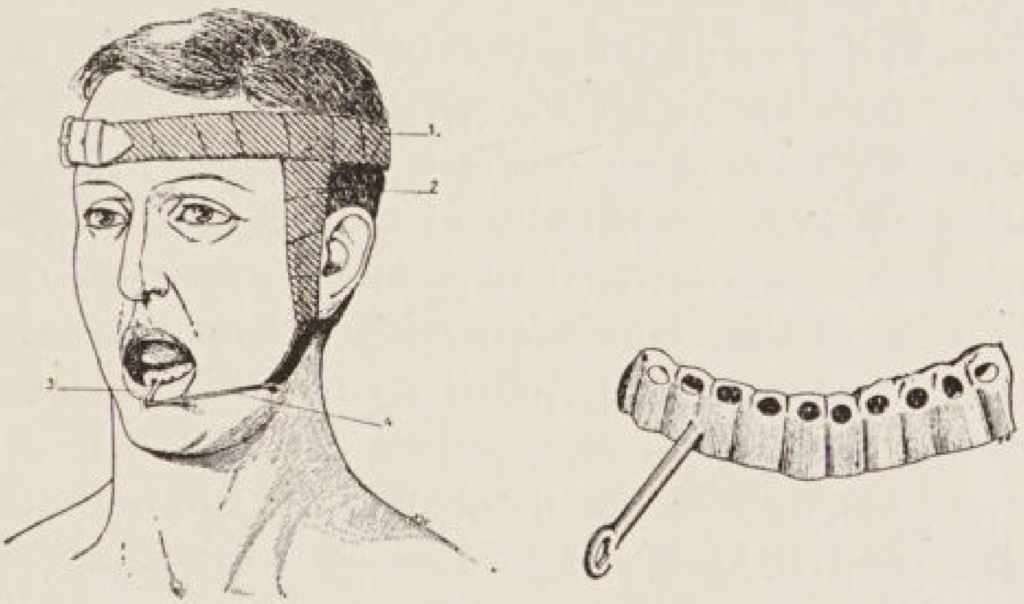


FIG. 12.—Apparatus to pull on the Mandibular Fragments. (Cl. Martin.)

casque encircling the head. Cl. Martin has successfully employed an apparatus composed of the following pieces (Fig. 12):

1. A metal gutter encircling all the teeth of the remaining segment of the deviated jaw. In the incisive region is soldered a rod, bent into a semicircle to allow free movement to the lower lip. This rod bears a hook at its end.

2. A metal band surrounds the head like a crown. On this crown is fixed, on the side opposite the

resected part of the jaw, at the level of the temporal fossa, a second metal rod continued downwards for the length of the ascending ramus, and descending to the level of the mouth. It bears a ring at its end.

3. A strand of rubber, stretched between the ring of the temporal rod and the hook of the buccal rod, pulls the deviated segment outwards.*

Frey, with a similar appliance, has published some excellent results.†

Delair has made an apparatus based on the same principle, a spring acting on the dental arch and taking its *point d'appui* from a casque. This apparatus consists essentially of a steel rod, of which one of the ends is fixed to a metal gutter covering the teeth of that bone segment which one wishes to reduce; the other end, rolled up on itself to form a closely coiled spiral spring, is held at the level of the occiput by a casque made of bands of aluminium, which encircle the head in different directions (Figs. 13 to 16).

This spring, curved inwards in a half-circle to pass round the cheek, has then its fixed point at the occiput, and its movable point of action at the jaw which calls for reduction.‡ Its action is powerful; it carries the jaw segment forwards and outwards, and quickly, in a few days, it re-establishes the interdental articulation, which is thereafter maintained.

* Cl. Martin, " Treatise of Immediate Prosthesis."

† Frey, " Gunshot Fracture of the Whole of One Ascending Ramus of the Lower Jaw: Prosthetic Treatment " (National Dental Congress, Cherbourg, 1905).

‡ Delair, " Exhibition of an Apparatus for replacing the Jaw in Position " (*Odontologie,* 28 Févr., 1906, p. 157).

However, apparatus with casques are open to severa criticisms:

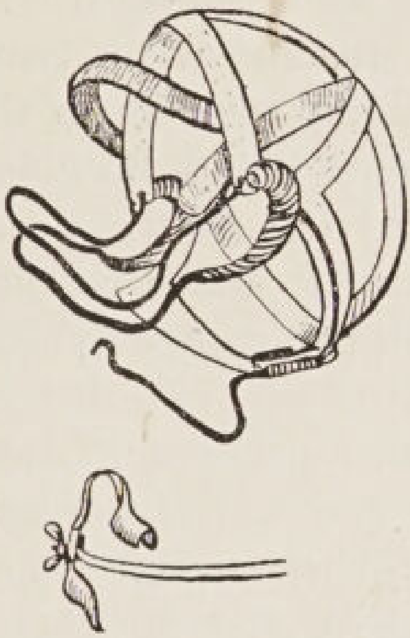


Fig. 13.

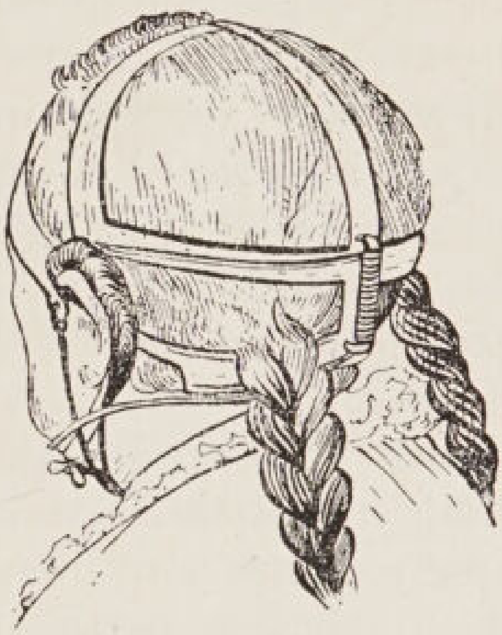


Fig. 14

Fig. 15.

Fig. 16.

Figs. 13 to 16.—Traction Apparatus of Delair.

1. They are fatiguing for the patient; the spring passing between the lips near to the commissure

provokes a flow of saliva difficult to prevent; to wear the casque becomes quite distressing and even painful; the projection of the spring at the level of the cheek and the occiput is very irksome when lying down; lastly, the appliance attracts attention to the patient who wears it, and prevents him from going out and attending to his work.

2. The apparatus is comparatively quite complicated to make, and the execution is not so simple as the idea.

With these reservations, one must admit that Delair's appliance attains the end aimed at, and rapidly brings into abduction the cicatricial bands which follow a partial resection of the horizontal ramus of the lower jaw.

Frey, having applied in one case the more simple elastic traction appliance of Martin, has obtained a very fine success. None the less, in his notes of the case, drawn up with extreme exactness, we observe the following remark: "At this time S—— fell ill with a serious pleuro-pneumonia, and all prosthetic interference was stopped. It is very probable that, despite antiseptic douches, the irritation of the mucosa provoked by our efforts allowed some pathogenic organisms to infect the respiratory passages. Moreover, the weather was warm, and S—— was tired by his casque and by the loss of saliva; for the strand of stretched elastic which attached the apparatus to the casque kept the mouth for ever open."*

* Frey, "Remarks on Prosthesis of the Lower Jaw. Indications for Immediate Prosthesis" (*Revue de Stomatologie*, Juin, 1903).

We consider this quotation to be the best illustration of the general criticisms which we have just been levelling. In taking stock of the disadvantages of appliances which take their *point d'appui* from a casque, one of us has been persuaded to make this *point d'appui* intrabuccal by the use of the following small appliance.* A capsule of stamped metal covers the premolars and first and second molars of the upper jaw on the side opposite the resection. This capsule, bearing at its posterior end and on its outer surface a hook opening backwards, is fixed on the teeth with cement like an ordinary metal crown. A similar capsule is sealed in the same way on to the deviated fragment of the lower arch, but it fits on to a group of teeth farther forward, maybe the canine and premolars. On the outer surface of its anterior end is soldered a hook opening forwards. An elastic band with a buttonhole at each end engages these hooks (Fig. 17).

The fixed *point d'appui* is formed by the upper jaw, and under the action of the traction produced by the rubber the mandible, displaced inwards and backwards, steadily corrects itself, and in a few weeks retakes its normal position. This little appliance, resembling those used by orthodontists, causes no fatigue to patients, and gives rise to none of the objections to which those which take an extrabuccal support from a metal casque are liable. It is ex-

* Georges Lemerle, "Appliance of Reduction after Resection of the Lower Jaw" (*Le Laboratoire*, 26 Janv., 1908, and Société d'Odontologie, Juin, 1906).—Sébileau and Lemerle, Soc. de Chir., 26 Déc., 1906.

tremely easy to make, and that is an interesting consideration. Whatever be the appliance used, the abduction of the fragments of a resected mandible is generally achieved easily. To depress the scar tissue from above downwards is beyond all comparison a more lengthy and difficult matter to negotiate satisfactorily.

Apparatus for pulling down the Band of Scar Tissue.—The object of these is that, once the abduction of the jaw segments is accomplished, they shall gradually depress the cicatrix, ultimately hollowing

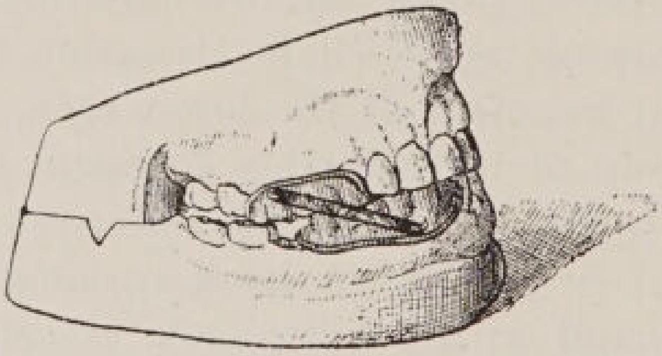


FIG. 17.—Reduction Apparatus of G. Lemerle.

out of it, as it were, a cell to contain the final appliance of late prosthesis. Martin achieves this reduction by the use of a slow and continuous pressure by heavy appliances fitted with pieces of tin. Since the originator of this plan demonstrated its use, there has been no alteration in this method; and this is the best evidence of its adequacy.

Granted, for instance, a resection extending from the angle of the jaw to the vertical level of the premolars of the same side, Martin's appliance is built up as follows: After taking the impression of the remaining teeth, one fashions a piece of rubber taking its support from the latter. This piece of rubber is prolonged backwards, making a narrow border as far as the position of the original angle of the jaw. After several days, when the patient is thoroughly accustomed to wearing this appliance, one adds a piece of tin extending the whole length of the cicatrix, and fitting on the lower border of the rubber—*i.e.*, the border in contact with the mucosa. The appliance is thus also lifted upwards (Figs. 18 and 19).

At the end of five or six weeks, thanks to the weight of the tin slab and the pressure exercised by the teeth of the upper jaw during mastication, the upper rim of the appliance becomes lowered to the same level as the alveolar border of the opposite side. Then one adds another piece of tin, which causes a further sinking, later a third, and so on until the scar has completely yielded. The heavy apparatus, driving back the scar tissue, scoops out at the site of the original gingivo-buccal groove a hollow big enough to lodge a final appliance replacing the missing part of the jaw. One of us has used since 1898 an appliance of this kind which has given him the finest results. The patient had undergone operation for a sarcoma of the mandible. The resection extended from the right lower canine to the condyle. The cicatricial bands were thick, under great tension, and pulled towards them the remaining part of the lower jaw, displacing the fragment inwards. The apparatus was composed of—

1. A platinum cage, which covered nearly every part of the fragment of the mandible; it extended

downwards a long way, thus taking a firm support from the jaw, and not from the teeth, so that the

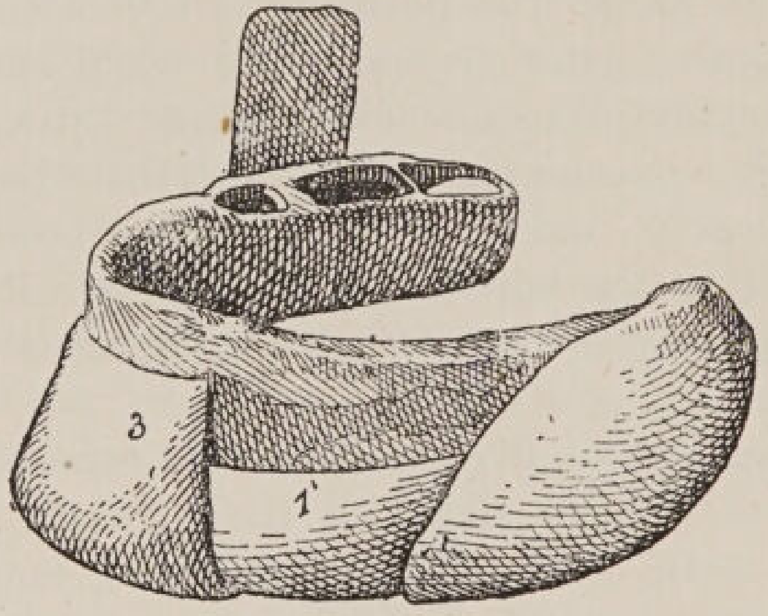
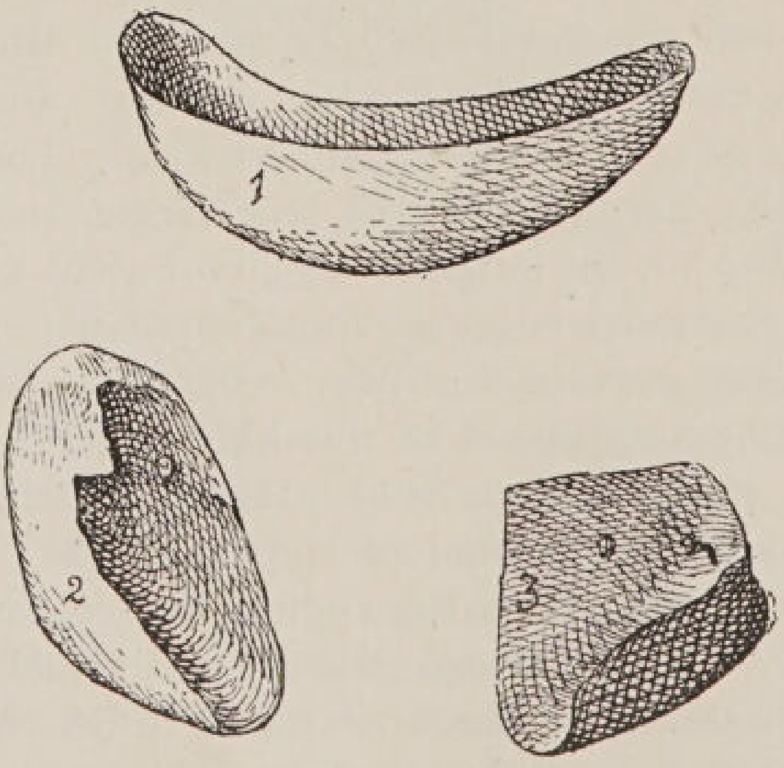


FIG. 18.—Apparatus built up with all its Pieces. (Martin.)



FIGS. 19 AND 21.—Pieces for expanding the Heavy Appliance of Martin, seen separately.

latter were protected. To this cage were soldered two strong rods of German silver; the object of these was to bear a piece of brown rubber, with a shape and curve resembling the mandible. This rubber itself rested on the cicatricial bands. The upper part of the rubber came in contact with the teeth of the corresponding maxilla, which provided the points of contact requisite to re-establish the articulation; the lower or basal portion and the intermediate part in the cheek were intended slowly to distend the cicatricial bands by progressive addition to the bulk of the appliance, and by the mechanical massage exercised by the apparatus on the tissues during the various movements of the jaw (Fig. 20).

2. An upper appliance in platinum, to which is soldered vertically on the right side another small platinum plate, almost rectangular in shape. This small plate on its buccal side glided on another, rubber plate, which in turn was fixed to the platinum cage by a screw. The two plates, mutually gliding on each other, were intended to prevent lateral movements, so that, during the motions of the lower jaw in opening the mouth, the portion of bone spared by the surgeon should be always kept in its normal position.

On the left side a strong spiral spring, attached by means of spring-holders, was placed, to exercise a vertical pressure strong enough to stretch little by little the cicatricial bands. In proportion as the bands yielded and relaxed, one added to the lower and outer aspects of the appliance a thickness of gutta-percha; this was destined to be replaced by brown rubber at the time when the next apparatus, which was naturally more bulky, should be made. Fifteen days after the first apparatus had been placed in position, the spring was removed without any trouble, and the apparatus was well in place; the steady stretching of the cicatricial bands took place simply by adding to the volume of the apparatus. Several appliances of this sort should precede the final apparatus furnished with teeth. In this final

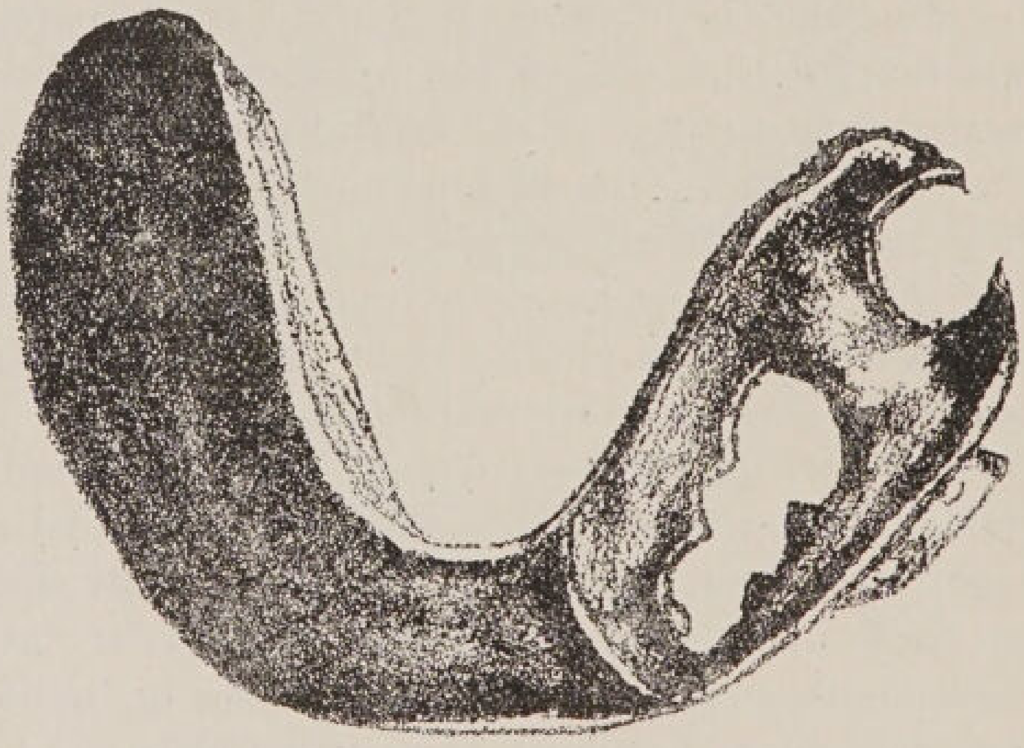


FIG. 20.—Appliance for Restoring the Lower Jaw. (Martinier.

apparatus one replaces the brown rubber on the inner and outer surfaces by pink rubber; this is essential for æsthetic reasons.

To sum up: Confronted with a patient who has undergone a partial or total resection of one or other jaw, the goal of prosthetic treatment should be—

I. To re-establish the physiological functions of the jaws.

II. To give to the face its normal appearance.

We can arrive at this goal by a survey of the two phases which we have described:

1. Phase of correction of scar tissue.

2. Phase of prosthesis proper.

The first of these phases comprises the following procedures:

(*a*) Taking a plaster impression.

(*b*) Constructing the skeletal or basal part of the correcting appliance, of which the objects are—

(i.) To assure its retention.
(ii.) To resist the displacements of the fragments.
(iii.) To stretch the cicatricial bands.

3. Trying the appliance in the mouth. Before doing so we shall have attached a mass of wax or composition, with the object of moulding the parts on which the appliance will rest and the parts with which it will be in contact. At the same time we shall instantly re-establish articulation with the teeth of the corresponding upper jaw.

4. Reproduction in rubber of the piece of wax or composition, or the casting in tin of this piece, according to the case.

5. Placing in position the first, provisional apparatus, and attentive watching of the tissues on which they rest or against which they press.

6. Any modification of the appliance.

7. Making successive provisional apparatus, and modifications brought to bear on these, if such be necessary.

The second phase, referred to above as prosthesis proper, comprises:

(*a*) The combined construction of the final apparatus bearing artificial teeth, and the various parts of the apparatus, which should conform as far as possible to the lines of the face.

(*b*) Placing the apparatus in the mouth and making the requisite final touches. To get a good result one needs time and patience. Fifteen days to a month are enough to obtain abduction of the deviated section of bone; but twelve to fifteen months are wanted to depress the cicatrix vertically and make it ready to accommodate a final prosthesis. That is why, whenever possible, one should make use of preoperative appliances.

Preoperative Appliances.—When the application of an immediate prosthesis at the time of resection of the lower jaw is not indicated, or if we intend to fix there, subsequently, a late internal prosthesis, we must seek to prevent the inward and backward retraction of the remaining fragment of the jaw. In other words, we strive at the outset to conserve for the remaining moiety its normal position; and we do not delay in resisting the effects of cicatricial contraction until these are obvious.

Be it understood that these appliances for minimizing the retraction of the jaw can only be used where we are concerned with a resection which was partial, and where some of the jaw persists.

When the surgeon has defined the extent of his operation, Cl. Martin places on that bony segment which is fated to persist an appliance of vulcanized rubber which encloses the remaining teeth; to the latter it is fixed by screws, if it cannot grip sufficiently by itself.

This appliance bears an external lateral wing pointing upwards, controlled by a second wing which is part of a similar appliance attached to the upper

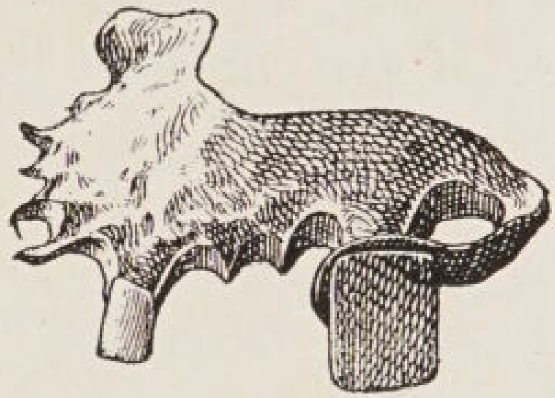


FIG. 22.—Preoperative Prosthetic Appliance of Cl. Martin: Upper Piece.

jaw. The upper wing is on the inner side of the lower; this helps the latter to resist the pull of the muscles on the remaining piece of the mandible and the retropulsion resulting from scar retraction.*

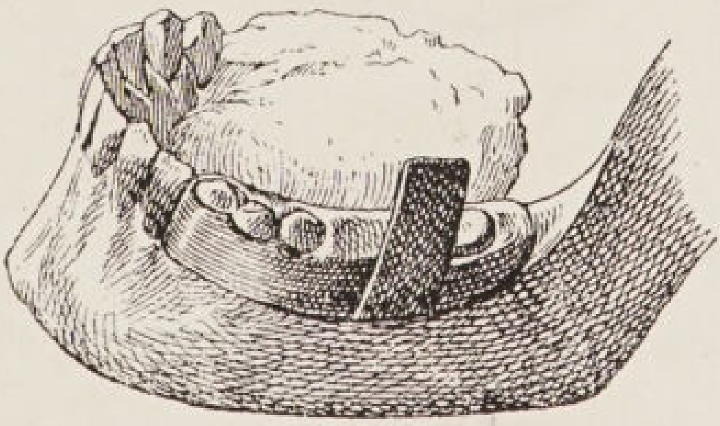


FIG. 23.—Preoperative Prosthetic Appliance of Cl. Martin: Lower Piece.

When the wound has healed, Cl. Martin finishes the work by pressing down the scar tissue by means of his heavy appliances, until he can re-establish the

* It is of importance, for this purpose, that the surface of gliding of the wings should be in the form of a groove.

continuity of the jaw by means of a final prosthetic apparatus* (Fig. 24).

One of us has on several occasions availed himself, in the clinic of his chief, M. Sébileau, of the following device by way of a preoperative appliance: some

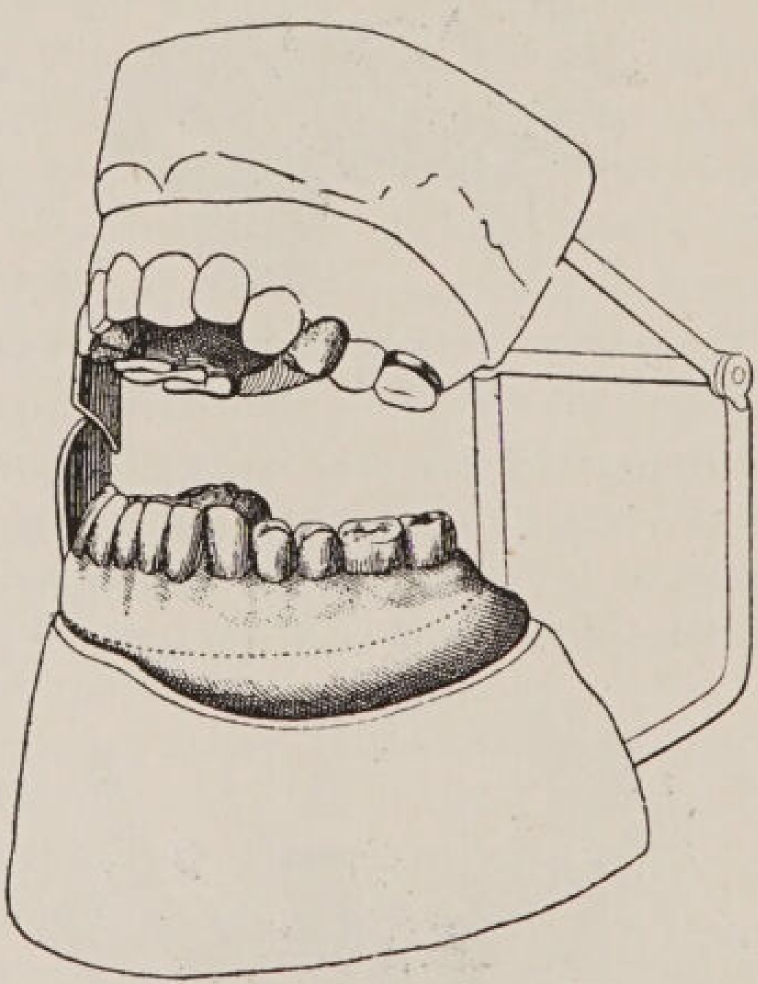


FIG. 24.—Final Prosthetic Apparatus showing the Purpose of the Wings.

metal capsules sealed on to the teeth and joined by an elastic band, as described in a previous section.

This scheme of prophylaxis against early deformities following on resections of the mandible has always given the best results. We go so far as to

* Cl. Martin, "Preoperative Prosthesis": Congrès de Lyon Août, 1906 (*Laboratoire*, 18 Nov., 1906).

say that no resection of the mandible should be undertaken unless it is either followed by an immediate prosthesis or preceded by a preoperative appliance. One or other of these will serve the purpose of checking the immediate displacements following surgical intervention, and will afterwards allow of the use of a late external or internal prosthesis.

III. Reduction of Nasal Deformities.

Deformities of the nose owe their origin to lesions of the skull bones consequent on either trauma, syphilis, or tuberculosis. The bony framework is sometimes merely deformed, sometimes has suffered a loss of substance more or less.

The straightening of the nose may be effected by either a sudden or a gradual correction.

1. **Sudden Correction** is especially indicated after fractures affecting the nasal skeleton. At an early moment the fracture is reduced. Thereafter a suitable prosthetic appliance maintains the reduction. Cl. Martin has designed, to effect this reduction, a surgical forceps which greatly facilitates its performance.*

Sudden correction has been used with equal success in some cases of nasal deformity due to vicious union of certain fractures or to specific lesions. In such cases the treatment is firstly surgical, then prosthetic.

The surgical stage comprises the breaking down of

* Congrès dent. internat., Paris, 1900.

cicatricial bands or the osteotomy of the nasal bones joined in a faulty position.

The prosthetic stage consists in the application of an apparatus to hold the nose in a correct position. Sauer and Skogsborg in Germany, and Aeyrâpââ in Russia, have obtained by this method satisfactory results, following Kingsley, who since 1868 made experiments in this direction. But it is above all Cl. Martin who extended this procedure to a large number of cases and systematized its technique.

Once the scar tissue has been freed, the difficulty lies in finding a solid support for the apparatus which is to be kept there. The walls and borders of the nasal fossæ only supply the most mediocre supports. The best is that which may be borrowed from an upper denture when a perforation of the palate coexists. When no such perforation exists, one can, as exemplified by Aeyrâpââ, trephine the palatine vault to make a passage for a metallic rod to sustain the apparatus which is to hold up the nose. We consider, with Cl. Martin, that this is the best method for retention of these nasal correction appliances. The palatine perforation is not specially difficult to make, nor does it entail any functional disability for the patient.

2. **Gradual Correction.**—This is applicable to the majority of cases treated by the preceding method, but is particularly called for when the deformity concerns mainly the fleshy or cartilaginous parts of the nose.

To raise a depressed and thickened septum, Cl. Martin has thought out the following appliance:

Two parallel sheets of hardened rubber are joined at their front part by a U-shaped spring. Their free ends are buried fore and aft in the nasal fossæ on each side of the septum. At the front end of these plates are articulated two similar plates. These latter are movable in a vertical plane, and are lifted up in this direction by a spring placed near to their point of junction with the lower plates. This spring consists of an annealed gold wire, which can be bent to any desired shape. As Cl. Martin puts it, the upper plates move on the lower like the blade of a pocket-knife in its handle.

This appliance acts by taking its purchase from the two sides of the septum and the floor of the nasal fossæ. The two lower plates, compressing the septum in the transverse plane, tend to diminish its thickness and lengthen it vertically. The upper plates, gently urged by the springs, lift up the whole front part of the nose. Thus, the combination of these two movements tends to give to the nose a more prominent and a narrower shape. To get satisfactory results, this apparatus should be continuously worn, and should not be removed except for just enough time to cleanse it. The force of the springs should be regulated so that their pressure never becomes painful. This type of appliance can be modified according to the variations of the cases, and Cl. Martin has made several depending on this principle. He says: " For the twenty-five years that I have used them, I have obtained with these appliances some excellent results. None the less one can make two adverse criticisms: First, they act very slowly; secondly, the anterior spring is visible externally below the columella. This latter drawback is negligible in children and young people, and it is precisely in this category that I use this mode of correction for preference. Therefore I do not hesitate to recommend it, because I have got and am getting in my practice some fine results."*

3. **Corrective Apparatus for the Nose.**—These are intended to remedy congenital or acquired nasal deformities, when the bony and cartilaginous framework is still preserved.

We can distinguish two sorts of apparatus:

(*a*) Apparatus to dilate the nostrils and reshape the septum.

(*b*) Apparatus to reshape flattened noses.

(*a*) *Dilators of the Nostrils.*—Cl. Martin has constructed many appliances of this sort, consisting essentially of—

Two vulcanized rubber plates which are placed in the nostrils on either side of the septum. An anterior spring which joins these two plates and holds them against the septum. Two other plates of hard rubber which glide on the first plates, imitating the movement of a knife-blade in its handle. By means of a spring these two plates are applied to the upper part of the nasal fossæ, thus dilating the nostrils in the vertical direction, simultaneously raising the lobule and the soft parts (Fig. 26).

To effect a transverse widening of a nostril, Cl. Martin applied an appliance consisting of two sheets of vulcanized rubber joined along one side by the

* Cl. Martin, "Rapport au Congrès de Madrid," 1903, p. 31.

same substance. One of these sheets rested against the septum, the other against the inner surface of the ala to be dilated. The appliance for straightening the septum comprises two upright plates of vulcanized rubber corresponding in size to the deviation, which are applied to each side of the septum by means of a spring placed in front.

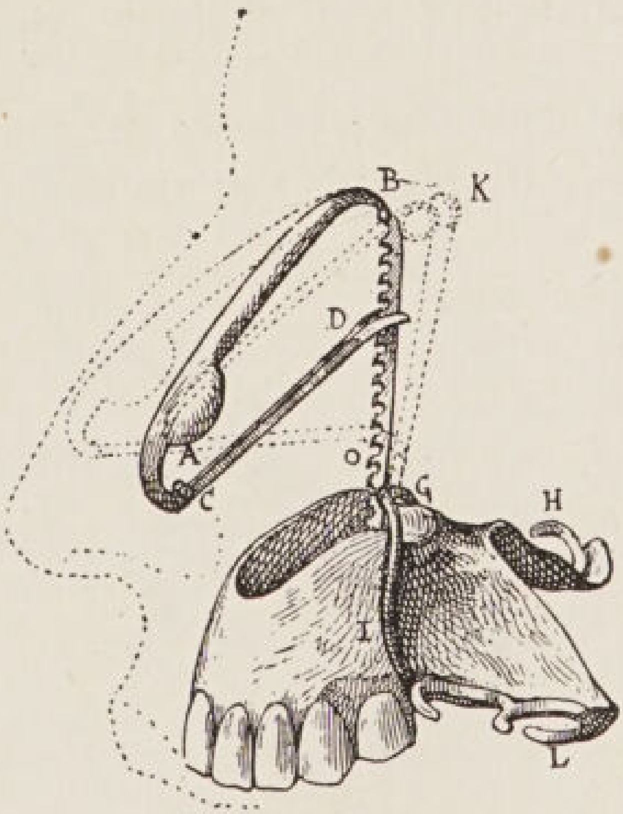


FIG. 25.—Continuous Pressure Apparatus. (Martin.)

In these appliances the parts which have to exercise pressure on the mucosa are covered with rubber to guard against ulceration.

(*b*) *Apparatus to reshape Flattened Noses.*—An attempt has been made to reshape saddle-back noses by means of rods of rolled metal, which fitted by one end on to the floor of the nasal fossæ, and by the other propped up the nasal bones. No results were obtained; the rolled metal rod slipped down in the nasal fossa and ceased to act.

Cl. Martin has invented an apparatus which is certain of achieving its purpose, is not cumbersome, allows of nasal breathing, and is hardly visible. It consists of—

(i.) Two plates of vulcanized rubber to lie on the nasal floor and thus give a stable support to the spring.

(ii.) A gold wire which follows the contours of the lower outline of the nostrils and unites the two plates,

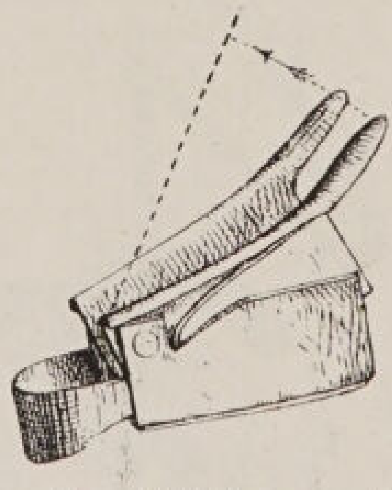


FIG. 26.—Nasal Dilator. (Martin.)

to which it is attached by a hinge. The hinge gives a large range of movement to the plates, and allows them to lie snug against the nasal floor. This gold wire is barely visible, and may be made still less noticeable if covered with pink rubber.

(iii.) Two springs of gold wire, varying in shape according to the point on which they are to act; these emerge from the upper surface of the intranasal plates, and end in—

(iv.) Two tongues of hardened rubber, applied against the nasal vault, which they lift up and replace in its normal shape.

The introduction of this apparatus is easy, and causes no annoyance when in place (Fig. 27).

Cl. Martin, for narrowing the root of a nose which is as wide above as below, uses an appliance which takes its support from the front part of the septum and the floor of the nasal fossæ; by means of two springs and two small plates the arrangement pinches the upper and external part of the nose.

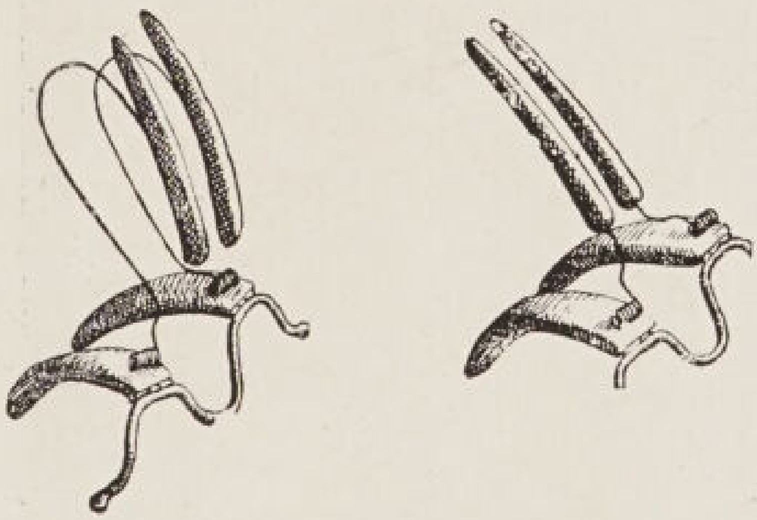


FIG. 27.—Appliance for Flattened Noses. (Martin.)

The correction takes a long time; surgeon and patient must equip themselves with an enormous deal of patience. As a reward, we can promise the patient that if he wears the apparatus consistently success is certain.

4. **Cicatricial Stenosis of the Oro-Pharynx.***—Cl. Martin has had occasion to apply his system of bloodless correction of cicatricial bands at the site of a cicatricial narrowing of the oro-pharynx. For

* Cl. Martin, Congrès de Madrid.

this particular case he devised the following apparatus, consisting of two parts:

(i.) A palatine plate fixed in the usual way to the teeth, and completely covering the palate.

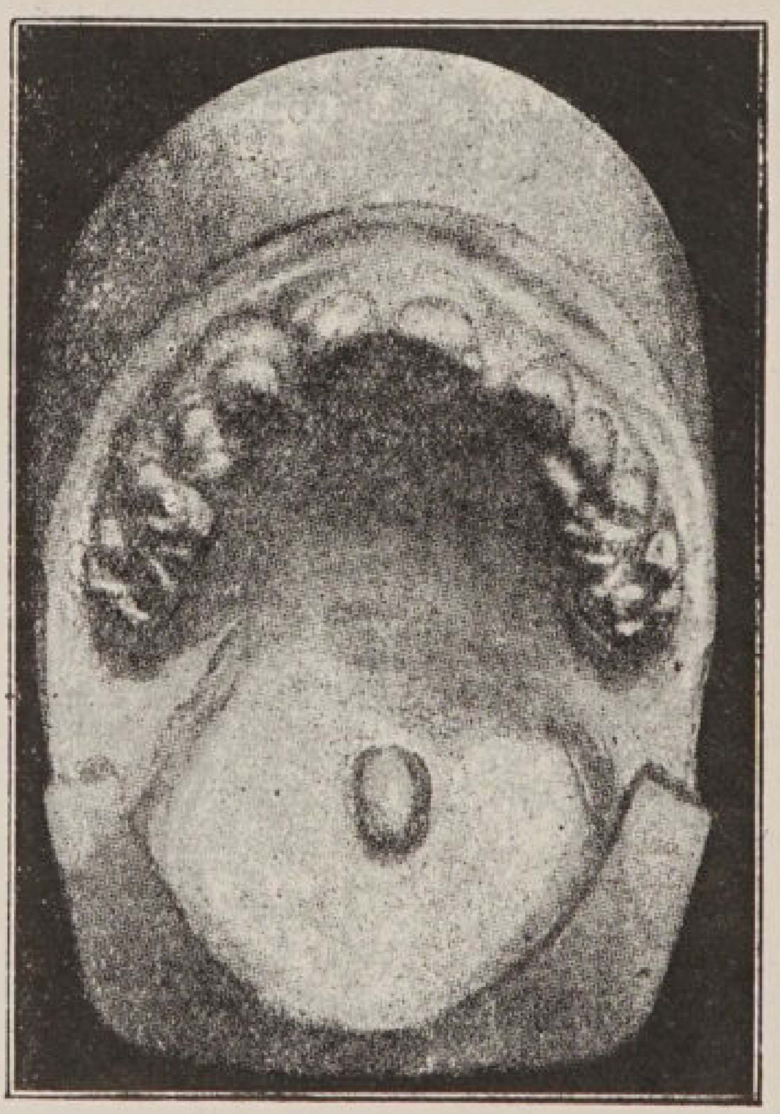


FIG. 28.—Adhesions of Palate and Pharyngeal Wall: Cast of the Mouth and Pharynx before Operation. (Delair.)

(ii.) A dilating apparatus constituted by a spring screwed on to the middle of the plate. This spring is made of an annealed gold wire feebly stretched, and shaped like a compass of which the limbs, bent back in a curve, diverge. Their lower ends are prolonged into two semi-hard rubber balls. When the apparatus is in place, these balls press against the boundaries of the narrowed part, and the two branches of the spring cause the widening of the stenosis.

FIG. 29.—Palato-Pharyngeal Adhesions: Cast of the Mouth and Nose after Operation. (Delair.)

5. **Palato-Pharyngeal Adhesions.**—The same principles find a happy application for the correction of adhesions between palate and pharyngeal wall. Having freed the adhesion of the velum to the pharyngeal wall, one has to prevent any new ad-

hesions from forming until the bleeding surfaces have completely healed, meanwhile keeping these apart. Cl. Martin has obtained the best results with the following apparatus: A block of rubber in the shape of the pharynx is made by means of a mould taken from the cadaver. This block is kept in place by two prolongations entering the posterior nares, and ending in two rubber tubes which emerge from the

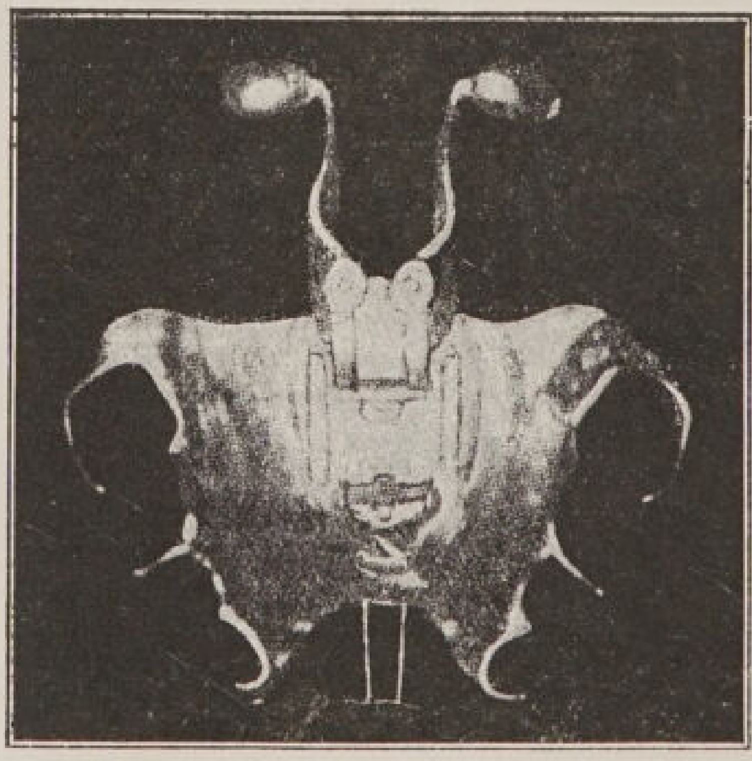


FIG. 30.—Palato-Pharyngeal Adhesions: Delair's Appliance, seen from Below, with the Carriage and the Dilators.

nostrils. These facilitate easy retention of the whole arrangement. The wearing of this apparatus, for the whole period of cicatrization, enables one to prevent the formation of new adhesions.

Delair* (Figs. 28 to 32) also has made an apparatus

* Delair, "Demonstration of a Child wearing a Dilator of the Naso-Pharynx: Delair's Plan to counteract Palato-Pharyngeal Adhesions" (*Odontologie*, 15 Juillet, 1909, p. 12).

to correct adhesions of the palate. It depends on a mechanism which is ingenious, but more complicated than the pharyngeal separator of Cl. Martin above described. Delair's apparatus comprises four pieces, as follows:

1. A metallic palatine plate kept in place by rings fitted to the teeth.

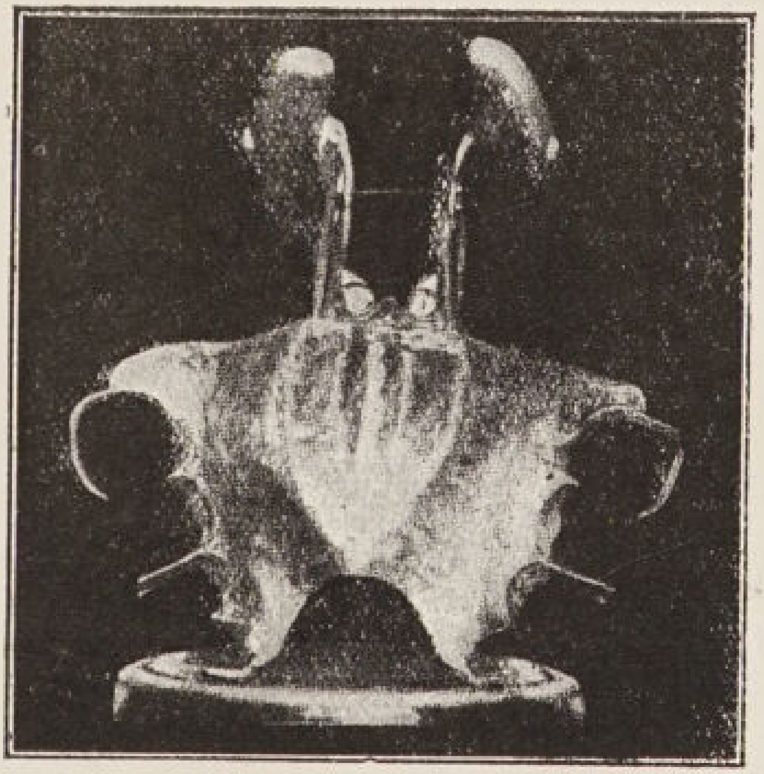


FIG. 31.—Delair's Appliance, seen from Above, with the Projection caused by the Upper Longitudinal Groove, in which glides the Safety-Screw.

2. In the centre of this plate a carriage; this is of gold, and consists of two pieces joined along their contiguous surfaces in an antero-posterior direction.

3. At the end of the carriage, two movable branches like the limbs of a compass, embracing the concavity of the velum and encircling the uvula to prevent any trauma of this latter.

4. The two movable branches are furnished at

their ends with two prolongations of aluminium, destined to lie on the postero-superior aspect of the velum after it has been surgically freed.

The several sections of this apparatus play one upon the other, and coax the velum free in various directions, with the help of elastic traction. A

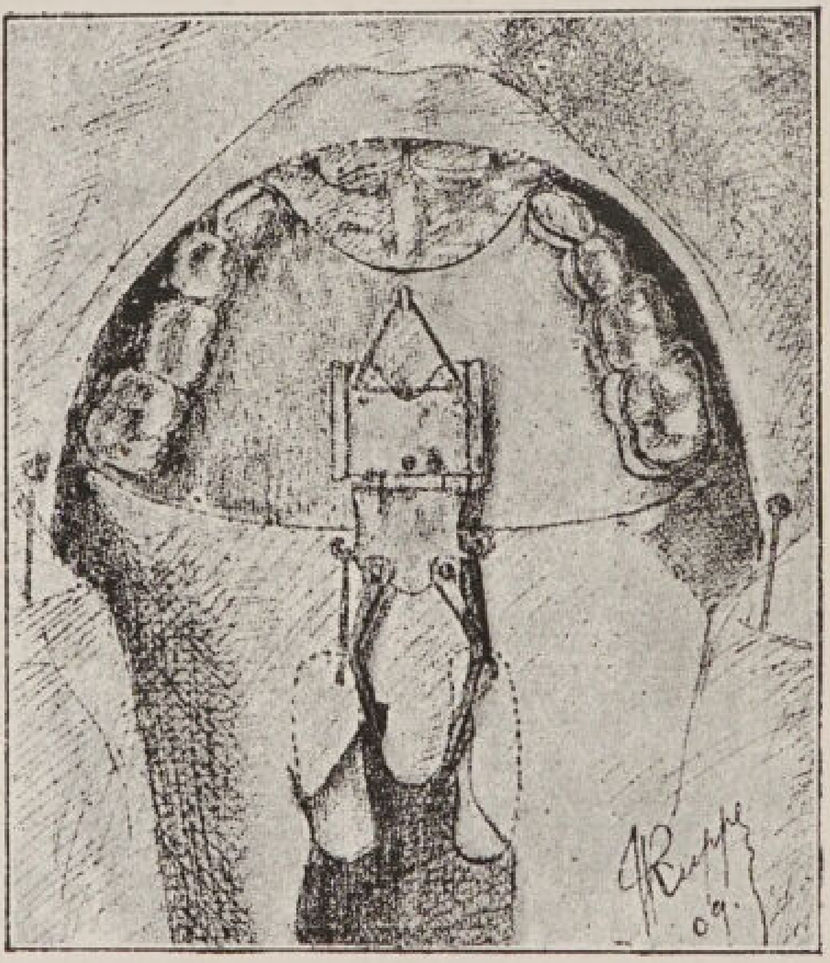


FIG. 32.—Diagram to show the Details of Delair's Apparatus in Place.

rubber ring connects the carriage of the palatine plate, producing a pull from above and behind; this, acting on the velum, prevents it from again touching the posterior pharyngeal wall. Some other rubber strands pull on the movable articulated branches of the carriage, making them diverge. This movement, occurring in a transverse plane, moves outwards the extreme borders of the newly formed velum, and prevents the raw edges from coming into mutual contact in the middle line.

Delair's appliance has undoubtedly the advantage that, much lighter than Martin's and of very small bulk, it is much less irksome to him who wears it. Nevertheless, Martin's has one great merit, its simple construction; and for an apparatus essentially temporary, and which has to be worn only for a few weeks, this is an advantage not to be despised.*

CHAPTER III

LATE PROSTHESIS

The Prosthetic Stage Proper.

By "late prosthesis" is meant the prosthetic restoration of losses of substance due to accident or surgical interference, such restoration being performed at a smaller or greater interval after the complete healing of the soft parts. In the preceding chapter we saw that the retraction of scar tissue brings in its train divers deformities, and we have studied the methods used to rectify this. In the matter of late prosthesis, it is the stage of cicatricial contraction which beyond doubt offers the greatest difficulty. Late prosthesis proper—that is, the final appliance to remedy the loss of substance after obtaining correction of scar

* Mixed velo-palatine prosthesis: surgical and prosthetic method. *Vide* Prosthetic Intervention after Staphylorrhaphy, Chapter III.

tissue—constitutes a very much easier phase of the restoration. We shall study in sequence late apparatus for restoration of the jaws, the soft and hard palates, the larynx, the bucco-facial region, the nose, and so on.

I. Late Prosthesis of the Jaws.

Apparatus and methods vary according to whether we are concerned with the upper or lower jaw. But we will now point out certain rules which must be kept.

Impressions.—We take impressions in plaster for choice; plaster exerts but a moderate pressure on the tissues, and thus the replica which it provides is a faithful copy of the supporting tissues, cicatricial or otherwise, when these are at rest. We are often obliged to make a special impression tray for the case in hand. With this idea we take, using an ordinary impression tray, a rough cast of the tissues which the appliance is ultimately to support. We cast this impression, and on the model thus obtained we make the impression tray either by stamping it on a sheet of German silver, or by making a tray in wax and substituting for it vulcanized rubber or aluminium cast in the wax. By means of this tray it becomes easy to bring the substance used for the impression in contact with all the tissues, exercising an equal pressure at all points.

It is often necessary, in anfractuous cavities, to take the impression in several parts; this composite impression (see p. 183) gives, when it is assembled, the total impression.

Apparatus.—The apparatus is furnished with teeth on the alveolar border. We employ for choice vulcanized rubber for making them. The base is made of undressed brown rubber, which is at the same time lighter and firmer; the gums in pink rubber; and the backing or lingual cusp, if necessary, of white rubber. The base may equally well be made of cast aluminium, which is so well tolerated by mucous membranes. We more often use, for the bases in bulky appliances, soft rubber, which has the following advantages:

1. It causes no pain by pressure on the tissues which are in contact with it.

2. Its elasticity facilitates the removal of the appliances, and therefore their cleaning.

3. It does not lessen the humidity of neighbouring tissues. Hence its usefulness for prosthetic appliances in contact with the nasal mucosa. Apparatus used after resections of the mandible may conveniently be massive; for by their weight they resist the cicatricial deformities of neighbouring tissues and facilitate the lowering of the jaw.

For lower jaw appliances destined to replace large losses of substance, it is good to introduce into the rubber to be vulcanized, at the moment of packing, some fragments of rubber themselves previously vulcanized, or some pieces of tin, to get rid of the porosity caused by the unusual thickness of the part to be produced.

It is by no means the same thing with the upper jaw appliances designed to remedy the functional troubles following a loss of substance after a surgical operation, or resulting from congenital default. In such case lightness is a condition indispensable to success. These appliances are often bulky; to preserve the necessary size, all the while maintaining the lightness which is imperative, the thickest parts must be hollow. It has been suggested to incorporate in them a block of aluminium; but this metal, howbeit light, is still too heavy, and the results have not been satisfactory. Another experiment has been the introduction of pieces of cork in the rubber, at the time of the packing of the apparatus. The best plan is to leave a cavity in the centre of the thick parts of the contrivance.

To get this result we avail ourselves of various processes:

The appliance is flasked as usual. We cover with a sheet of rubber the deep part of the apparatus. In the hollow thus formed we pour a certain amount of plaster, representing what is to be the cavity. The plaster once hardened, and the seams loosened, we carry on the packing, as if we had to make a piece of an ordinary prosthesis. The block of plaster is thus included in the centre of the rubber.

Geoffroy* has published an interesting process for obtaining extremely light apparatus. We cannot here describe the technical details. Enough to say that the hollow is obtained by means of two light boxes in stamped aluminium, and covered outside by rubber. They are exactly adapted by their borders, and united by the rubber which serves as their common envelope.

* Geoffroy, "Hollow Appliances for Restorative Prosthesis" (*Odontologie*, 30 Août, 1906, p. 166).

As a rule, prosthetic appliances come into contact with cicatricial tissue which is more fragile than normal tissues; so the appliance should not possess sharp angles, its rough points should be carefully rounded off. Moreover, as we have already pointed out, we prevent contusions and undue pressure on the tissues by using soft rubber for those points

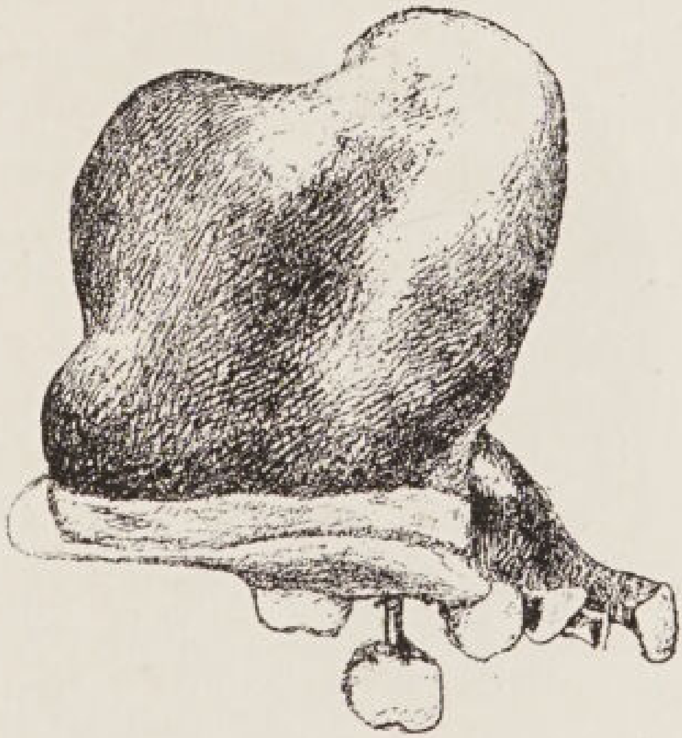


FIG. 33.—Late Prosthesis for the Upper Jaw, as used by Pont of Lyons.

which have to be against them. Pont* has exhibited an entirely original apparatus for the restoration of the upper jaw (Figs. 33 and 34).

* Pont, " General Considerations on Restorative Prosthesis for the Upper Jaw. Exhibition of a New Appliance " (*Odontologie*, v., 1903, p. 471). We must also call attention to an important memoir recounting seventeen cases of prosthetic restoration after resection of the upper jaw. *Vide* Billing, "Von der Oberkiefer Resektions Prothèse," Stockholm, 1912; Isaac Marcus, editor.

This apparatus consists of a hard vulcanized rubber palatine plate, supporting artificial teeth and resembling an ordinary denture. This plate is surmounted by a soft rubber pocket closely approaching to the shape of the maxilla or of the missing part. A gold tube, sunk into the palatine plate, puts this pocket into communication with the outer world.

FIG. 34.—Late Prosthesis for the Upper Jaw: Pont of Lyons

The inner end of the tube is closed by a valve, and the outer end by a pivot which supports one of the false teeth of the apparatus.

When the patient wants to wear this arrangement, he has only to empty the pocket of air. It is easy to flatten the pocket and put the appliance in place. This done, the patient with a pear-shaped inflator refills the pocket with air, and it swells and hardens.

In this way its retention is complete. The advantage of this appliance is its extreme lightness. Moreover, it can be used with effect for treating vicious scars.

II. Prosthesis for Soft and Hard Palate.

Perforations or losses of substance of the velum or hard palate may be congenital or acquired. In the latter case they occur most often from tertiary syphilis. The functional disabilities vary in degree with the amount of substance lost; nasal speech may be noticed, and the escape of liquid, or occasionally solid food, from the nose. The patient experiences great difficulty in swallowing, above all of fluids; he throws back his head and drinks in tiny mouthfuls. Nearly always phonation is heavily handicapped, even to the point of being quite unintelligible. We cure these incapacities by methods surgical or prosthetic; the indications for these respective plans are drawn, as we shall see later, now from the age of the patient, now from the extent of the lesion. But the functional gain accruing is very variable, according to whether we are concerned with an acquired perforation or a congenital fissure. In the former the cure of speech is rapid, sometimes even immediate. Varying with the sort of case, a simple obturator plate or a flexible velum generally suffices to correct functional troubles perfectly. "This fact," says A. Martin, "is easily explained by the existence of previously educated muscles; and in these cases the imperfect speech depends rather on mechanical defects resulting from the lesion than on the abnormal play of the muscles. Thus, it suffices to re-establish these mechanical conditions in suppressing the communication between the mouth and the post-nasal space, for speech to redevelop as pure as of yore.

"The treatment of congenital losses of substance

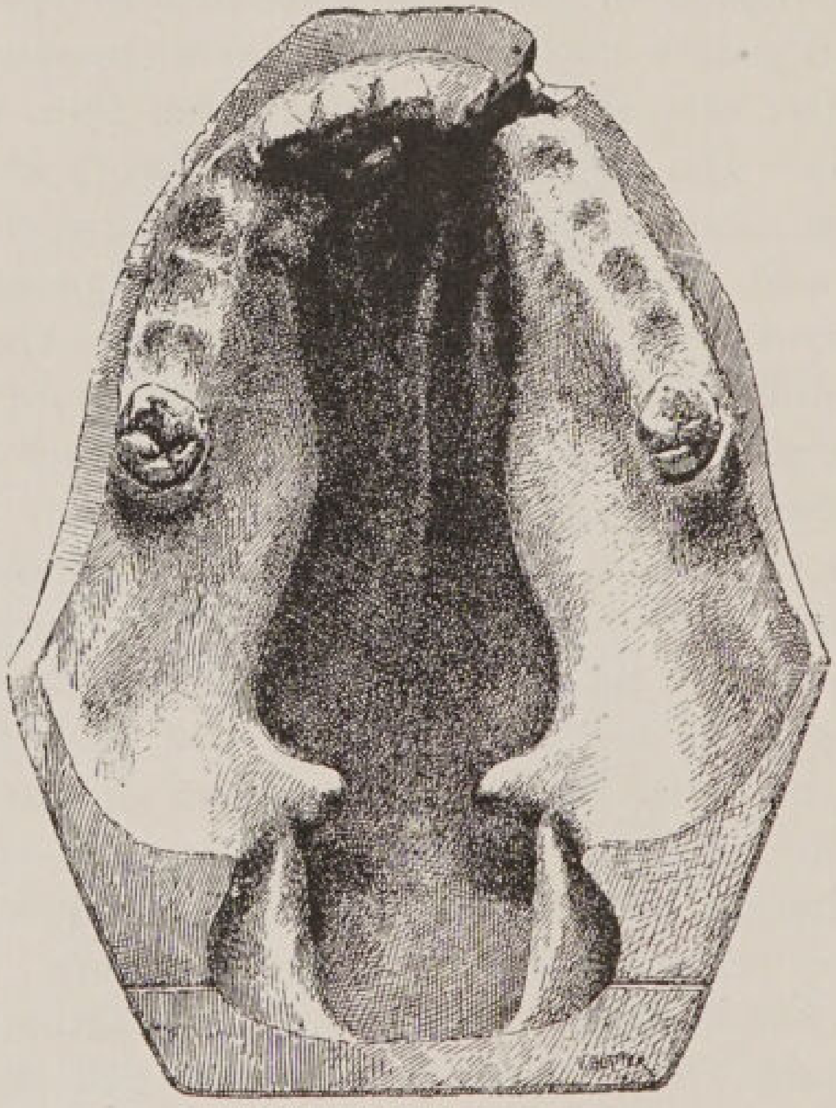


FIG. 35.—Cast of a Hare-Lip. (Delair.)

is different, and presents complex difficulties. To create anew the normal mechanical conditions never suffices to obtain a rapid and satisfactory functional result. The fact is that in these cases the chief impediment arises, not only from the actual loss of substance, but above all from the atrophy of muscles, and because their education has been nil or faulty. So far is this a truism that, even with a good apparatus, we get an insignificant result as regards speech.

"The prosthetic treatment should then always be followed by a period of re-education of speech, necessary to obtain a good final result, but which itself would not be enough."*

Now, as we shall see later, this is a consideration often not fully realized. In the matter of congenital fissures of the velum, one cannot repeat too often that a long speech-training is indispensable. Orthophonia must be deemed the logical outcome of all efforts for restoration, surgical or prosthetic, and the majority of functional failures may be lain at the door of negligence of this paramount rule.

There are two methods to cure clefts of the soft or hard palate: (1) surgical, (2) prosthetic.

1. **Surgical or Autoplastic Method.**—We can only deal with this in passing. By two parallel incisions at the palatine cleft we can elevate the mucosa, and by sliding bring together the two flaps thus obtained. We thereafter freshen their edges, and suture them in the mid-line. When our object is to reconstruct the hard palate we use the term "uranoplasty"; when the soft palate is concerned it is a "staphylorrhaphy." The immediate post-operative outcome is sometimes very pretty. But the functional results are not constant, because too often the surgeon neglects the observation and after-care of the velopalatine scar tissue. We have seen in an earlier

* Cl. Martin, Cong. Madrid, p. 45.

chapter that the character of scar tissue depends on its retractility; but it is this very elasticity which enables it to elongate and soften easily by pressure or traction, gentle and continuous, or at any rate frequent. Later we shall see how systematic massage of the velum, after staphylorrhaphy, makes it supple and able to resist shortening. In certain cases, even to wear an appliance resembling an elastic ball for a brief space gives a fair amount of lengthening.

2. **Prosthetic Method.**—This comprises essentially two sorts of apparatus: artificial vela and obturators. *The object of artificial vela is an anatomical restoration. The paramount end to be gained by obturators is a functional restoration, and, neglecting the reconstitution of the loss of substance, their only destiny is to correct its results by occluding the abnormal communication existing between the mouth and the naso-pharynx.*

Certain authors (Cl. Martin, Delair, Norman Kingsley) have sought to combine in one apparatus these different principles. Petronius in 1565 spoke of palatine obturators, and recommended wax, tow, sponge. Ambroise Paré described two sorts of obturators for fissures of the hard palate, consisting of a metal plate and a sponge. Fauchard combined obturators with dentures, and omitted the sponges hitherto employed. Bourdet noticed the tendency of acquired palatal fissures to close spontaneously, and invented a series of obturators consisting of a simple plate of gold, held by wires, and intended to encourage the reunion of the edges of the perforation. Delabarre in 1820 introduced into their construction a soft hinged velum. In 1823 Snell discovered one of the most important principles of this special prosthesis: to communicate to the artificial velum the movement of the remaining stumps of the palate. In 1840 Stearn made an obturator on this plan, and Schange in 1841 made the first model entirely in gold. Kingsley in 1864 constructed an artificial velum by means of two superposed sheets of soft rubber; the stumps of the velum fitted in between these, and communicated to them their mobility. Gariel in 1855 made an obturator in vulcanite having the form of a double shirt button. Préterre has made a large number of obturating arrangements and artificial vela, deriving his ideas from those of Stearn, carried out with greater simplicity.*

After Préterre, the study of velo-palatine prosthesis came to a halt in France, although in Germany Suerson, then Brugger, gave it a great impetus. In these latter years, Cl. Martin and Delair in France, and Calvin Case in the United States, have published important work on the question; and velo-palatine prosthesis seems now to be in good working order, at any rate as far as concerns its underlying principles.

Prosthesis for the Hard Palate.—The disabilities resulting from losses of substance of the palatine vault are easily curable. It is sufficient, in order to cure the functional trouble, to fit an obturator consisting of a palatine plate which takes its *point d'appui* from the neighbouring teeth, and adapts itself exactly to the circumference of the perforation. This plaque may be of either metal or vulcanite. *It must pass*

* Préterre, "Treatise of Congenital or Acquired Fissures of the Soft and Hard Palate," Paris, 1884.

across the perforation like a bridge, without penetrating, because small losses of substance, notably of the acquired variety, tend to fill up spontaneously. The appliance must not hinder this tendency to repair.

Contrivances which pass through the perforation and take their support from the floor of the nasal fossæ are thus absolutely contra-indicated.

Prosthesis for the Soft Palate.—When the lesion involves the velum, the difficulty is much greater than in the preceding case. To replace by a prosthetic appliance a muscular and eminently mobile organ presents almost insurmountable difficulties. Hence the legion of contrivances suggested and the faulty results often achieved. The importance of an artificial velum varies according to the size of the fissure. The greater the breach, the more is it worth while to fill it up.

Impression.—The material of choice is plaster; a special impression tray is useful. But it is often preferable to fashion it in the way already mentioned in the earlier book.* For it is rarely that impression trays when made have the desired measurements; this is especially true as regards the height of the palatine vault. We must make many trials until we succeed in getting the velum and the stumps of its pillars in a state of relaxation. In this case even more than in any other it is expedient, from the moment that the plaster is introduced into the mouth, to lower the patient's head, so that no plaster runs into his throat. In the event of requiring an im-

* *Vide* P. Martinier and G. Villain, "Clinique de Prothèse."

pression of the edges of the perforation and the naso-pharynx, we take one impression (see p. 183) superposed on the other; or we can adopt the plan described apropos of the apparatus of Calvin Case.

Contrivance of the Apparatus.—The apparatus is divided into two parts: one fixed, the other movable. The first or fixed part forms the base plate. It is rigid, extends along the surface of the palatine vault, and takes its point of attachment from the teeth by means of the various arrangements in practice for retention of apparatus. If we have a combined lesion of the soft and hard palates, it answers also as an obturator. This part may be in vulcanite or metal. It should be fitted as accurately as possible, so that the obturator may be very rigid.

The second or movable part is as a rule in soft rubber, less often in hard rubber or metal. It plays the part of velum, and should have as far as possible the same relations and physiological movements as does the velum under normal conditions. It should fit on to the borders of the cleft, and follow smoothly whatever movements the stumps of the natural velum can impart to it.

These two parts are united at the junction of the hard and soft palates by an articulation which differs with the importance of the gap and the type of appliance used: sometimes there is no line of demarcation, but simply soft rubber succeeding hard; sometimes there is a small hinge. This articulation must be very mobile and very delicate, so as to react to the least movement; it must not become dirty, which would check the working of the appliance. Having framed these general laws, we will study a few of the best-known apparatus.

Simple Appliance without a Hinge.—This apparatus consists of—

1. A palatine plate extending no farther than the level of the palate bones; it is sometimes of metal, usually of hard vulcanite, and is prolonged backwards in the direction of the velum in the form of a stanchion.

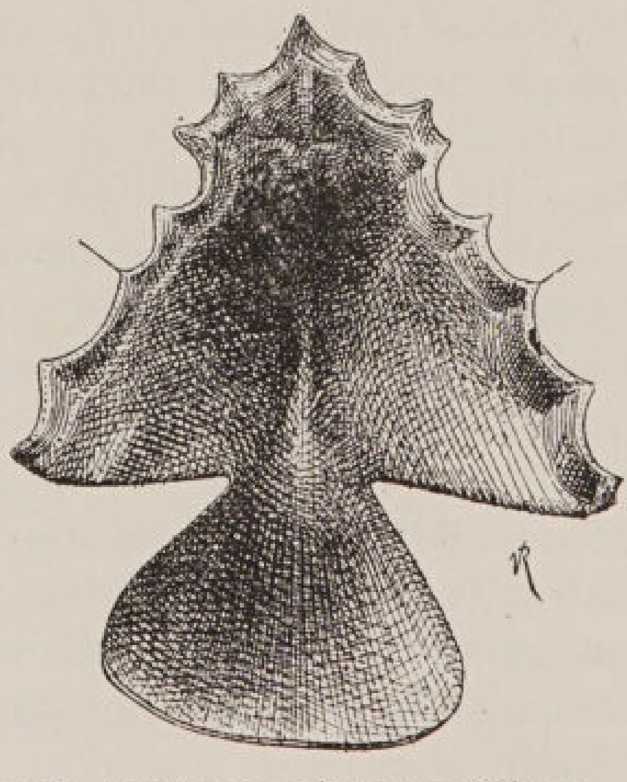


FIG. 36.—Simple Appliance without a Hinge. (Martinier.)

2. A plate of soft rubber corresponding to the loss of soft tissue in the hard and soft palates, and lying over the edges of this gap. The palatine and velo-palatine plates are continuous without the interposition of a hinge or other joint. The hard part, which is continued into the centre of the soft rubber, acts as its guide, and keeps it along the borders of the perforation (Fig. 36).

The artificial velum so made has been adversely criticized in that it does not possess the desired mobility. When first inserted and the palate is in repose, it shuts off the cleft well; but in the movements of swallowing it fits badly and hampers the physiological work of neighbouring muscular structures. After the lapse of some time the soft rubber becomes misshapen under the influence of this continuous pressure, and ceases to fit even in repose. It hardens, and its mobility, never reliable, becomes still less. It cracks and becomes severed from the palatine plate at its point of union with the latter.

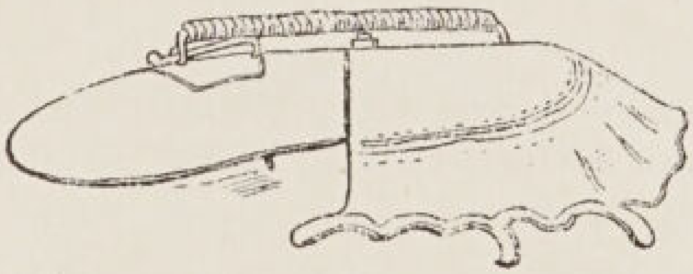


FIG. 37.—Kingsley's Appliance.

But above all we must indict this artificial velum of a faulty functional restoration; this, moreover, it shares more or less with all appliances which shut off the naso-pharynx only incompletely.

Kingsley's Appliance.—This consists of—

1. A palatine plate of vulcanite or metal.

2. An artificial velum of soft rubber.

3. A hinge to join these two parts and assure free movement to the artificial velum (Fig. 37).

This hinge does not put beyond doubt the close fitting of the remaining muscular parts. To it we must also add a spring which keeps it snug against the borders of the hole. This spring may be inferior —*i.e.*, buccal; in this case it consists of a sheet of flattened gold fixed to the base plate, playing on the velo-palatine part which it carries upwards in the movements of swallowing. Or, again, the spring may be superior—*i.e.*, nasal—in which case it consists of a spiral spring, fixed in front to the base plate, and behind to the artificial velum, which it lifts upwards. Thus, it is certain that the latter maintains contact with what remains of the soft palate. A rubber ring can be substituted for the spiral spring, fixed in the same way.

*Appliance of Guerini of Naples.**—This consists of—

1. A palatine plate, preferably metallic.
2. An artificial velum in soft rubber.
3. A joint uniting these two parts.

It is the latter (the joint) which gives originality to the arrangement. It comprises a series of small transverse plates joined by hinges, constituting in this way many small joints which give the obturator a great mobility on the palatine plate [a lobster-tailed joint—Tr.]. The pressure required to fit the appliance to the neighbouring parts during all their movements is provided by a small sheet of gold perpendicular to the segments of the lobster-tail, forming a spring. This small sheet is yielding enough to give way to movements of lowering, meanwhile carrying the velum upwards in movements of elevation (Fig. 38).

* "New System of Obturator for the Soft Palate" (Congrès dentaire international de Paris).

Martin's Appliances—1. *Appliance with Bags of Water.*—Martin did not rest content with shutting off the buccal from the naso-pharyngeal cavities; in order to obtain a practically normal voice, he entirely

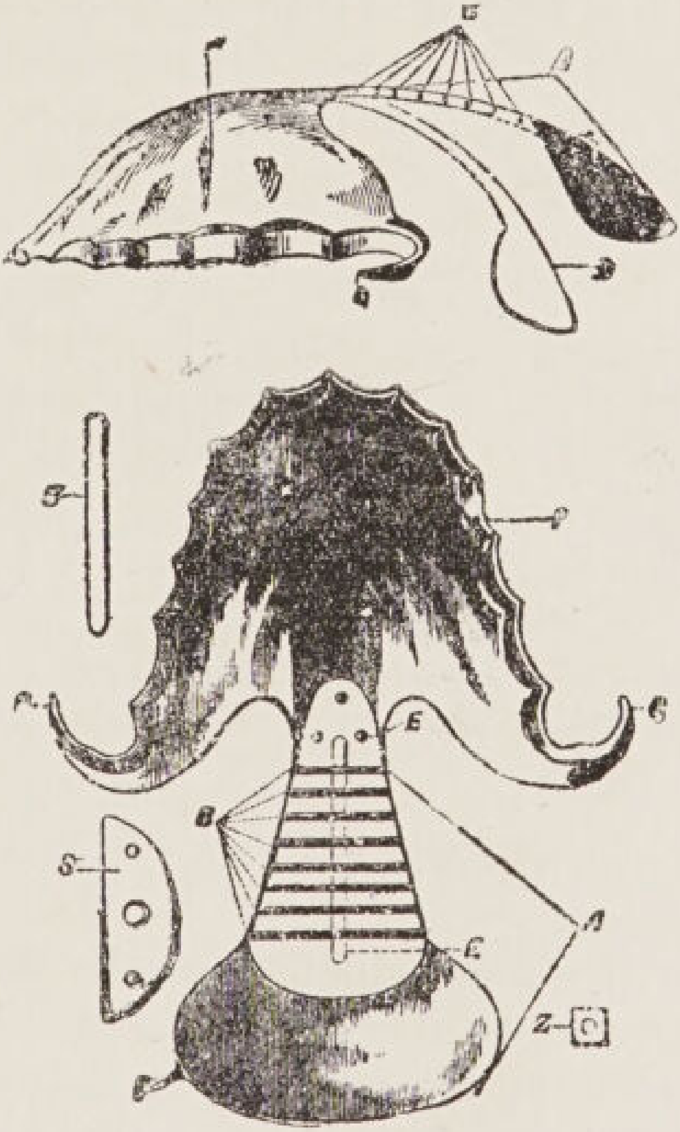


FIG. 38.—Appliance of Guerini.

replaced the lost substance. "The appliances which we use are of hard and soft rubber, which allows us to obtain an artificial velum having the free play of natural vela. Moreover—and herein lies the originality of our system—we replace by hollow rubber bodies all the lost tissue, so as to give to the buccal and nasal cavities their natural form. This is, in fact, the only plan which enables us to obtain a correct pronunciation."*

Consistent with this principle, Martin constructed some apparatus bearing at their posterior end globular masses of hollow soft rubber. If the vomer is partly missing, he replaces it in his obturator by a median

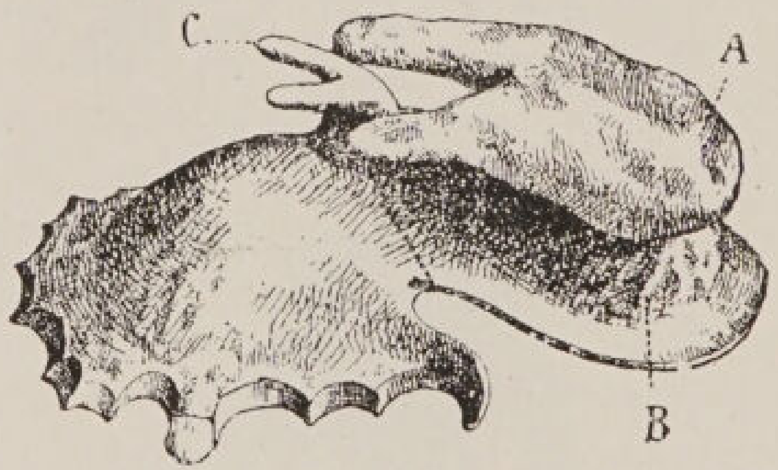


FIG. 39.—Martin's Appliance with Bags of Water. A, Upper bag of water; B, artificial velum; C, nasal prolongation.

projection which meets the remains of the natural vomer (Fig. 39).

So as to give more mobility to the obturator, in order that it may be able to follow all the movements conveyed to it by the muscles, he partly fills with fluid the shallow cavity in the hollow soft rubber situated at the posterior part. He gives to this obturating part the shape of two bags joined by a constriction. The lower bag in front is continuous with the palatine plate of the apparatus, and its upper surface lies against the lower surface of the

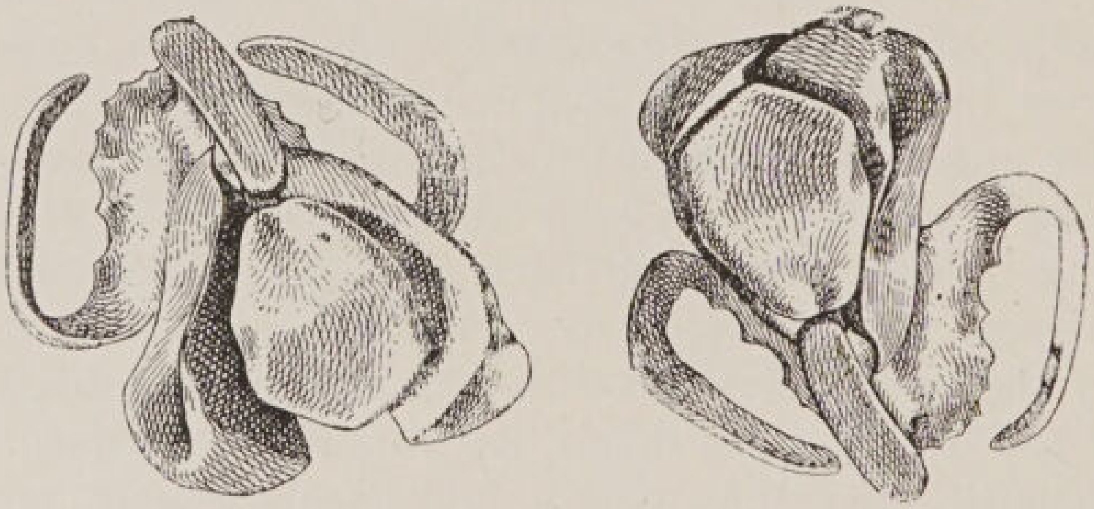
* Cl. Martin, "Concerning Immediate Prosthesis," Paris, 1889; Masson, editor.

remaining parts of the velum. The upper and smaller bag is placed in the nasal fossæ, on the floor of which it rests by its inferior surface, overlapping a little the borders of the loss of tissue. The constricted part joining the two bags corresponds to the margin of the perforation, which are thus enclosed by the two valves (*i.e.*, bags).

The two bags are hollow, and communicate by an opening at the level of the constriction. This subdivided cavity is partly filled with fluid. Under the influence of the muscular movements which compress the lower bag its contained fluid is driven into the upper, which swells and presses the appliance snugly on the nasal floor. The apparatus in this way follows all the movements of the velum, and answers to every muscular impulse conveyed to it by the surrounding muscles. By altering the shape of the bags, we can divert the fluid into convenient channels, and thus obtain movements closely resembling those of the normal velum.

2. *Trap-Door Obturators.* — Meanwhile Martin, changing his point of view, has invented another obturator called a "trap-door," which is described in his own words as follows: "It consists primarily of a palatine piece in hard rubber, and a soft or hard velum joined together by a hinge (Figs. 40 and 41).

"Above the velum the second part of the apparatus is fixed; this is destined to fill up in part the pharyngeal cavity. It consists of three traps: one median and two lateral. The latter present, along their external borders, a gutter where the stumps of the velum will lodge; and the velum will communicate to these lateral traps their movement. In transverse section these traps are triangular, with the apex inwards; and the lower surface of one rests and glides on the upper surface of the other. The median valve also is triangular, in transverse section, the apex of the triangle pointing downwards, and fits into the angle formed by the two lateral traps; its lateral aspects rest and move on their upper aspects. When the



FIGS. 40 AND 41.—Martin's Trap-Door Obturator.

Fig. 40.—Position of the Traps when the Pharyngeal Muscles are at Rest.

Fig. 41.—The Same during the Contraction of the Pharyngeal Muscles.

stumps of the soft palate contract, they compress the lateral traps, which glide one on the other by their inclined surfaces, pressing backwards and upwards the median trap, which becomes pushed against the posterior pharyngeal wall. During relaxation the median trap descends by its own weight, opening out the lateral traps; these latter return to their position of rest, and the communication be tween the pharynx and nasal cavity is once more patent."*

To make these hollow appliances, we construct a plaster model of the parts which are to be represented by hollow rubber—that is, the traps. We next cover all aspects of the rubber with a sufficient thickness of plaster, and vulcanize it. We take out the plaster by making a hole, which is forthwith filled up again.

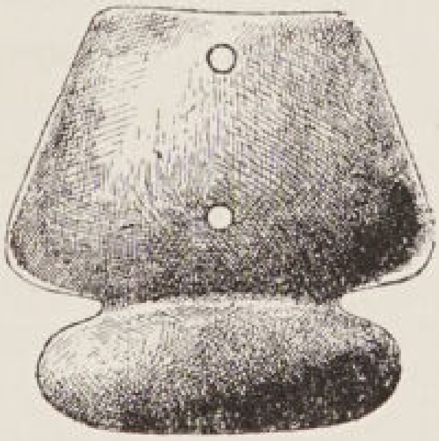


FIG. 42.—Valve-Velum.

Delair's Artificial Valve-Velum.†—This contrivance is founded on the following postulates which Delair's exhaustive work has allowed him to formulate:

1. The basal or palatine part of an artificial velum should be of metal, to obtain a resonance superior to that given by vulcanized rubber.

2. The velum, whatever its shape, should be soft and supple.

* Cl. Martin, Cong. de Madrid, 1903, p. 54.

† Delair, "Artificial Valve-Velum" (Cong. dent. nat. Ajaccio, *Odontol.*, Juillet, 1902, p. 59).—"On Velo-Palatine Prosthesis" (*Odontol.*, 1905, p. 143).—"New Method of Restorative Velo-Palatine Prosthesis" (*Odontol.*, 1901, p. 353).

3. The velum should be united to the palatine plate by an absolutely mobile joint, so that the former may be able to follow, in their movements of elevation and depression, the stumps of the cleft velum and the faucial pillars.

4. The false velum should extend to beyond the limits of the anterior pillars, so as to close the pharyngeal cavity, and thus reduce the resonance. The posterior margin of this velum should come into accurate contact with the cushion which is formed by the superior pharyngeal constrictor during swallowing and phonation.

Delair's valve-velum is of soft rubber, with convex borders. It is attached to a fixed denture by a hinge. This velum passes up behind the posterior pillars, and ends in the form of an oval cupola, of which the flexible and thin borders tightly fit the contours of the pharynx. A sort of valve is thus produced, which checks the passage of air. When the soft rubber perishes, the valve can be changed. "To facilitate the elevation of the artificial velum, and allow it to follow the excursions of the natural one, a simple soft rubber washer serves as a spring. It is held by a rod and ring at the top of the posterior part of the basal plate, and is caught on to a hook soldered to one of the two nuts which screw the velum to the movable posterior section of the appliance."

To fashion his appliance, Delair simply took a mould of the upper jaw, not extending beyond the limits of the bony palate. After this mould he made the basal retention plate or denture. To construct the mobile part—that is, the artificial velum and its valve destined to shut off the pharynx—the author preferred to rely on measurements. As a fact, the margins of the palatine gap and pillars have a divergence which varies consecutive to the state of rest or contraction of the residual stumps of soft palate. Now, the taking of the impression (which necessitates the use of cocaine) gives the position of the respective remnants of velum when in repose; and if a valve were constructed on these data it would be too small, in that the stumps in contracting increase the gape of the fissure margins. As a corollary to this, the final apparatus will shut off the pharynx only when in a state of rest; this occlusion will become imperfect at the exact moment when the stumps contract. Delair accordingly took his measurements while allowing for the extreme gaping of the edges of the fissure, which he obtained by eliciting muscular contraction by tickling the mucosa.

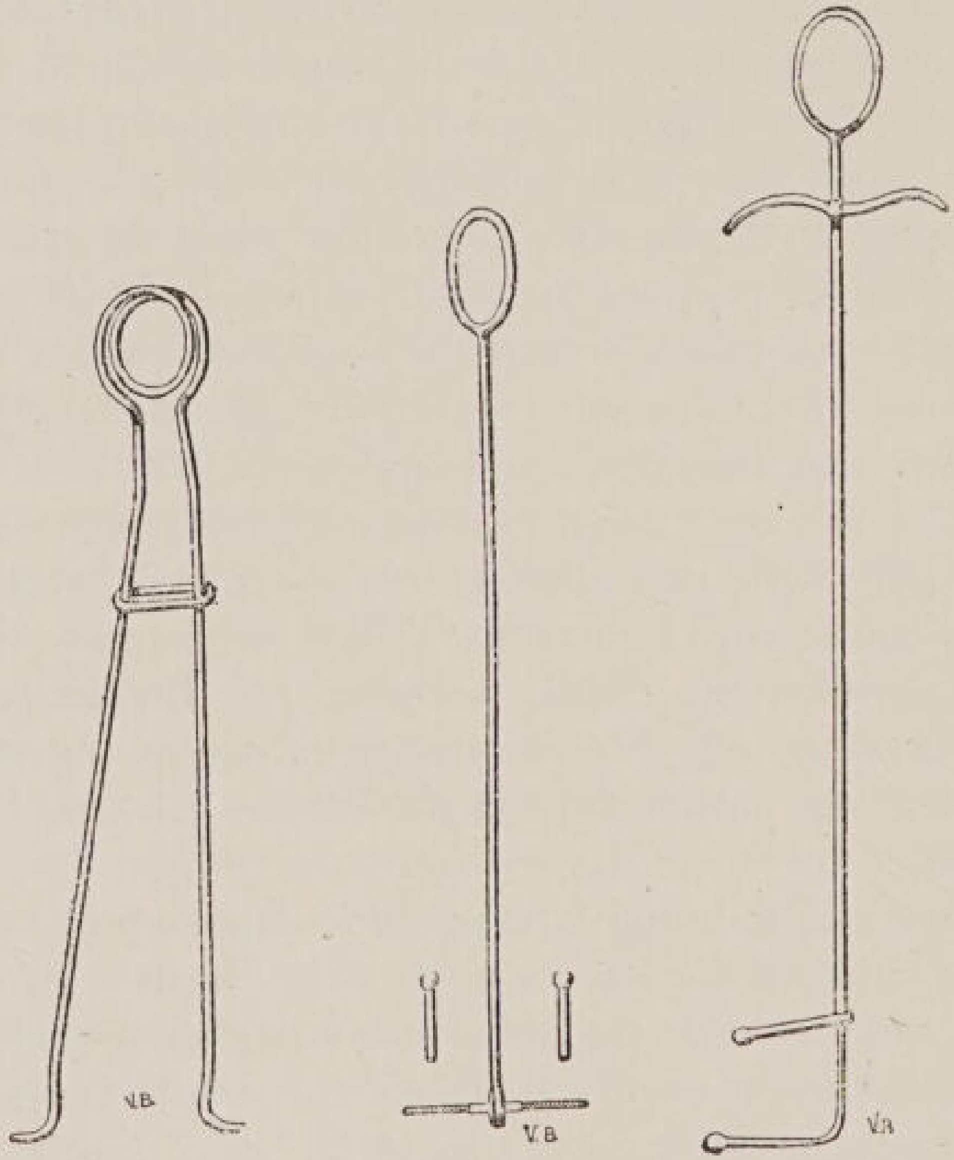
A certain number of special compasses thought out by the author are requisite (Figs. 43 to 45), and enable us to obtain the following three measurements:

1. Maximum width between the borders of the fissure.

2. Maximum distance from the edges of the uvula to the posterior pharyngeal wall.

3. Distance between the lateral pharyngeal walls.

Nevertheless, we ought not to make an appliance having these exact dimensions. In fact, if the notch of the velum at the level of the pillars measures exactly the same as the maximum distance between the stumps, there is a risk that the appliance will ulcerate the mucosa by friction. The velum, then, should be at this level about 3 mm. less than the figure obtained by measuring. Likewise the valve



FIGS. 43 TO 45.—Delair's Compasses for Bucco-Pharyngeal Measurements.

should be, in the sagittal plane, about 2 mm. less than the figure obtained by measurement; for if the valve be as deep as the pharynx, the occlusion will be complete just as much in repose as during contraction, and passage of air for respiration will become impossible. Lastly, if the breadth of the valve correspond to the transverse space between the lateral pharyngeal walls, the friction will prevent it from rising during contraction; hence the necessity of making it narrower by 3 mm.

"To recapitulate," says Delair,* "in the case of a complete cleft, a plate denture, bridging the palatine fissure from one border to the other, will form a rigid obturator as far as the level of the aponeurotic part of the velum. It is exactly at this point, which corresponds to the anterior surface of the wisdom-teeth, that the mechanism of an artificial valve-velum should be fixed on to the denture. Then, given the width of any complete fissure whatsoever, we shall determine that of the artificial velum which we have in hand by adding 7 to 8 mm. to each margin, so as to insure absolute contact with the stumps during their maximum separation—that is, in swallowing, speaking, and singing. Its length will be less by 1 cm. We have studied mathematically the dimensions to be given to the two notches situated between velum and valve. Let us revert to this most important point, for on the perfect grasp of this depends success in many cases.

"It is understood that the width of each notch should correspond to the thickness of the stump of the uvula, which it should cover. This thickness varies in different cases; its average is from 4 to 6 mm. Each notch should bestride, as it were, the corresponding stump exactly at the point where the

* Delair, "On Velo-Palatine Prosthesis" (*Odontologie*, 15 Févr., 1905, p. 151).

remnants of uvula and velum are continuous. As for the valve, let me recall in passing that its object is to shut off the naso-pharynx during swallowing as well as when speaking four-fifths of all spoken sounds. I have already given the reason why it should be joined on to the artificial velum proper; I demonstrated its physiological rôle when, two years ago,

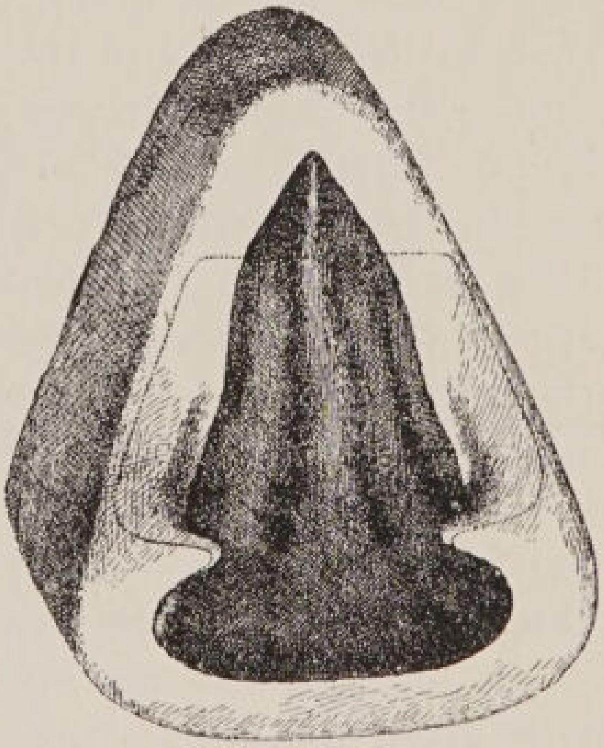


FIG. 46.—Horizontal Section of a Cleft Palate.

I exhibited several patients to whom it had been applied.

"As regards its applicability, I repeat that, save only in the rare event of an extremely narrow fissure, it can always be used.

"There is no precise anatomical ratio between the width and the depth of the space between the pharynx and the uvula stumps. As a fact, the tonsils are often a cause of stenosis of the cavity; by their size they sometimes push forward the anterior pillars, which enlarges the dimensions of the space to be filled. In other cases they are rudimentary, and this space is narrower.

"The valve will always be oval, but not with a geometrical regularity. Its transverse diameter in front should be straight from one notch to the other; and its posterior border should have a slightly accentuated curve, so as to fit itself, inside the naso-pharynx, against the superior pharyngeal constrictor during its contraction."

Delair has instituted a table showing the dimensions to give to the velum and valve after measuring the pharynx. He classified seven principal types corresponding to cases met with in practice. We think it right to publish this table, whose value in constituting a valve-velum is very great. As we see, according to this table of proportions, a valve-velum may easily be applied to fissures of from 20 to 30 mm. and more. Below these measurements Delair considers that staphylorrhaphy is indicated rather than prosthetic apparatus. The valve-velum should not be applied at once, for it will provoke reflex contraction of the pharynx.

It is necessary to obtain previously a tolerance of the pharyngeal region when in contact with the foreign body which one wishes to place there. With this idea we first of all make the patient wear a basal plate, which meanwhile acts as an obturator in any case of cleft palate.

When the patient is accustomed to use this piece we add a rubber tongue which acts as a sort of half velum. Some days later this demi-velum is replaced by an entire velum.

Later we substitute a valve-velum. Latest of all and finally, when tolerance is perfect, we fit the complete and final apparatus. This education of the pharynx takes about three weeks (Delair).

Measurements taken from Nature.					Corresponding Measurements of Vela.			
Type.	*Distance between Stumps of Velum when at Rest.*	*Maximum Distance between Stumps during Contraction.*	*Depth of Pharyngeal Cavity.*	*Distance between Lateral Walls of Pharynx.*	*Width of Notches.*	*Maximum Width of Velum.*	*Length of Valve.*	*Width of Valve.*
	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.
I.	23	31	16	47	29	48	14	44
II.	22	30·5	16	45	27·5	46	14	42
III.	21	29	15	43	26	44	13	40
IV.	20	28	14	42	25	42	12	38
V.	19	26·5	13	41	23·5	41	11	38
VI.	18	25	14	37	22	30	12	34
VII.	17	23	12	35	20	39	10	32

*Artificial Velum of Calvin Case.**—This appliance comprises a triangular metal plate of which the apex points forwards and the base backwards. The margins of this plate are fitted with a soft rubber tube destined to make contact with the mucosa.

* Calvin Case, "Mechanical Treatment of Congenital Fissures of the Palatine Vault" (Cong. dent. internat., Saint-Louis, Août, 1904; *Odontologie*, 30 Oct., 1905).

The rubber tube in its front part is hollowed out to form a gutter which shall receive the edges of the palatine cleft (Figs. 47 to 60). In front the appliance is retained by a metal plate, held by hooks which clasp the neighbouring teeth. But when the patient has worn the obturator in this way for some time, and is quite accustomed to it, he can, according to Calvin Case, dispense with the palatine plate and hooks, and easily keep it in position.

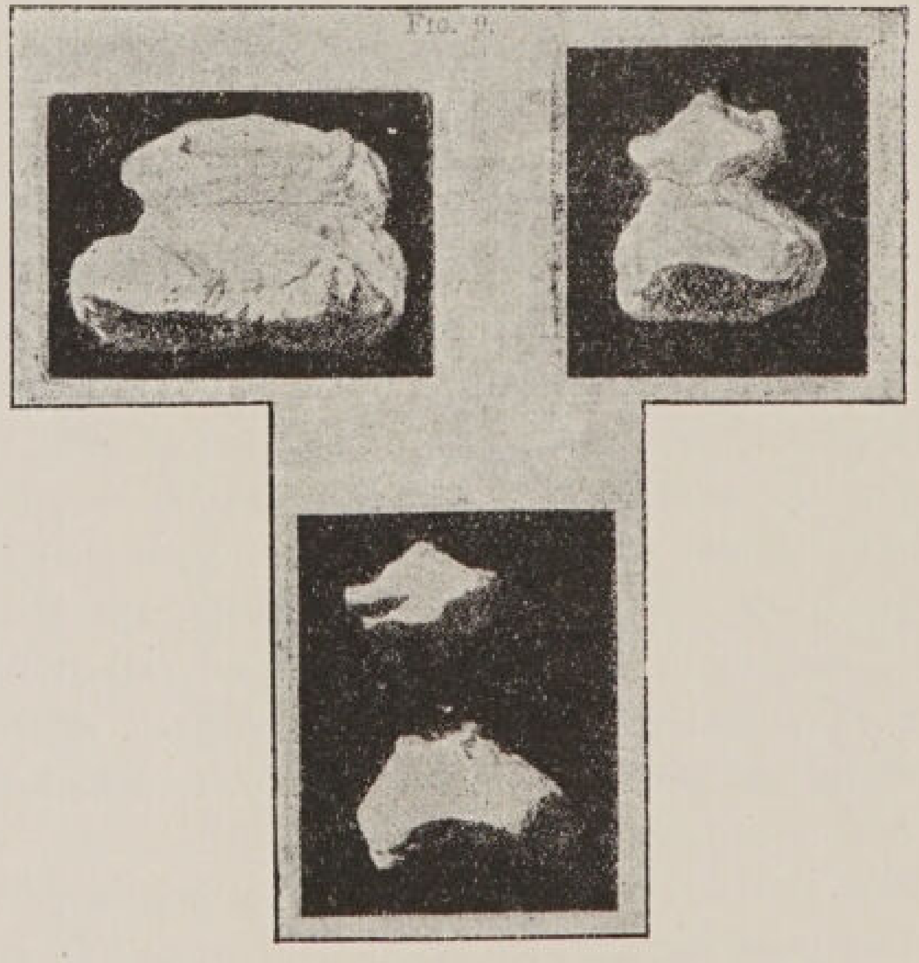
To make a velum on Case's model, it is necessary to take the exact impression of the buccal and nasal surfaces of the fissure. To get good impressions the author advises the following methods:

"(1) Make a base of moulded composition on which plaster is spread. (2) Use plaster only.

"For the first of the above methods, we smother the index-finger with composition and press it gently into position. By removing, softening, and if necessary reshaping this composition, and removing the excess several times, we finally obtain with this modelling composition an impression which does not dislocate the soft posterior margins, and which supports perfectly the plaster for the final impression.

"The palatine surface is then arranged in such a way that the plaster adheres to it, and any composition which spreads above the nearest borders of the fissures is cut, and the trimmed surface is joined and oiled.

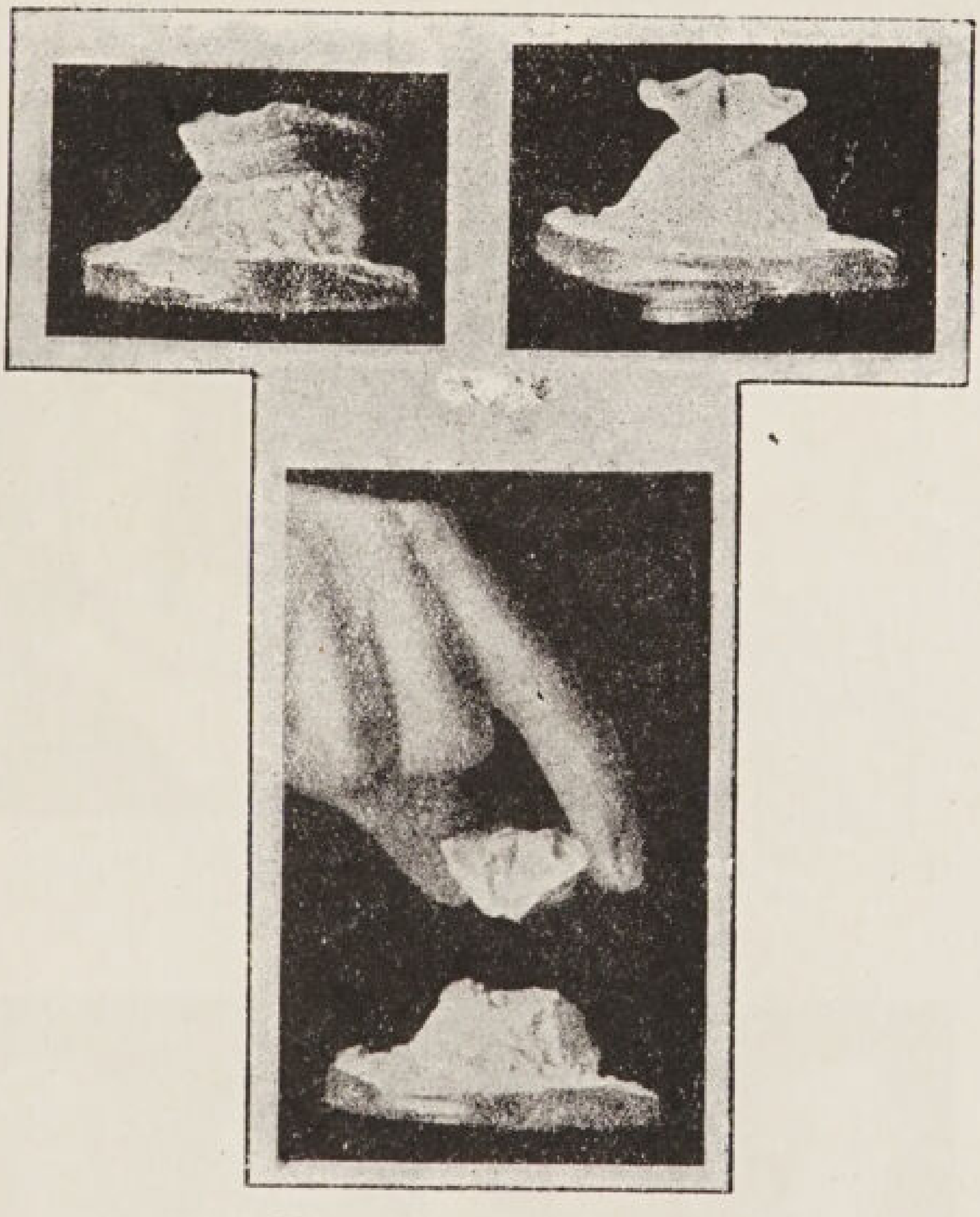
"When the mass has settled down in position with the plaster, we need not apprehend difficulty in removing it, even though the plaster be in excess, provided that it does not encroach forwards over the alveolar border in extensive double fissures. For the whole of that part which extends above the edge of the fissures, and takes the impression of the nasal fossæ, will come away easily from the smooth and oiled surface of the composition when the impression is removed. In fact, there is nothing else to hold



FIGS. 47 AND 48.—Different Views of the Plaster Impression of an Extensive Fissure. (Calvin Case.)

it to the lower parts, when the composition forms a complete bridge between the fissures and their most neighbouring borders.

"The nasal section can then be pressed back towards the most open part of the fissures, and we can let it fall on to a dental mirror, and then replace it on the impression. Ordinarily I prefer simple plaster, assembled in parts as above, at the margins of the cleft."*



FIGS. 49 AND 50.—Impression in Plaster and Composition. (Calvin Case.)

First of all we make the part which is hollowed out gutterwise, and should enclose the borders of the

* Calvin Case, "Mechanical Treatment of Congenital Fissures of the Palatine Vault" (Cong. dent. internat., Saint-Louis, Août, 1904; *Odontologie*, 30 Oct., 1905).

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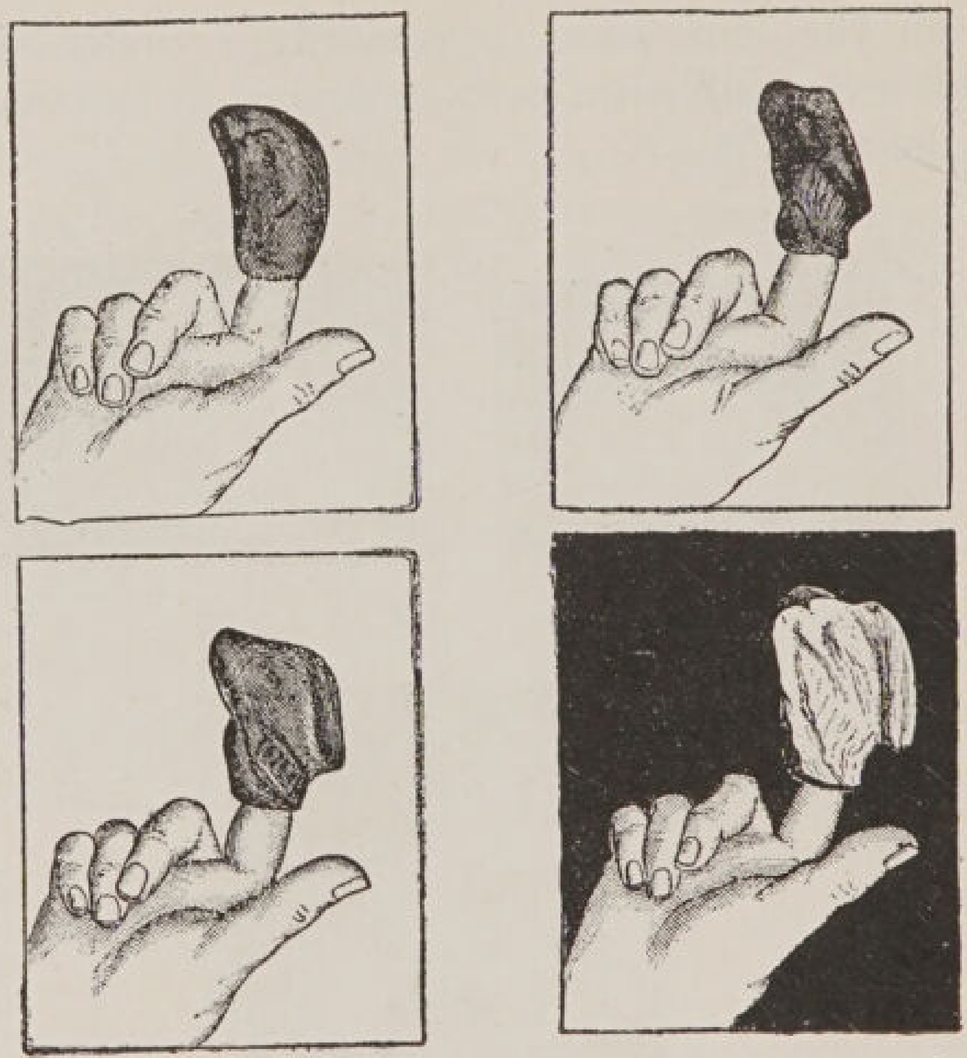


FIG. 51.—Different Stages in taking the Impression. (Calvin Case.)

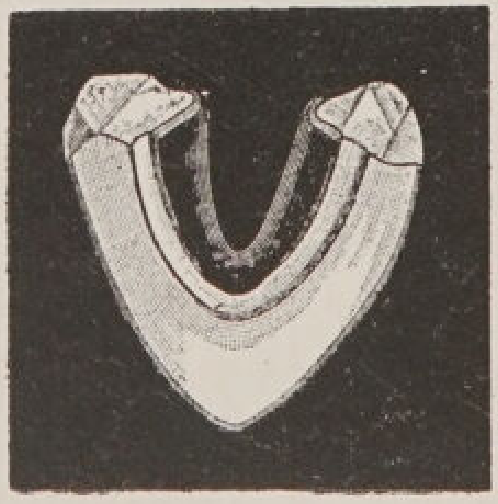


FIG. 52.—Buccal Aspect of the Finished Model. (Calvin Case.)

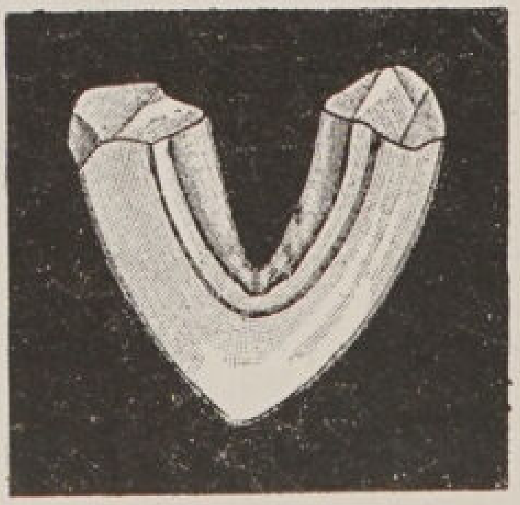
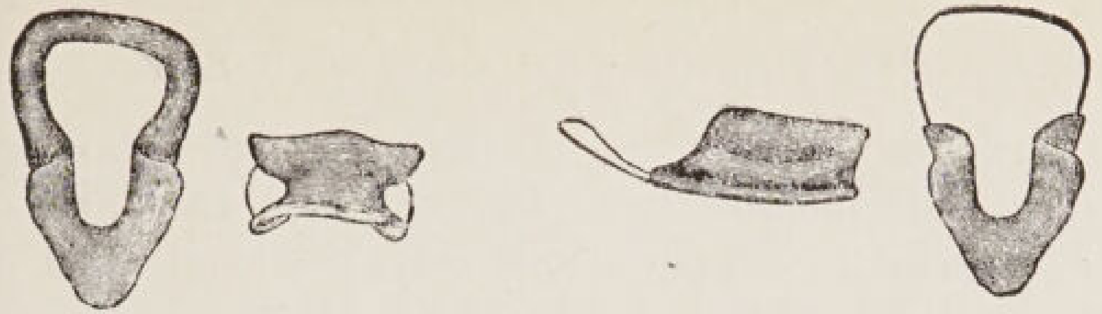


FIG. 53.—Nasal View. (Calvin Case.)



FIGS. 54 AND 55.—Arrangement of the Metal Wire which is to serve as Support for the Composition for an Impression of the Contracted Pharynx.

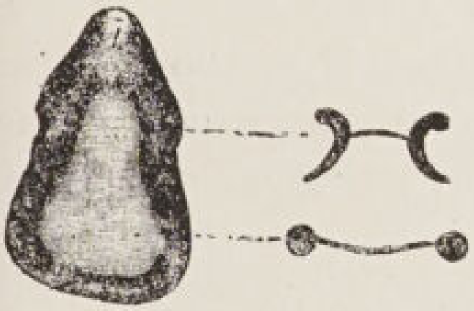


FIG. 56.—Lingual Aspect and Transverse Section of Case's Appliance.

FIG. 57.—Longitudinal Sections.

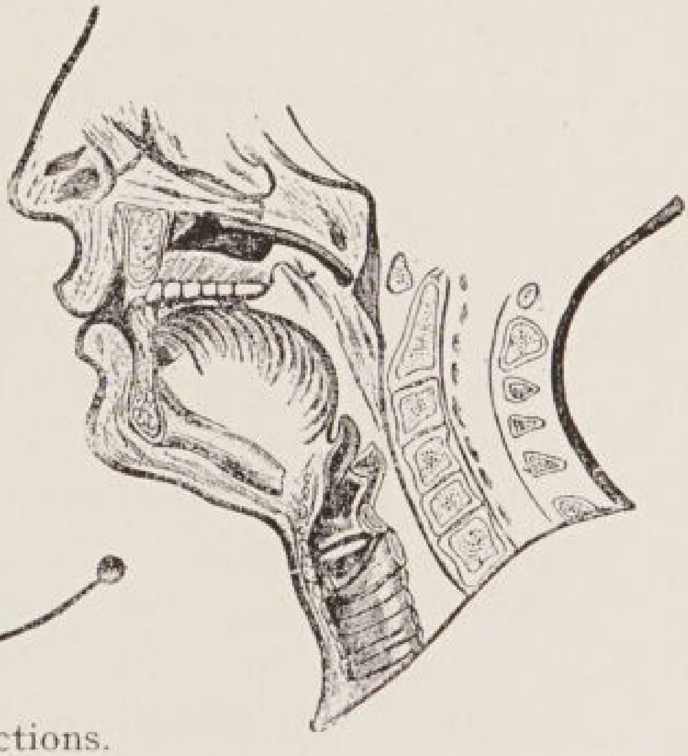


FIG. 58.—Relations of the Appliance to the Pharynx.

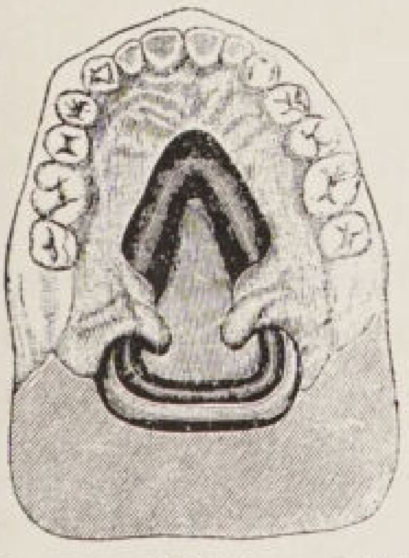


FIG. 59.—Relations of the Appliance to the Stumps of the Velum.

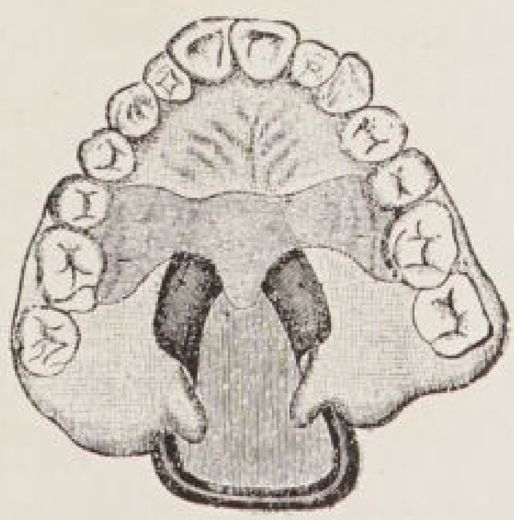


FIG. 60.—Palatine Plate of Support.

(Calvin Case.)

palatal fissure. At the posterior part of this piece we fit two metallic tubes into which fit the limbs of a copper wire staple. This staple is lengthened or shortened until it makes contact with the pharyngeal walls. "Having adjusted the wire to mark the desired lines of the velum, a roll of composition can be attached to the staple, following the contours of the peripheral surface. It is placed warm in the mouth, and we direct the patient to swallow; after a few swallows this gives a perfect impression of the outer margin of the zone which we want, when the muscles are contracted" (Case).

*Artificial Velum of Norman W. Kingsley.**—This appliance consists of two valves, made of soft rubber, joined in the mid-line. The lower valve is a velum; it covers the buccal margin of the fissure. Its usual shape is triangular. The most acute of its angles closes the apex of the fissure, and its base is placed across the uvula. The valve is superposed on the soft parts, which restrain it in so far that it cannot be thrown up, across the fissure, into the higher (naso-pharyngeal) space. The upper valve is meant to close off the pharyngeal cavity. Like the former one, it is triangular, but its base extends farther back so as to touch the pharyngeal wall (Fig. 61).

This upper valve rests with its nasal surface on the palatal fissure. It is not attached to the lower valve, save along the middle line. Thus, between the two there exists a gutter in which the margins of

* B. Ottolengui, "On Palatine Fissures": "American Textbook of Prosthetic Dentistry," Philadelphia, 1907 (*Laboratoire*, 4 Août, 1907).

the fissure fit, as in the velum of Calvin Case. The anterior extremity of this double valve is fixed, by means of a metal button, to a palatine plate; this, again, is kept in place by hooks which encircle the teeth. The manufacture of this whole contrivance requires very accurate impressions of both aspects of the margins of the fissure. They can be taken

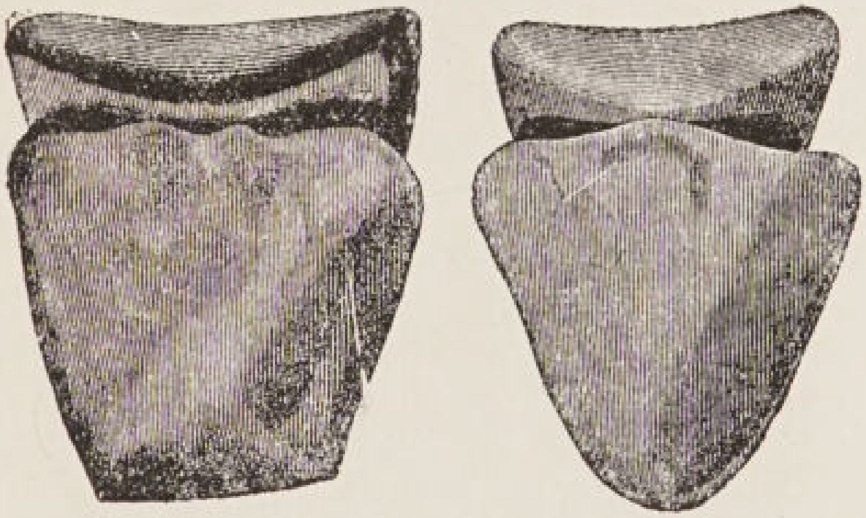


FIG. 61.—Norman Kingsley's Velum.

by the method recommended by Calvin Case (Figs. 51 to 53).

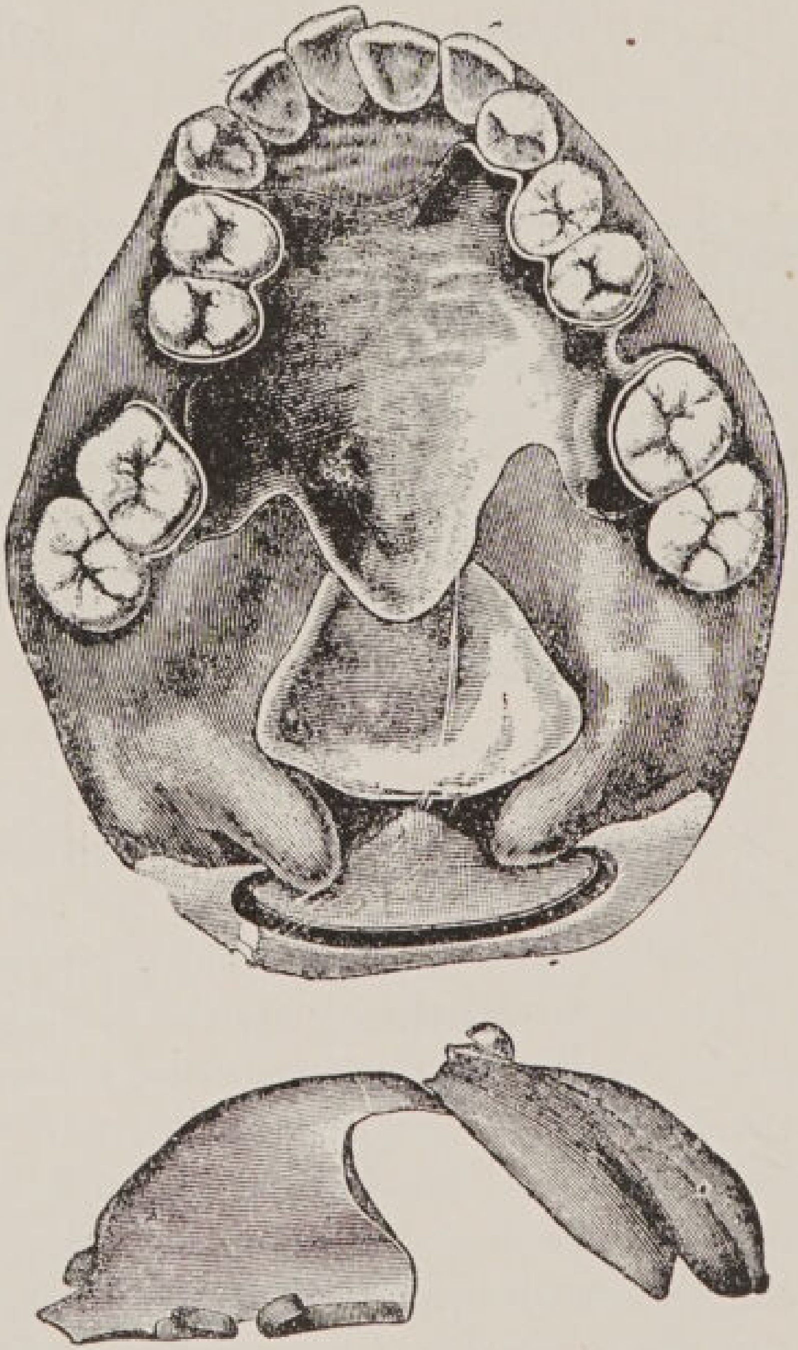
Suersen's Obturator.—In 1877 Suersen* made an entirely original contrivance, which at that time amounted to a veritable revolution in the matter of velo-palatine prosthesis (Fig. 64).

The point of this is that he was less bent upon reconstituting the velum, but strove only to restore function by insuring the occlusion of the naso-pharynx.

To attain this occlusion, he availed himself of the pad which the superior constrictor forms on the

* Suersen, "On Defects of the Palate." A work extracted from the "Treatise on Operative Dentistry," by Robert Baume, Leipzig, 1877, édition of Arthur Félix.

posterior pharyngeal wall. The appliance used for this purpose was a single rigid piece. The front part covered the palatine vault; the back part filled the



FIGS. 62 AND 63.—Norman Kingsley's Velum.

whole width of the post-nasal space. The superior constrictor applied itself to the posterior edge of the pharyngeal part, thus attaining the occlusion of the naso-pharynx. When the muscle is at rest, there remains enough of a slit to assure the passage of air for breathing. The stumps of the velum no longer have to play any part; the constrictor by itself takes charge, and, at the moment of pronouncing any letters of the alphabet, compels the column of air to pass via the mouth.

Suersen's appliance is made of hard rubber. First one must make the palatine piece, then with some gutta-percha take the impression of the pharynx. For that, one arranges behind the palatine piece a

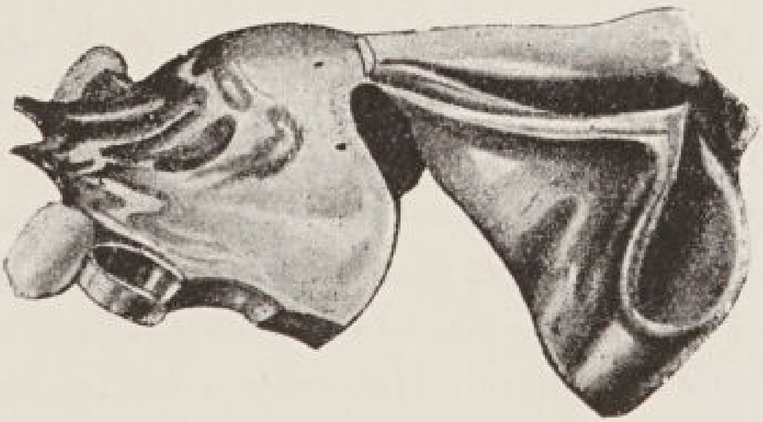


FIG. 64.—Suersen's Obturator.

lump of gutta-percha, softened, filling the greater part of the post-nasal space. Taking advantage of the short time that the gutta remains soft, one makes the patient speak and swallow, thus obtaining the imprint of the various muscular projections of the region. The cooled and hardened gutta is pulled out for the excess material to be removed, then put back in place and worn by the patient for forty-eight hours. At the end of this time the impression, which is equally the rough model of the appliance, has become ready to a nicety, and all that remains is to make with its help the hard rubber piece. Excepting the impression-taking, which is a delicate business, Suersen's appliance is, as we see, easy to make, because of its utter simplicity.

Third Apparatus of Martin.—Suersen's apparatus is only able to help a person to whom has been vouchsafed a superior constrictor powerful enough to form, in contraction, a pad able to shut off the naso-pharynx. But the pad does not always exist; in fact, it seems to be very underdeveloped in our country—too much so, according to Cl. Martin, for us to use Suersen's contrivance. Cl. Martin, despite having examined a host of patients, only found this pad once, and that was in a patient wearing a Brugger's appliance.

"This disparity in our observations is explicable," he says, "by the very characteristics of the patient's national tongue. German is essentially guttural, and the pharyngeal muscles take an important part in uttering almost all sounds; so it is easy to understand the hypertrophy of these muscles. On the contrary, French is very soft; I will even assert that the guttural consonants in French take on a more mellow pronunciation. Maybe that is the reason which has led us to look for lighter and more movable appliances."*

It is in virtue of these ideas that Cl. Martin has simplified his trap-door obturator by reducing it to a completely rigid appliance, in the same way as Suersen's. But this appliance, "instead of ending behind in a cubical mass, carries here a simple 2 mm.

* Cl. Martin, Cong. Madrid, p. 48.

sheet of rubber, which makes contact with the pharyngeal wall at the level of the superior constrictor. This plate, where it leaves the hard palate, passes above the stumps of the velum, and expands to the full width of the floor of the nasal fossæ. Thus it prevents the current of respired air from passing into the nasal cavity. Fairly thick in front, where it fills part of the nasal fossæ, it thins out as it passes backwards; and its posterior edge ends in a thin sheet of soft rubber, which is brought to bear on the pharyngeal wall. The stumps of the velum, instead of gliding on to the sides of the appliance, as in Suersen's, lie slack on its under-surface. The apparatus is first of all put in position for eight or ten days. Owing to its construction, the air is obliged to pass entirely by the mouth, thanks to which, at the end of forty-eight hours, the patient begins to talk fairly well. The voice is very pure, but has the timbre which one gets by closing the nostrils."

When the velum stumps are sufficiently used to the contact of the appliance, we hollow grooves out of the latter at the level of the points where the stumps will impinge during their contractions. These grooves are prolonged as far as the nasal fossæ in such fashion as to allow the patient gentle nasal respiration. After another trial of a fortnight, we increase the depth of these grooves which lodge the velum stumps. Thus we provide for the air current a sufficient passage to re-establish nasal respiration of full amplitude.

At the moment of contraction of the velum, the stumps impinge in the groove and close off all communication with the nasal fossæ. The results obtained by Martin with this latest obturator have been remarkable.

With this apparatus Martin endeavoured to restore their physiological functions to the stumps, by giving them a *point d'appui*. "The direct use of these stumps," he says, "in the production of sound gives to it a softer and more natural quality. It is no longer the appliance which vibrates to and fro in front of the muscle, but the muscle which keeps its normal play and simply takes its support from the appliance. In a very short time the muscles succeed in executing wonderfully their new function. Thus by a similar evolution of thought I have arrived at practically the same results as Suersen. The essential difierence between his appliances and mine lies in this, that, instead of using the pharyngeal muscles as an active occluding agent, I use the muscles of the velum. In each apparatus, Suersen's and mine, the type is indicated by the language spoken by the patient. It is highly probable that in Germany my contrivance will render less service than will Suersen's; conversely, Suersen's gives a poorer result among patients who converse in French. But, from the fact that they allow a free muscular play, which can only help their development, the result can only ameliorate in the long-run; for the patient is using muscular mechanisms which grow and grow in strength."

III. Prosthetic Intervention after Staphylorrhaphy.

We have seen in an earlier chapter that scar tissue tends perpetually to retract, but that gentle and continuous pressure succeeds fairly easily in correcting this retractility.

After a velo-palatine restoration by staphylorrhaphy, we see as a rule a certain shortening of the remade velum, due to cicatricial retraction. Occasionally this retraction is such that some functional disability persists by reason of the undue shortness of the velum. To generalize, one may say that after staphylorrhaphy the velum is too short, too tense, and made rigid by cicatricial tissue.

Many authors have tried by prosthetic means to cure such happenings, which rob the patient of much of the benefit that he ought to extract from the surgical procedure which he has undergone.

Schiltsky's Appliance.—This is inspired by Suersen's principle, and intended to remedy the shortness of the velum which is often apparent in the train of a staphylorrhaphy. This appliance, instead of being all in one piece, is divided into two parts: a palatine plate and a pharyngeal block, joined only by a metallic spring which can move on the anterior surface of the repaired velum. Thus, the pharyngeal block comes to rest between the posterior surface of the velum and the pharyngeal wall. The palatine piece is made of hard rubber. The impression of the pharynx is taken according to Suersen's process; and the pharyngeal block is made by Schiltsky in gum elastic, so as to be slightly compressible. This substance having the disadvantage of changing very quickly, it would be preferable to use soft vulcanized rubber (Fig. 65).

Method of Krouschoff.—Krouschoff,* in 1885, was the first to think of making supple the velum (created by staphylorrhaphy) by applying pressure with an arrangement formed as follows: A palatine plate in hard rubber carries a prolongation covering the lower surface of the restored velum. A spring keeps this

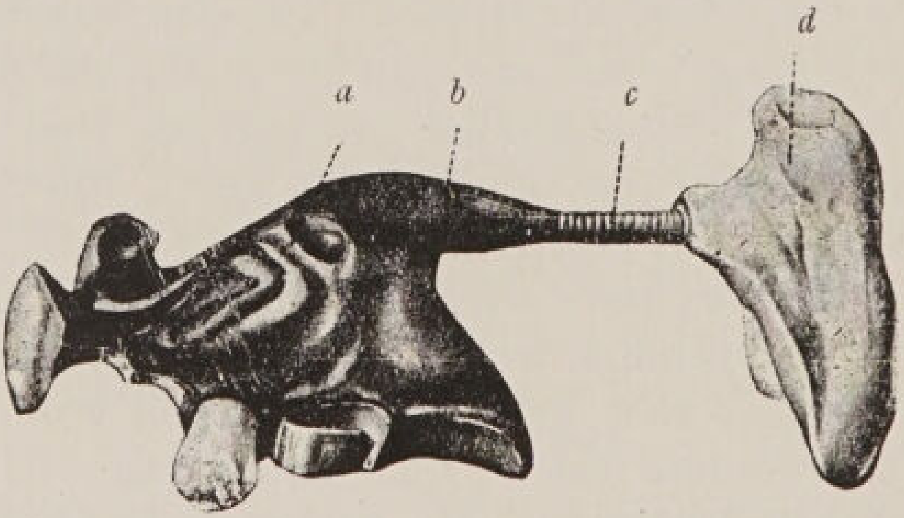


FIG. 65.—Schiltsky's Obturator.

prolongation on the velum, thus exercising a continuous pressure sufficient to obtain its lengthening.

Method of Brugger.—Later Brugger† replaced the continuous pressure by massage, carried out several times daily for some minutes. After the lapse of a certain time the velum gets soft and elongated

* Krouschoff, "Treatment of Palatine Fissures and Perforations by a New Method: Staphylorrhaphy-Uranoplasty and Obturators," St. Petersburg, 1885.

† Brugger, "Treatment of Palatine Fissures: Prosthesis with a Core of Cork," Leipzig, 1895.

enough to raise itself naturally. At the outset the patient wears an appliance of Schiltsky or that of Brugger himself, which differs from the former in that the pharyngeal piece, instead of being in gum elastic, is made of a core of cork surrounded by soft vulcanized rubber. In proportion as the velum, under the influence of the massage, lengthens and becomes supple, Brugger reduces the thickness of the pharyngeal appliance, and occasionally arrives at its complete suppression (Figs. 66 to 71). We do not

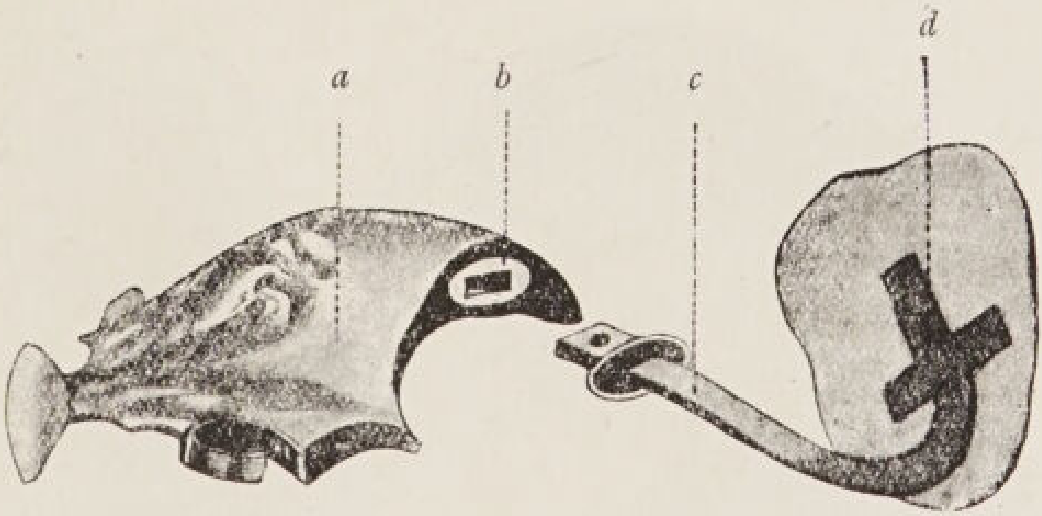


FIG. 66.—Brugger's Obturator.

know enough as to the value of massage to remedy the shortness of the cicatricial velum. One of us has demonstrated, on a patient, an elongation of 10 mm.; this was in five months of massage helped by orthophonic exercises.

Massage is the necessary complement of staphylorrhaphy. But that is an axiom that is unfortunately not generally known.

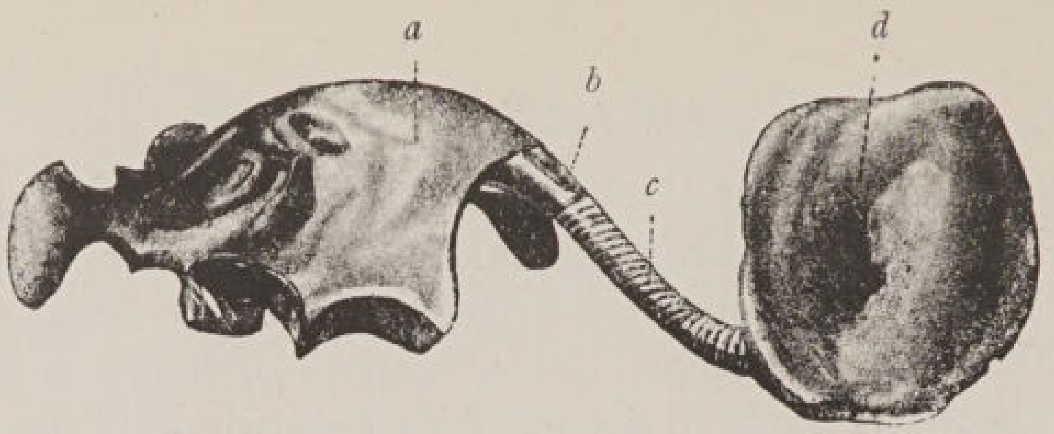


FIG. 67.—Brugger's Obturator complete.
a, Palatine plate; *b*, spring; *c*, rubber sheath protecting the spring; *d*, obturating part.

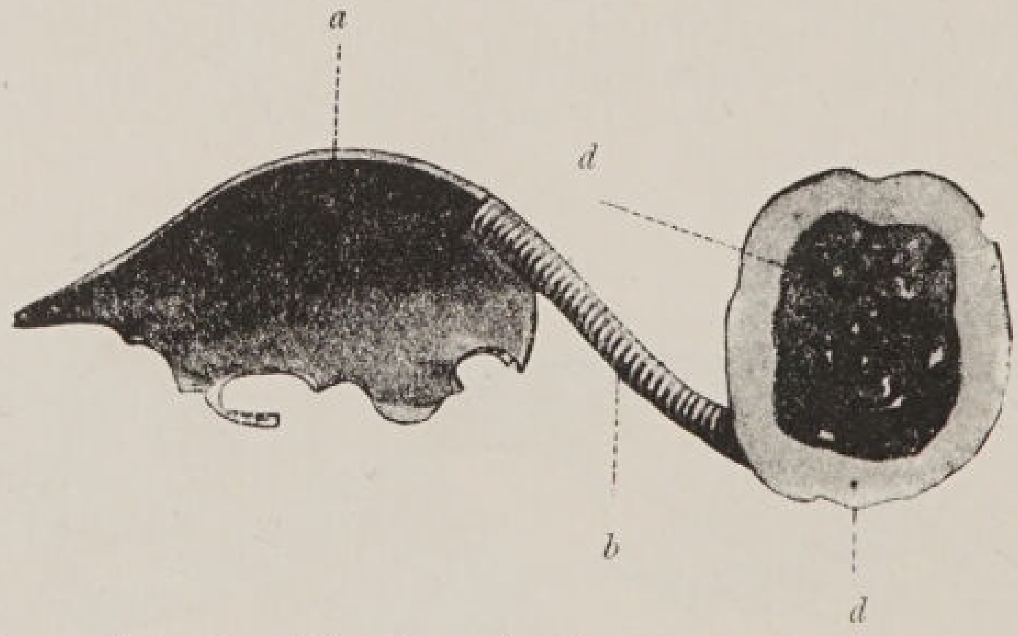


FIG. 68.—The Same in Transverse Section.

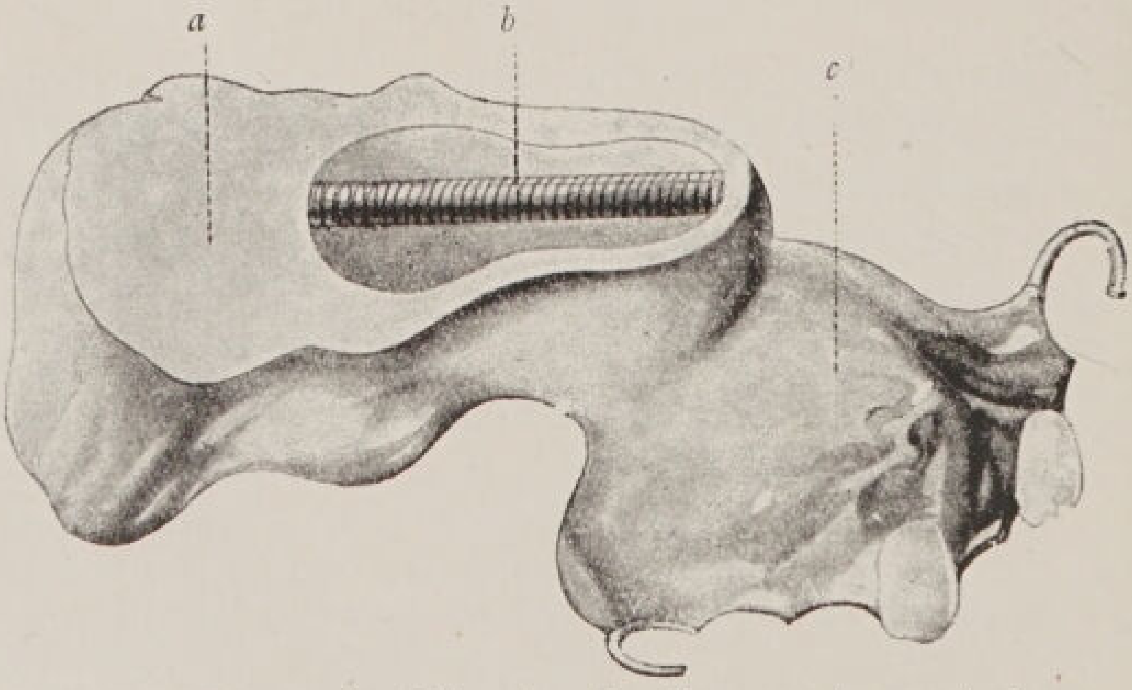


FIG. 69.—Brugger's Obturator for Cases not operated on.

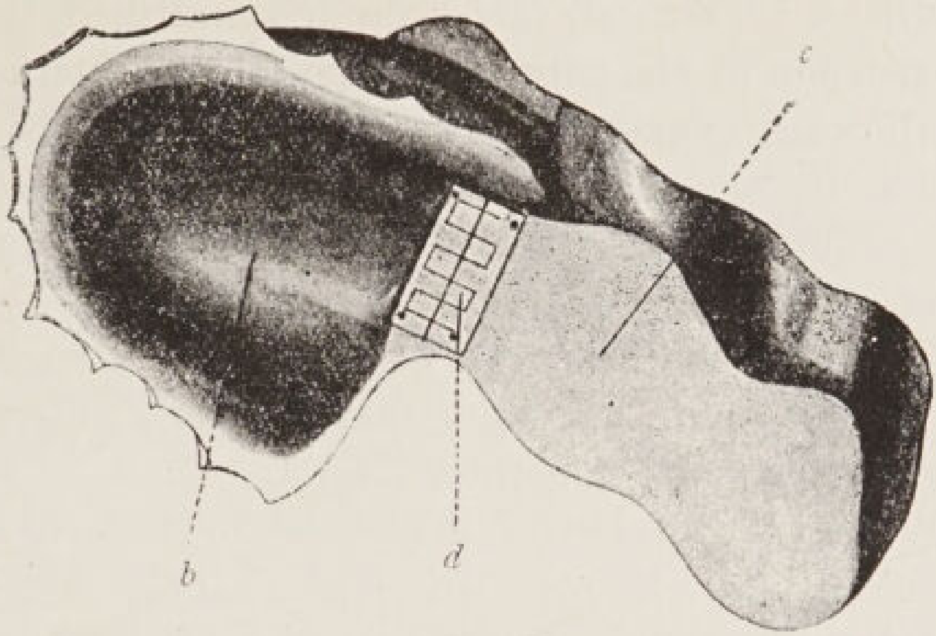


FIG. 70.—Brugger's Obturator for Cases not operated on.

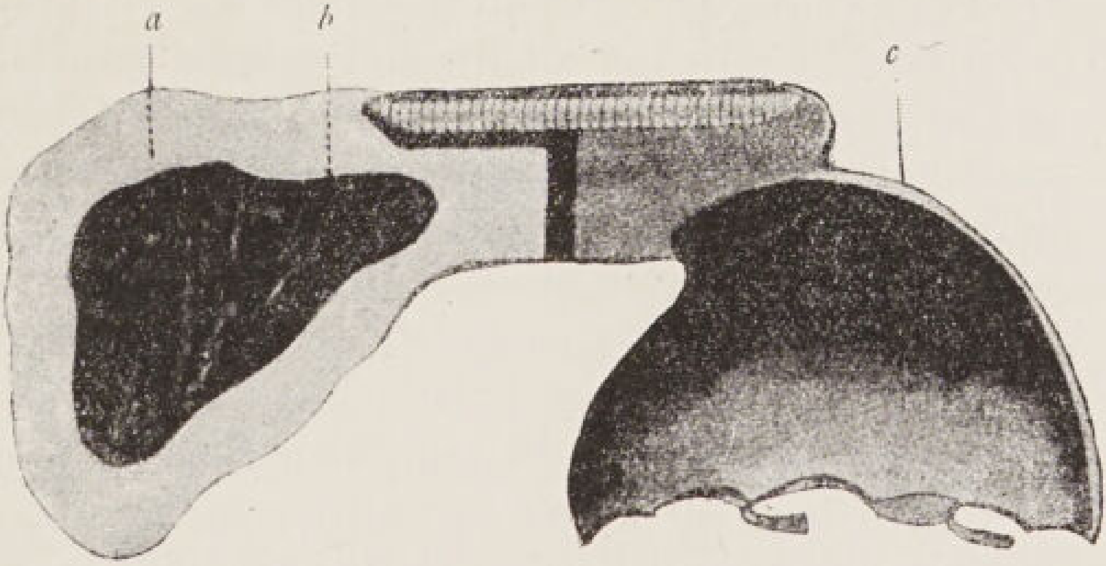


FIG. 71.—The Same in Longitudinal Section.
a, Rubber outer covering; *b*, core of cork; *c*, plate; *d*, intermediate part.

IV. Obturators enabling Newly-born Children, afflicted with Labial or Palatine Fissures, to be suckled.

The mortality of nurslings suffering from congenital fissure of lip and palate is much raised owing to the difficulty of feeding them. Suckling at the mother's breast can never be accomplished, because prehension of the nipple is impossible. Suction and swallowing cannot be effected, and the milk is rejected by the nares. To nourish these infants, we are reduced to the use of either a small spoon, a long pharyngeal teat, or a stomach-tube. Under such faulty conditions of alimentation, the majority of these infants succumb rapidly, most often from the sequelæ of gastro-enteritis.

Warnekros of Berlin made the first appliance to enable these infants to suck. This appliance, wonderfully simple, has given him the best results. He uses as an impression tray a small spoon, and covers its convexity with a little Stent's. The whole is introduced into the mouth and pressed gradually against the vault. As soon as he has cast the impression in plaster, he makes the appliance by pressing on to the model a leaf of wax, covering all the palatine region. At the front of this plate is fixed a wire loop. The whole is flasked. The wax is replaced by rubber, and there we have a small apparatus in vulcanite. It closes the palatine fissure, and presents in front a loop by which we can introduce and remove it, and hold it in place during sucking.

One can make, to facilitate sucking, two appliances, similar except that the metal loop is to the right of the mid-line in one, to the left in the other. This arrangement is useful to enable the mother to hold the appliance during suckling at the right and left breasts. Naturally, the appliance is removed during the interval between feeds.

The feeding of the infant may thus be well carried

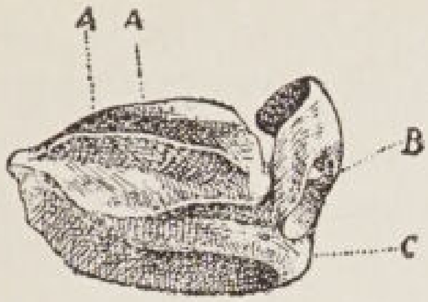


FIG. 72.—Martin's Appliance.

A, Soft rubber cushions which grip the septum; B, retention-plate which rests on the premaxilla; C, artificial lip in soft rubber, hollow, filled with water.

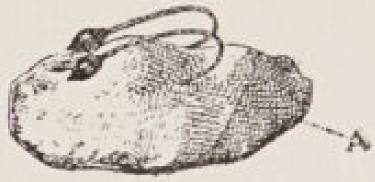


FIG. 73.—Martin's Appliance: Springs passing into the Nares.

A, Soft rubber velum.

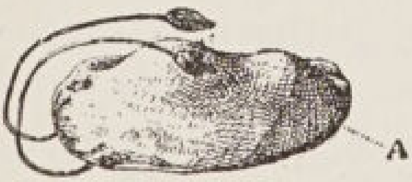


FIG. 74. — Spring passing through the Palatal Fissure.

A, Soft rubber velum.

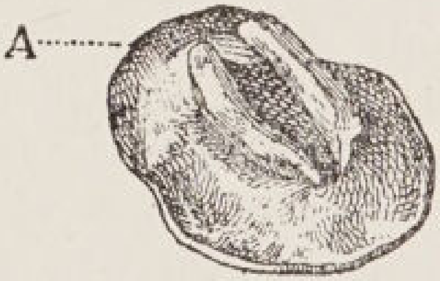


FIG. 75.—Fixation by Soft Rubber Pads which take their Support from the Upper Surface of the Bony Margins of the Palatine Fissure.

A, Soft rubber velum.

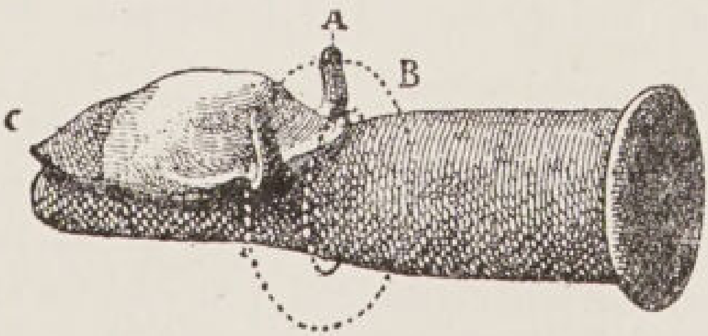


FIG. 76.—Teat with Obturating Palatine Plate.

A, Prolongations to prevent the backward displacement of the teat; B, ivory ring which may if desired replace the prolongations A; C, palatine plate in soft rubber.

out, thanks to the palatine plate giving a *point d'appui* for suction and preventing reflux by the nose.

Cl. and Fr. Martin have made some appliances for the same purpose, but they have sought to obtain their retention by taking a *point d'appui* from the margins of the fissure and the walls of the nasal fossæ. They recommend the use of plates of hard rubber to cover the vault, and soft rubber in the region corresponding to the split velum. This pliable part of the obturator is thus able to receive, from the stumps of the natural velum, light movements, helping a little to facilitate suction. The appliance is kept in place by means of two gold wires fixed from the fore part of the palatine piece. From there these wires pass out of the mouth, describing a curve to encircle the upper lip, and their free end enters the nasal fossæ by the nares.

Each of these wires carries at its end a small soft rubber olive, 4 or 5 mm. in diameter; these increase the surface of contact and make the pressure more gentle. Thus they constitute two springs which exercise a very light pressure on the floor of the nasal fossæ, and so keep the plate snug against the vault.

"Moreover, this mode of retention can be modified," say the brothers Martin, "to suit the varieties and degree of the deformity. Thus, when the palatine vault itself is fissured, one can fix the springs on the upper surface of the appliance, and direct them forwards through the fissure. In another case, when the alveolar margin itself is cleft, one can put pads at the margin of the fissure; and the upper surfaces of these pads take the pressure of the springs. Lastly, in some cases, one will be able to take a *point d'appui* from soft rubber appendages, which grip either the septum itself or the premaxilla, or the borders of the fissure when these make a sufficiently sharp projection.

"Thus the mode of retention can vary according to the anatomical condition existing in each particular case."*

When it is necessary to re-establish the continuity of the upper lip, Martin has shown that it is feasible to add to the palatine piece a hollow soft rubber artificial lip, filled with water, supple enough to fit perfectly on to the lower lip.

The use of these prostheses is only of absorbing interest when the child can be fed at the breast of its mother or a nurse. When it can only feed from a bottle, Martin adapts to the upper part of the teat a vulcanized rubber plate, slightly softened, having approximately the form of the palatal vault. This plate provides a sufficient closure of the nasal fossæ, and a solid purchase for the tongue during the attempt to suck. It is well that the part of this plate which corresponds to the velum should be of soft rubber, for the reasons shown above. Delair also has made a false velum for the newly-born with fissures; but his contrivance is more complicated than Martin's.†

* Cl. and Fr. Martin, "Labio-Palatine Prosthesis permitting Suction to the New-born afflicted with Cleft Palate and Hare-Lip" (1er Cong. de stomatol., Paris, Août, 1907; *Laboratoire*, 3 Nov., 1907).

† Delair, "Artificial Velum for the New-born" (Congrès dent. national, Cherbourg, 1904).

It is essentially composed of two parts. One, the upper piece, comprises a palatine plate, prolonged backwards, without a joint, into a soft rubber velum; and the other, lower piece is applied to the alveolar border of the mandible. The surface of these pieces which lies against the mucosa is of soft rubber; they have an artificial alveolar margin of hard rubber. Some bilateral springs join the upper to the lower part, and thus is constituted a mode of retention entirely similar to that in use in certain cases for complete upper and lower dentures.

V. Conclusions.

What conclusions ought we to draw from this study of velo-palatine restorations?

Staphylorrhaphy evidently constitutes the best solution of the problem. But it is not always possible, nor is it applicable at all ages. Surgeons are agreed in declaring all intervention at the level of the velum contra-indicated before the age of six to eight years. Nevertheless, Brophy* interferes a few days after birth, but his very special mode of operation, still much under discussion, has not come into common practice.

Now, prosthetic interference is useful, in the majority of cases, a few days after birth; apropos of this we have seen some appliances invented by Warnekros, Cl. Martin, Delair, to facilitate suckling for infants afflicted with hare-lip. When the patient

* Brophy, Cong. dent. internat., 1900; *vide* also the general review of the question by Lenormant (*Presse Méd.*, 28 Févr., 1914, p. 167).

reaches an age propitious for intervention, staphylorrhaphy will be performed. At this stage, again, the prosthesist can give the surgeon invaluable help. It occurs, as a fact, in certain cases, that the velo-palatine cleft is considerable; and that the borders, too far separated, do not allow of finding in the neighbouring mucosa enough material to close the fissure and make a good junction of flaps. In the same way, sometimes in hare-lip the premaxilla projects forwards, pushing out the lip and interrupting the dental arch. A. Ducourneau has reduced the incisor bud with the help of elastic traction, applied through the medium of an orthodontal apparatus on a principle analogous to that applied every day for misplaced incisors. He has shown how this prosthetic intervention, in reducing a skeletal deformity, facilitates the surgeon's task.

One of us, inspired by the same ideas, has utilized the following apparatus to allow of surgical interference in a case of too great spreading of the margins of a velo-palatine fissure. It occurred in an infant who had been operated on by his professor, M. Sébileau.

Some metal caps are sealed on to the upper molars of each side. They are joined transversely by a strand of rubber, and the elastic traction of this without delay brings together the two maxillæ, thus reducing the intervening cleft. It is even possible to bring the edges of the palatal fissure entirely into contact. When the surgeon deems the reduction sufficient, he operates on the patient and the appliance is removed. Subsequently the two maxillæ separate anew, and the interdental articulation, temporarily deranged, becomes spontaneously restored; but thanks to the staphylorrhaphy the fissure remains closed. The elasticity which is peculiar to scar tissue lends itself easily to this unaided stretching.

Such is the rôle of the dentist before staphylorrhaphy. As regards after the operation, we know how useful it can be in the event of cicatricial shortness of the velum (Brugger, Schiltsky, Krouschoff); and we have shown the indispensable part played by massage, or by the lengthening appliances which supplement massage by their more continuous action.

Lastly, when we are dealing with an intractable infant whom it will be impossible to keep silent, operation may eventuate in catastrophe. The wires cut through the mucosa, the stitches loosen gradually, and the patient recovers with a fissure larger than before the surgical interference. The stumps of soft palate, jagged and retracted, have now lost, owing to scar tissue, their mobility, and perchance there is not enough material of the neighbouring mucosa left over to justify operating anew. In such an event, and in another fairly frequent, where an adult patient refuses any surgical intervention, it falls to the dentist to treat the infirmity of the invalid by prosthetic means. Among the legion of false vela and obturators which have been devised, what is the apparatus of choice ?

One should turn to the most simple, and never lose the point of view that anatomical reconstitution matters little, but solely functional restoration is of advantage. And above all it is wise to answer this question:

At what age should an obturator be fitted ?

According to Suersen, we must wait until the ninth or tenth year to be able to use as *point d'appui* the first permanent molars. Previous to this, the deciduous molars give no adequate support. Parkinson puts back the age to fourteen or sixteen years as favourable for applying apparatus. The prospects of success are so much the greater as the child is more developed and intelligent.

At a too tender age prostheses give less satisfaction as regards speech. But this does not apply from the point of view of feeding. The babies, not being irritated by their eating and drinking, feed normally, and one sees puny children develop in an amazing fashion. Speech cannot be ameliorated until later on, when the infant can be put through an orthophonic training.

The obturator of Cl. Martin or that of Suersen are the contrivances of choice. They are simple, very easy to make, inexpensive, and, above all, they can be altered by the orthophonist during the actual course of the patient's training. There we have a consideration too often neglected among people who have to decide on the choice of a suitable appliance. In fact, we must not forget that, from the point of view of functional results (at any rate, as far as speech is concerned), the rôle of surgeon or prosthetist has not the decisive importance which people are often pleased to accord them.

An infant is the victim of a congenital fissure of the soft palate. We operate; his velum is remade, but for that matter he speaks not much more correctly than before the operation. This velum made surgically is in very truth an artificial one. It does not escape the laws which govern all cicatricial tissue: it retracts and becomes shorter. This soft palate is admittedly restored in its anatomy, but not in its function; it is nothing but a fibrous sheet, robbed of suppleness and real mobility.

The patient operated on will not derive a true and complete benefit from the procedure unless he is placed in the hands of a competent orthophonist. This latter by frequently repeated massage will lengthen and make flexible the velum reconstructed by the surgeon. And he will teach the patient, by means of painstaking and progressive exercises of the pharyngeal muscles, to help himself to speak. Similarly, if for one reason or another we have declined against operation for a congenital cleft palate, the patient will not be enabled to speak merely because a prosthesist has fitted a false velum, no matter how ingenious and well thought out it be. An orthophonist will have to teach the invalid to make good use of the prosthesis which he has given him.

Now, exercises for the pharyngeal muscles and pillars stimulate their development, which is increased by the ridges made by these muscles beneath the mucosa. To such an extent does this occur that at the end of a few weeks, an obturator which at the outset exactly corresponded to neighbouring pharyngeal surroundings soon ceases to fit them properly. The orthophonist must be able to change this obturator in its pharyngeal part in proportion to the muscular development which is taking place in his subject. Thus, he should, for instance, with Suersen's appliance, now and again soften in warm water the gutta-percha ball which obstructs the pharynx, so that the pharyngeal muscles may be able to imprint on this ball the depressions, for ever growing deeper and deeper, which they make along its outer surface. When the education of the subject is finished, when his complete muscular development has been obtained, only then can one substitute for the gutta ball a final obturator of vulcanized rubber. Moreover, there again it is the orthophonist who decides as to when the prosthesist shall intervene; for the latter must only provide that instrument which the former orders and says shall be used. Lack of understanding of this indispensable collaboration has involved various handicaps, and is probably the cause responsible for the enormous multiplicity of divers types of apparatus. We blame the apparatus for not yielding results, we hunt for modifications, improvements, complications, meanwhile usually forgetting to teach the patient to use it.

"When an obturator has been placed with every possible care, and fulfils its purpose in perfect style; the subject who has never spoken speaks no better; on the contrary, his speech is often worse. It is necessary for the patient to undergo a special education, so that all the parts of the mouth come to get used to the contrivance; for we know that all the muscles of the soft parts co-ordinate in phonation and in the articulation of sounds. Now, they cannot suddenly execute movements which up to date they have never made" (Préterre).

This is equally true of persons who have undergone staphylorrhaphy. The methods in vogue at the present day for teaching the faculty of speech to the deaf and dumb render under such circumstances excellent service. But they are in use quite rarely in France for cleft vela, whether the subject has been operated on or wears an appliance. Abroad, notably in Germany and Switzerland, there is a real speciality of this nature; and a few schools for the deaf and dumb have classes entirely formed of patients operated on or wearing apparatus.

One of us has been able to demonstrate remarkable results thus obtained at the national institute for the deaf and dumb at Moudon (Switzerland). Phonetic training, according to the age of the subjects, lasts for from three to six months. It would seem that similar instruction could be obtained in our French deaf-and-dumb schools, if all surgeons and prosthesists, convinced of the paramount importance of this stage of treatment, systematically sent their patients, post-operative and wearers of appliances, to do their phonetic training there. As a fact, it is rarely that the prosthesist possesses simultaneously the time and the practical knowledge of orthophonia necessary to bring this education to a happy ending.*

* Delair, "Principles of Phonetics and Orthology" (Cong. dent. nat., Montauban, Août, 1902; *Odontol.*, 30 Juillet, 1902, p. 184).

CHAPTER IV

LARYNGEAL PROSTHESIS

BILLROTH was the first to practise total ablation of the larynx, and his pupil Gussenbauer invented the first artificial larynx which has been substituted for the organ removed. After him von Bruns, Foulès, Labbé and Cadier, and Julius Wolff, brought various improvements to bear on this special prosthesis. Aubry, instead of using the current of air expired by the lungs, availed himself of air expressed by means of a bulb compressed by the hand. Hochenegg used a bellows placed against the chest and pressed by the arm. Glück and Störk conducted the vibrations into the pharyngeal cavity by means of a long tube penetrating the nose or the mouth.

"From that time," says Cl. Martin, "these instruments were talking machines much more than true artificial larynxes, not conforming in principle and execution to the rules laid down by Gussenbauer."* The apparatus of Glück† consists of a rubber tube which fits by one end into the tracheal cannula, and by the other passes in by one of the nostrils, as far as the pharynx. The vibrating apparatus is put at the orifice of the cannula; it comprises a metal tube pierced by a window. The

* Cl. Martin, "On Artificial Larynges" (*Odontologie*, 30 Sept. et 15 Oct., 1902).

† Glück, "Total Extirpation of the Larynx, and the Use of Special Prostheses" (*Monatschr. für Ohrenheilk.*, t. xxxviii., No. 3, et Cong. internat. de laryngo-rhinologie, Vienne, 21-25 Avril, 1908; *Presse Méd.*, 6 Mai, 1908, p. 254).

window is closed by a very light valve. At the moment when the patient wants to speak, he adjusts the appliance on to the cannula. Inspiration lifts the valve and lets the air enter into the trachea, expiration closes the valve and the air is driven back into the tube; here it encounters a thin rubber band which makes it vibrate.

The sound produced is projected into the pharynx, where it is changed into articulate speech. "This external appliance," says M. Delair, "is able to render great service to those who wear tracheotomy-tubes, but the sound obtained is necessarily very feeble. Moreover, there are certain articulate sounds which, to be emitted into the cavity of buccal resonance, require the normal complete occlusion of the naso-pharynx. These are, however, now produced, on leaving the tube, in the back part of the nasal fossæ and in the maxillary antra, because the postero-superior surface of the velum, lying against the wall of the pharynx, opposes their passage into the buccal cavity. They have then a muffled timbre and are not very comprehensible."*

We owe it to Julius Wolff that, following von Bruns, he has brought some true improvements to bear on the construction of artificial larynxes. He has made it practically impossible for mucus and saliva to get into the apparatus, which allows it to work without interruption for an entire day. Wolff arrived at this result by closing the pharyngeal cannula with a sieve which resisted the passage of

* Delair, "Artificial Larynx and Glottis" (*Odontologie*, 15 Sept., 1904).

solid or viscous substances; but when at meals it was obligatory to block this cannula with a special cork, as in von Brun's appliance.

Michaëls' Artificial Larynx.*—The apparatus consists of three parts: a tracheal cannula, an œsophageal catheter, and two ensheathing tubes to hold them.

"The cannula has a diameter of 8 mm., and a length of 10 cm. On each side of its free end it carries two small metal cylinders, vertical and parallel, 1 cm. in diameter, 3 cm. long. The upper ends of these cylinders are open. Of the lower ends, the left is closed, the right has a lateral window by which the outer air can enter freely. Behind these small cylinders the cannula carries an expanded flange resembling that of the ordinary tracheotomy cannula; and the lateral wings of the flange are fenestrated for tying on the cords which are used to fix it behind the neck.

"The œsophageal catheter is of red rubber; it is largest at its upper end, of which the funnel-shaped mouth is 2 cm. in diameter; while the lower end, destined to be buried in the œsophagus, is a cylinder of 1 cm. diameter. Its total length is 30 cm.

"The third piece, which is likewise of rubber, is intended to join the first two and permit of their use. It is made so as to facilitate, on the one hand, the passage of air from the trachea into the nasal fossæ, and, on the other hand, the transit of fluids introduced into the mouth through the œsophageal catheter so as to reach the stomach. To fill this

* Michaëls, Congrès dentaire international de Nancy, Août, 1896.

double purpose by means of a single piece of apparatus, it was essential that this piece itself should possess two conduits, one for the passage of air, the other for the flow of liquids. Let us begin by describing the part which enables the tracheal air to arrive in the nasal fossæ. For this purpose, the lower part of the piece is made up of two rubber tubes, of which the lower ends engage by a joint which slides up and down in the upper half of the small cylinders placed each side of the tracheal cannula. By their other end they are firmly welded on each side of the larger tube, which we shall describe presently. These two rubber tubes are naturally more narrowed at their lower free end than at their upper fixed part. Since the lower ends are engaged for 2 cm. in the cylinders placed on each side of the cannula, it follows that in this way they are immovable, and that they in turn serve as a *point d'appui* for the piece on which they are grafted. The principal piece consists of a vertical cylinder 20 cm. long and 1·5 cm. in diameter, of which the lower conical end plunges into the œsophageal tube. The body of the latter carries on its anterior surface, above the point where the two small tubes previously described are fixed, a buttress 1 cm. square, whose upper end is obliquely bevelled.

"This principal vertical cylinder has inside it a tube of the same size as those which are coupled to its sides. This smaller tube, soldered along the posterior wall of the greater which contains it, is also itself vertical for the greater part of its length. Above, it projects 5 cm. from the outer tube. Below, the inner traverses the left side of the outer exactly at the level where the outer left lateral tube has

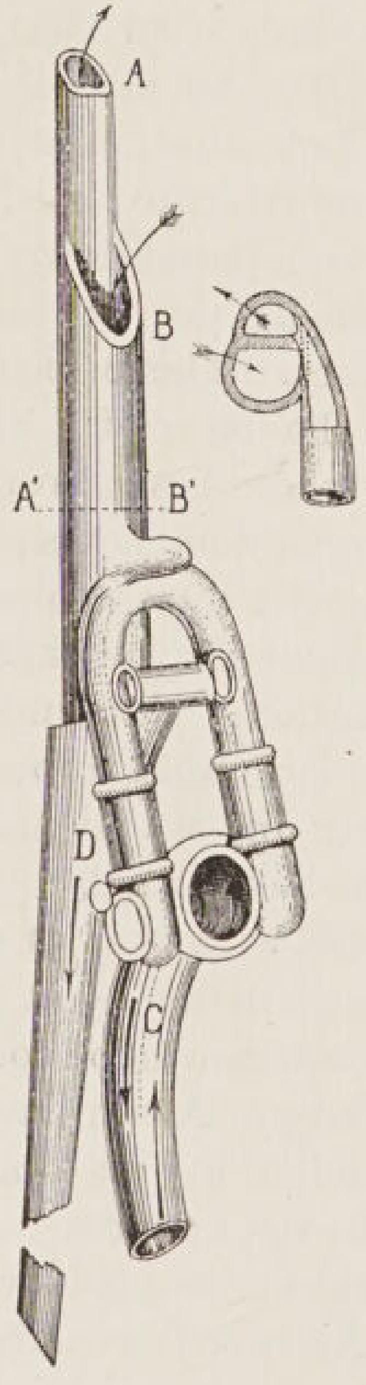


FIG. 77.—Artificial Larynx of Michaëls.

been grafted. Since the little tubes are grooved for their whole length, and continued uninterruptedly, it follows that they pass across the ensheathing outer tube; and that they serve to give passage to air from the trachea to the nasal fossæ, or *vice versa*. On the other hand, the large ensheathing tube is destined to allow fluids from the mouth to enter the œsophageal catheter. To insure the passage of air, it was necessary that the metal cylinder placed to the left of the cannula, into which the small rubber tube enters with an up-and-down motion, should be perforated, as well as the tracheal cannula at the level of their contact. This orifice of communication is oblong, with a diameter of 5 mm. In order that the bronchial air should penetrate the nasal fossæ, the tracheal opening has necessarily to be closed. This is easily achieved by a rubber valve.

"This arrangement of the apparatus allows the patient free respiration. But since, despite the large size of the tracheal cannula, bronchial mucus blown through may fill it up, M. Michaëls removed also a piece of the right-hand small cylinder, making its lumen communicate with that of the cannula. This communication was made by a round window on the outer and another window on the inner aspect of this little cylinder. Air enters at this level into the tracheal cannula, by pushing back a movable metal valve inside the cylinder. This valve, with a thickness of 1 mm., is fixed transversely in the right-hand cylinder. At rest it remains thus; during an inspiratory movement it is elevated. The opening of the large ensheathing tube corresponds very accurately to the base of the tongue and the level of the epiglottis, so that at the moment of swallowing liquids pass in without obstruction. The upper orifice of the ensheathed tube ascends the whole length of the posterior pharyngeal wall as far as the median septum of the nasal fossæ, in such a way that the mucus secreted by the latter, as also liquids from the mouth, cannot enter it. As for fluids coming from the bronchi, they exit at will by the anterior opening of the tracheal cannula, and are collected in a small rubber bag placed in front of it. This bag is itself provided with a special opening. In front this opening is tailed off like a movable tongue, and this serves to close the opening of the tracheal cannula during inspiration; whereas it allows itself to be bent open by the sputum which falls into the bag during efforts at spitting."

Artificial Larynx of Cl. Martin.—To Cl. Martin falls the honour of having devised a false larynx which acts continuously, and simultaneously allows the passage of liquids and mucus from the pharyngeal sound-box into the œsophagus.

The patient thus succeeds not only in speaking clearly, but also in drinking and eating with the appliance in place, and without having to pull out the sound-tube and plug the pharyngeal part. With a happy application to the larynx of his system of immediate prosthesis (already used with such success for the lower jaw), Cl. Martin fixes in the wound, soon after operating, a temporary appliance; the size of this is approximately that of the larynx removed.

This apparatus, as a sort of substitute for the larynx, resists cicatricial contraction during repair, and enables one to prevent the stenosis which is fatal

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to success. Thanks to this temporary appliance, which is a true "immediate prosthesis" of the larynx, one can preserve until healing is complete

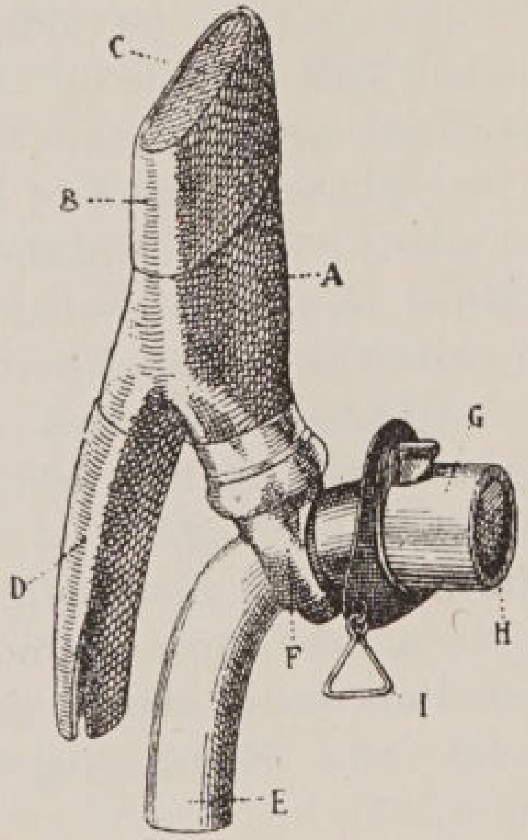


Fig. 78.—Martin's Apparatus.

A, Resonance box; B, terminal sleeve; C, wire gauze; D, œsophageal tube; E, tracheal cannula; F, bearing ring of the tracheal cannula and the false larynx; G, valve sleeve closing the front of the cannula; H, valve; I, fixation ring of the cannula.

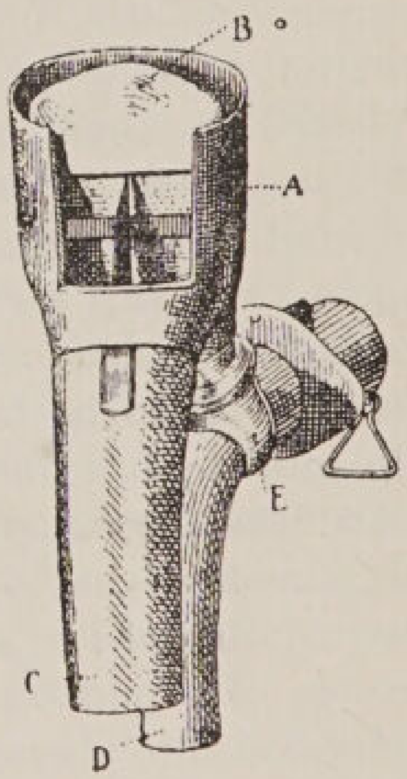


Fig. 79.—The Various Parts of the Apparatus assembled. (The terminal sleeve and the posterior plate have been removed.)

A, Resonance box; B, vibrating mouthpiece; C, œsophageal tube; D, tracheal cannula; E, bearing ring.

the necessary space for the final apparatus. This latter should only be substituted for the provisional one when the wound is completely epithelialized.

The artificial larynx of Cl. Martin, the first which really deserves this name, is comprised as follows:*

1. A tracheal cannula on which is fixed the sound-apparatus, by means of a ring pierced by the cannula.

2. The sound-apparatus, formed of three parts:

(*a*) A resonance box of nearly the same volume as the normal larynx, but flattened antero-posteriorly.

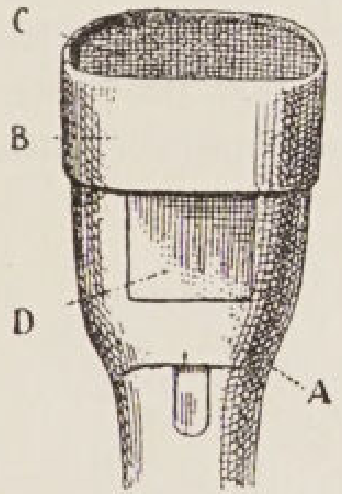


FIG. 80.—A, Resonance box seen from behind; B, sleeve which closes it at the top; C, wire gauze; D, posterior closing plate.

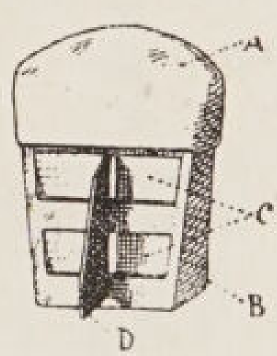


FIG. 81.—A, Vibrating mouthpiece; B, its metal support; C, rubber flaps forming a valve which opens during aspiration; D, fixation wing.

This box is covered on the top by fine wire gauze, to prevent the entrance of solid particles into the box.

(*b*) A vibrating mouthpiece mounted in a metal tube which is rectangular on section. This presents on its front and back surface rubber flaps, forming a valve, which opens during inspiration and closes during expiration. Thus the whole of the expired

* Cl. Martin, "On Artificial Larynges" (*Odontologie*, 30 Sept. et 15 Oct., 1902).

air current is compelled to pass into the vibrating mouthpiece. This consists of a thin rubber tube stretched transversely, and therefore flattened antero-posteriorly. Its upper lips limit a transverse slit, 25 mm. long, and they impart to the sound emitted great power.

(*c*) An œsophageal tube which leaves the posterior wall of the resonance box at its lowermost point and slopes downwards. The angle which at its origin it forms with the resonance box bestrides the tracheo-œsophageal spur, and so it passes into the œsophagus.

FIG. 82.—Rubber Sleeve shutting off the Larynx from Above and supporting the Wire Gauze B.

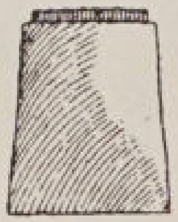


FIG. 83.—Closing Plate of the Posterior Face of the Outer Envelope of the Larynx.

[*Note by Translator.*—The tracheo-œsophageal spur is not a structure of normal anatomy. The author signifies the thickened transverse ridge which marks the uppermost limit of the remains of the party wall between œsophagus and air-passages. This represents the upper edge of the posterior surface of the trachea, if the cricoid cartilage has been removed. If not, it will be the scarred upper end of the cricoid.]

At its lower end this tube is cleft into a double beak, which forms a valve and resists the passage of fluids into the artificial larynx during regurgitation or vomiting.

A supple rubber collar encircles the pharyngeal part, and, fitting against neighbouring structures, prevents the stagnation of fluids around the apparatus and directs them into the œsophagus (Figs. 81 to 84).

Martin's artificial larynx is an incomparable advance, in that it offers the following advantages:

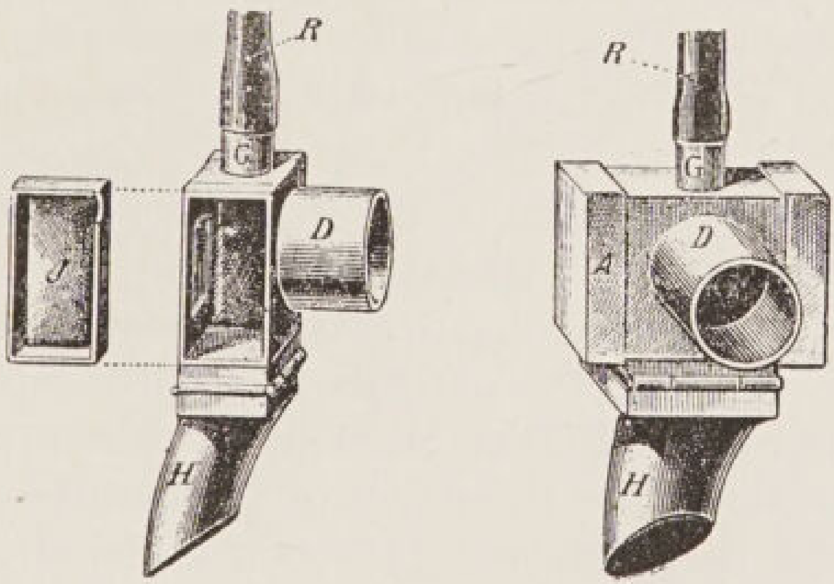


FIG. 84.—The Valve Box.

1. It allows patients to inspire easily by the mouth and nose. The inspired air current traverses the wire gauze, and throws widely open the rubber flaps of the rectangular tube which contains the vibrating mouthpiece.

2. It allows the invalid to drink and eat without touching his apparatus, and consequently to converse at meals. Actually, at the instant of swallowing, solid substances are held up by the wire gauze. Liquids fall through this into the resonance box, but

not into the vibrating mouthpiece, for its lips are closed; moreover, it is isolated in the middle of the box. They therefore flow together into the sloping part of the box, and are there caught in the œsophageal tube, which guides them to the gullet. As a result the trachea is sheltered from any entrance of foreign bodies.

Delair's Apparatus.—The larynx of Cl. Martin is indicated subsequent to a laryngotomy, performed on classical lines, in which the prosthesist finds himself confronted with a wound which communicates, above with the pharynx, below with the œsophagus and trachea.

This communication of the wound with the septic neighbourhood of the pharynx, consecutive to a total ablation of the larynx, can involve serious infectious sequelæ, to which the patients frequently succumb.

To get rid of infection, M. Sébileau* has introduced into the operative technique of laryngectomy some important modifications. He exerts himself in particular, in order to shelter it from infection, in isolating the trachea by remaking for the pharynx an anterior wall.

There is, then, no scope for the idea that an immediate prosthesis can prepare the ground for an artificial larynx, such a conception being opposed to that of Sébileau's operation. For he, on the contrary, strives to prevent finally any communication between mouth and trachea. Thus, the prosthesist finds himself compelled, in order to guide the air

* Sébileau, "Total Laryngectomy" (Soc. de Chir., 20 Juillet, 1904).

stream from the trachea into the mouth, to use a conduit which is artificial and of necessity external.

Glück's appliance could render service in such a case, but it has the drawback of giving a very feeble sound, and of directing it into the naso-pharynx, which entails a most faulty articulation. Delair has

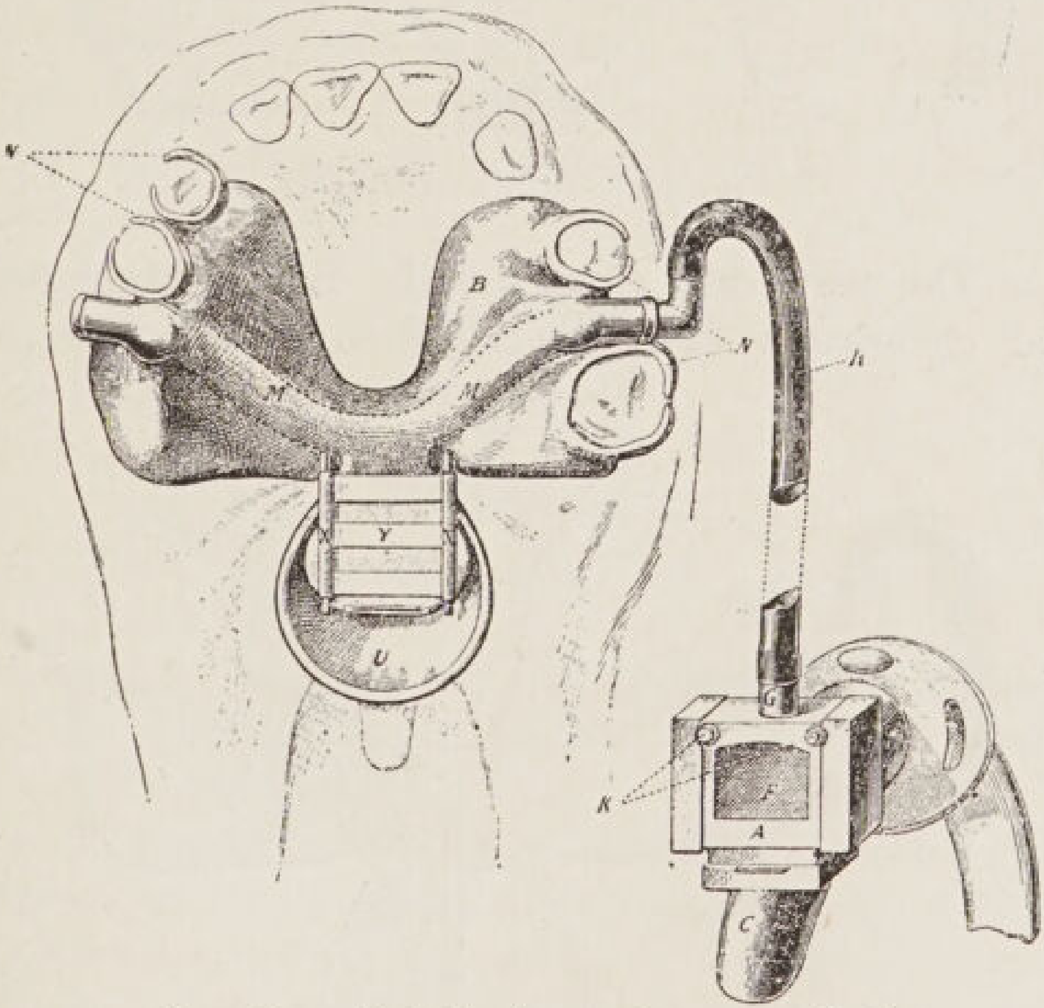


Fig. 85.—Delair's Apparatus assembled.

provided an elegant solution to this problem in prosthesis by devising the ingenious appliance which he calls an "artificial glottis"* (Fig. 85).

Delair's appliance consists of three principal

* L. Delair, "Artificial Larynx and Glottis" (*Odontologie*, 15 Sept., 1904).

elements: one external, the tracheal valve box; and two intrabuccal, the palatine piece and the artificial glottis.

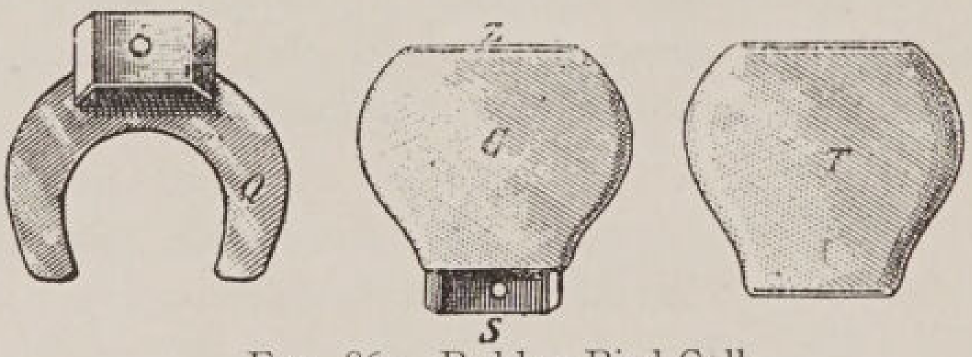


FIG. 86.—Rubber Bird-Call.

1. **The valve box** is of metal. It is rectangular, and encloses a flap of very thin rubber. On its

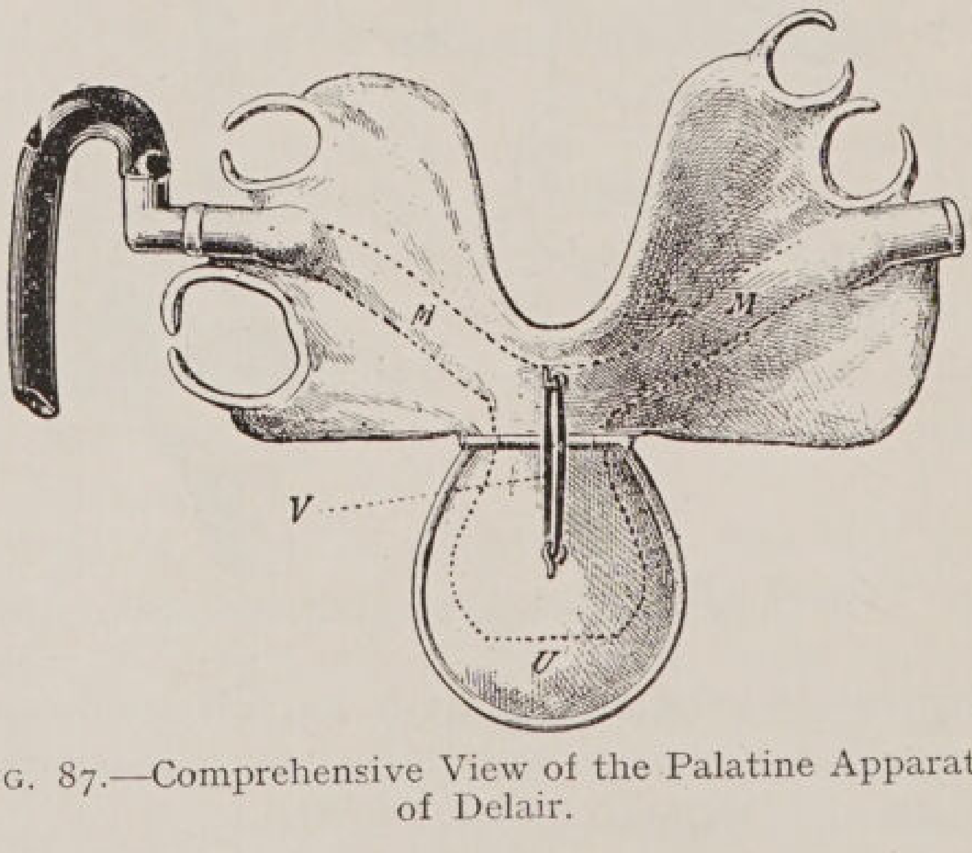


FIG. 87.—Comprehensive View of the Palatine Apparatus of Delair.

posterior wall is soldered a tube, fitting exactly into the tracheal cannula, for admitting air into the lungs. On its anterior wall is arranged a rectangular opening, behind which the rubber flap is stretched like a curtain. Through this opening the air enters the box, and from there into the trachea. The upper wall of this box bears a tube to carry the air to the palatine piece; the lower wall is pierced by a hole, closed by a cork, with the object of facilitating cleansing.

At each inspiration the air raises the flap placed on the anterior wall of the box and penetrates the tracheal cannula. On expiration the flap closes the anterior opening, and the air escapes by the upper tube. This latter supports a rubber tube which,

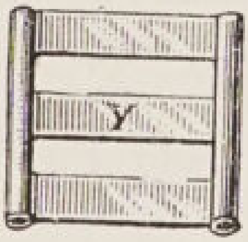


FIG. 88.—Metal Grill.

passing up the neck and encircling the jaw, adapts itself to the palatine appliance at the level of the labial commissure.

2. **The palatine appliance** (Fig. 88), also of metal, consists of two plates soldered together along their border. Between these plates is arranged a space, oval on section, a sort of flattened tube, which ends on each side opposite the first molar. A welded tube is screwed on to one of these ends, and by the other fits, opposite to the labial commissure, on to the rubber tube, which places it in connection with the valve box above described. This metal palatine plate is kept in place in classical fashion by a certain number of hooks gripping the teeth on either side.

The flattened tube (which traverses it in the form of a very obtuse **V** opening forwards) presents at its apex an opening. This opening is placed in the centre of the posterior border of the palatine piece, and on it is fixed the artificial glottis.

3. **The artificial glottis** (Fig. 87) comprises a rubber bird-call. This bird-call is composed of a metal guide in the form of a crescent, enveloped in a piece of very thin rubber tubing. At its posterior part is soldered an oval tube, for the fitting of the piece into the corresponding opening fashioned in the palatine plate. The two branches of the guide spread open the rubber bird-call, of which the two lips remain in close contact.

The current of air sent by the patient into the appliance separates the lips of the bird-call more or less, and puts them into vibration, thus producing a sound of varying intensity. The sound produced is directed towards the pharynx, and from this sound the organs of speech evolve words.

The lips of the bird-call, being in intimate contact, resist the penetration of food into the apparatus. This enables the subject to eat without discarding his palatine plate. But to this appliance for producing sound is supplemented a protective appliance, meant to spare the former from the compression to which it will be subjected by the velum behind and the tongue in front. This protective appliance consists, on its palatine aspect, of a convex metal plate articulated with the posterior edge of the palatine plate, and kept against the mucosa by the traction of a light rubber band.

On the lingual aspect the protection of the bird-call is assured by a tiny metal grill fixed on to the borders of the palatine plate. Such is the apparatus invented by Delair* for those who have undergone ablation of the larynx by Sébileau's method. An identical arrangement may be just as well fitted to tracheotomized patients who become aphonic. Delair's scheme offers the paramount advantage of placing the sonorous appliance deeply, on the posterior margin of the velum, at the boundary of the buccal and pharyngeal cavities. Thus, it enables those whose larynx has been ablated to articulate the sounds *que, ke, gue, x, e,* which cannot be emitted unless the sound produced by the glottis explodes (after being checked in the bucco-pharynx) in a resonance chamber bounded, in front by the base of the tongue touching the raised velum, and behind by the pharyngeal wall. "It is, then, indispensable," says Delair,† "to place the artificial glottis as remote as possible, to obtain the same phonetic results as with the human larynx. For in the case of the latter the sound reaches the pharynx from below upwards, whereas that of the artificial glottis is projected from above downwards and from before backwards. The sound thus obtained varies according to the dimensions given to the guide of the bird-call. In fact, the longer the lips of the 'glottis,' the deeper the note. It falls to the prosthesist to adjust the tension of the bird-call so as to give a

* Delair, "Artificial Larynx and Glottis" (*Odontologie*, 15 Sept., 1904).

† *Ibid.*

voice timbre consistent with the age, sex, strength, and vocation, of his patient."

The wearing of Delair's apparatus is subordinated to the education of the palate reflexes. This education is obtained in a few weeks with the aid of rubber appliances; these are made progressively more and more crescentic in shape, and soon engender a perfect tolerance.

Delair's appliance is contra-indicated in a patient whose trachea has not been shut off from the hypopharynx, the meeting-place of the respiratory and digestive tracts. In such a case Cl. Martin's contrivance gives better results. In other respects these two appliances are not divergent, since each is destined for a different type of patient. And their respective indications are drawn from the method which has been followed in the laryngectomy which they are to ameliorate.

CHAPTER V

LINGUAL PROSTHESIS

I. Artificial Tongue.

WITH the object of remedying in part the functional disabilities—dysphagia, trouble in masticating and speaking, perpetual flow of saliva outside the mouth—resulting from an amputation of the tongue, Martin has at different times inserted an appliance to replace this organ.* This appliance comprises two parts:

* Cl. Martin, "Treatise of Immediate Prosthesis," 1889 (Masson, editor), p. 374.

1. **A fixation appliance,** made of a lower vulcanite plate supported by the remaining teeth, and carrying artificial teeth to replace those missing. From the front and inner side of this plate a prolongation juts out, of variable length, made of flexible vulcanized rubber, and is directed from before backwards towards the false tongue which it serves to support.

2. **An artificial tongue** having the form and shape of the tongue removed. This tongue consists of a very soft and thin rubber bag, partly filled with

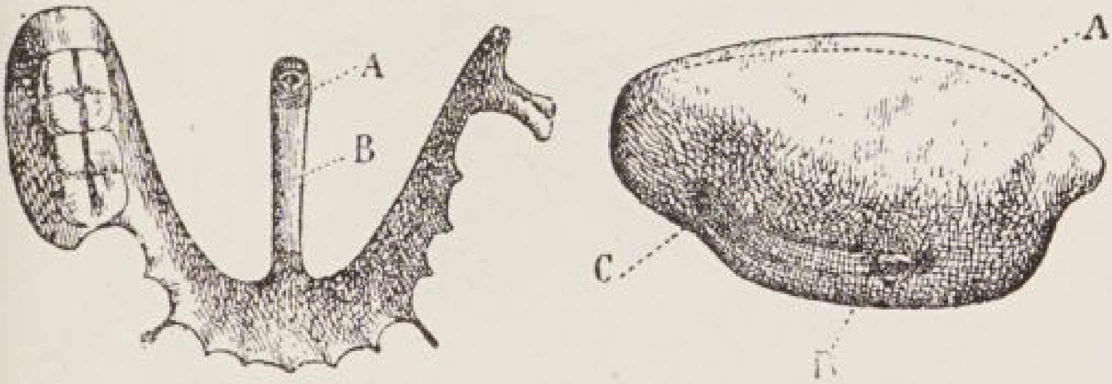


FIG. 89.—Cl. Martin's Artificial Tongue.

water or an antiseptic fluid. It is joined to the prolongation of the lower plate by a very mobile joint.

Under the influence of movements conveyed to it by the muscles of the floor of the mouth, and above all by the muscular sling formed by the mylohyoids, this tongue possesses great mobility. It can be placed against the palate or the dental arches, and projected from the mouth.

Pont* has had occasion to apply an artificial tongue made according to the same general prin-

* Pont, "Some Remarks on Lingual Prosthesis" (*Odontologie*, 30 Sept., 1903, p. 335).

ciples; but he substitutes for the tongue-shaped rubber prolongation (which is to support the bag of water) a single or double hinge. He has obtained the best results by his prosthetic intervention.

In a lecture on the surgical treatment of cancer of the tongue,* Poncet testified to the services rendered by Cl. Martin's invention to one of his patients, whose tongue had been removed, as follows: "Thanks to this apparatus, our patient no longer loses his saliva; he swallows easily, like anyone else;

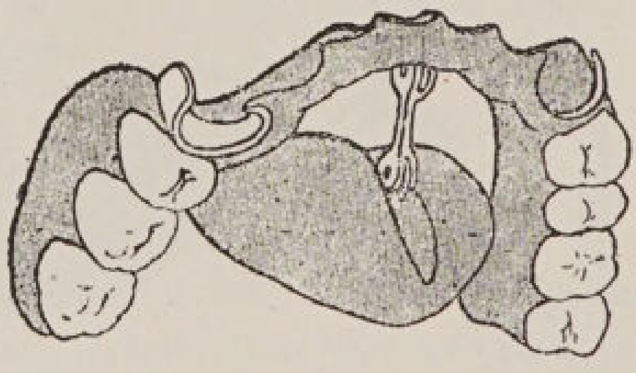


FIG. 90.—Pont's Artificial Tongue.

he no longer sends out heralds (to use a slang expression) when he talks. He eats more easily, and can even to a certain extent put his tongue out. These movements are explicable if you take note of this observation, that the mylohyoid sling was not interfered with at the time of the operation, and that the contraction of the mylohyoid throws forward the floor of the mouth."

At first speech is but little improved, for the patient must be long accustomed and educated to the false tongue; by this he gradually acquires a most obvious improvement.

* Poncet, *Province Méd.*, 16 Juin, 1888.

II. Sheath for the Tongue.

Certain ulcerations of the tongue are extremely rebellious to all treatment; this is due to the very great mobility of the organ, which makes it impossible to apply dressings which will keep their place. To make such dressings possible, and thus help recovery, Cl. Martin has invented the following apparatus, constructed in two parts (Fig. 91):

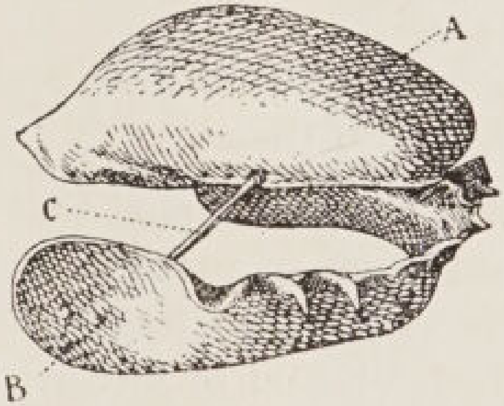


Fig. 91.—Tongue Cover.

A, Rubber sheath enveloping the tongue; B, piece playing on the lingual surface of the lower alveolus; C, rubber ring joining the sheath of the cover to the dental piece.

1. A sort of soft rubber sheath, ensheathing the tongue and holding the dressings against it.

2. A base plate for the lower jaw which serves to keep the sheath in its place, by means of an elastic fixed at one end to the back of the base plate, and at the other end to the front of the sheath. The sheath is thus drawn backwards and held by a gentle and constant pressure, which allows the tongue all its movements, but prevents it leaving the sheath.

Thanks to this arrangement, a rebellious ulceration, which lasted for some months, has been cured in a few days.

CHAPTER VI

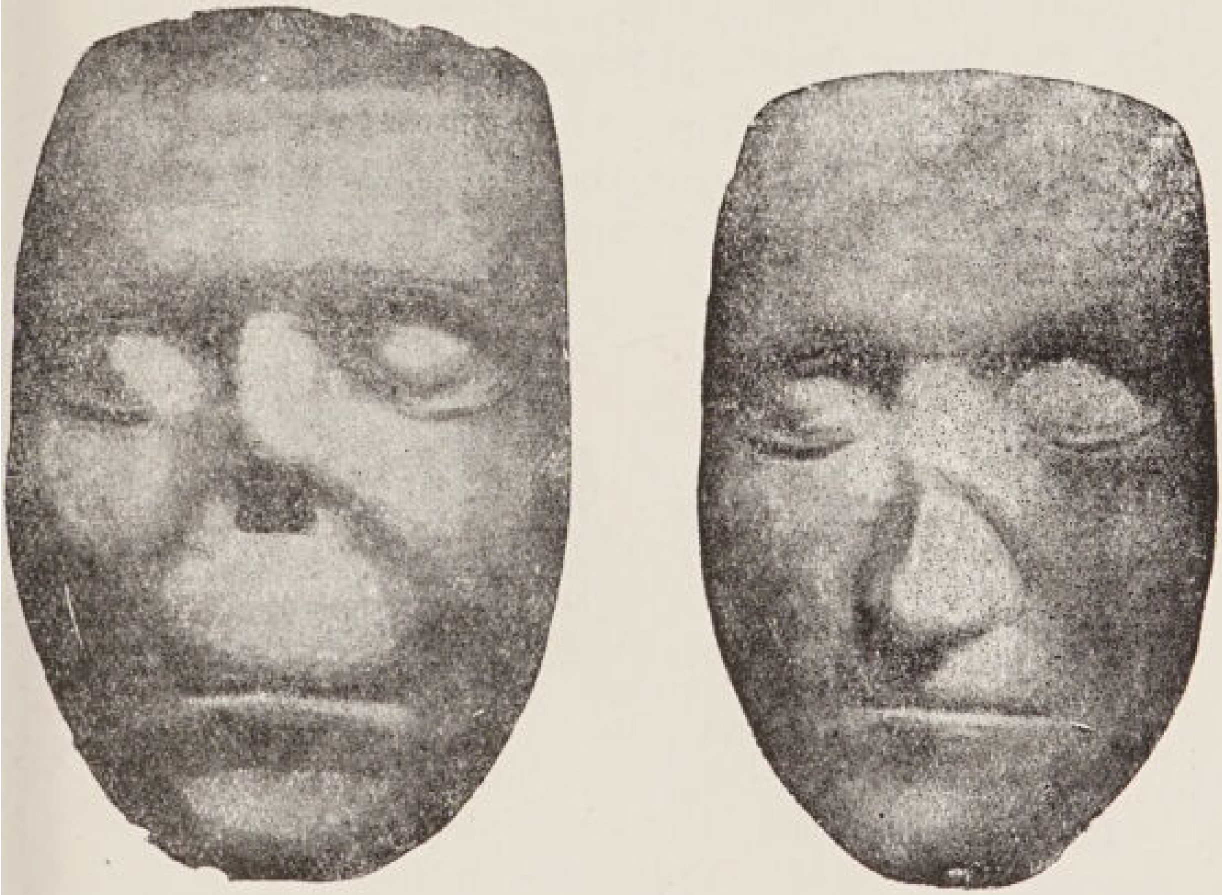
NASAL PROSTHESIS

We distinguish from methods of restoration of the nose—

1. Autoplastic methods.
2. Prosthesis combined with autoplasty (see p. 234).
3. Internal prosthesis by injection of paraffin.
4. Simple late prosthesis.

It is only of the last-mentioned that we shall speak here. The application of artificial noses goes back to a very ancient era. Ambroise Paré employs them still, making them of gold or silver. Metals, hippopotamus ivory, and such plastic substances as rubber and celluloid, have in succession been used to give them a more natural appearance; later we paint them. The making of an artificial nose necessitates the moulding of the whole face of the patient, and modelling on this mould, in wax, a nose which harmonizes as well as possible with the rest of the physiognomy.

The materials of choice to employ for this manufacture are hard rubber, alone or combined with soft rubber at the edges; and rubber supported by a metal armature. Apparatus thus made are solid, and paint sticks to them strongly. Nevertheless, soft rubber must be of some thickness, and has therefore a greater weight; and its manipulation is beyond doubt more delicate than that of hard rubber. From the æsthetic standpoint, porcelain noses give the best results, but that is an undertaking in porcelain work which is always most difficult to execute Added to this there is the drawback of the weight of this material, which demands rigid means of fixation. The methods of fixation of artificial noses



FIGS. 92 AND 93.—Replacement of a Nose destroyed by Lupus. (Schwartz.)

constitute one of the most interesting and difficult of nasal prosthesis. Following Cl. Martin,* we will divide them into four principal groups:

1. **External Procedures,** such as springs encircling the head, coloured head-pieces; such should only be

* Cl. Martin, "Dental Prosthesis for the Bony and Soft Parts of the Mouth and Face" (Rapport au Congr. int. de médecine, Madrid, Avril, 1913).

employed in cases, which are very rare, where any other method is impracticable. Spectacles provide an ingenious deception; they have the advantage that they can carry a fairly big weight, and they can be used with advantage on patients whose sight requires their habitual use.

2. **The Use of the Nasal Fossæ.**—We take advantage in these cases of rods or springs taking their support from the outer walls of the upper or lower nasal fossæ. [There is no such anatomical division of the

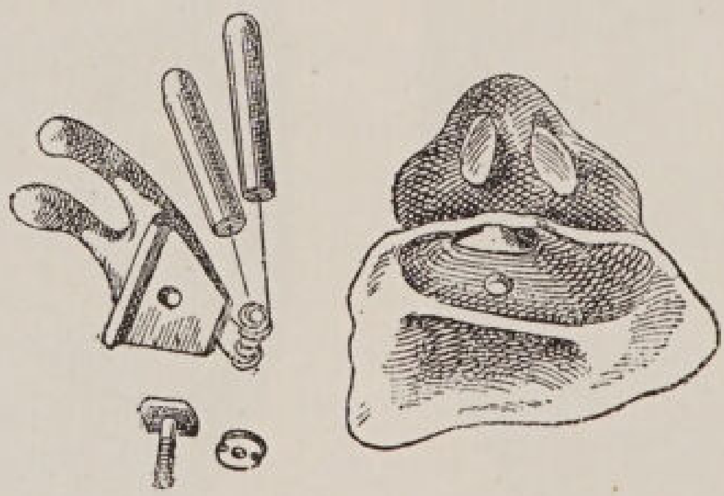


FIG. 94.—Replacement of a Nose destroyed by Lupus. (Schwartz.)

fossæ in our nomenclature.—TR.] The fact that the nose should weigh very little and the pressure of the springs be very weak will suggest indications for the use of this procedure. It seems that here we have the means of retention most commonly employed by actual prosthesists.

Cl. Martin has used it often for many years, and has never observed inflammatory sequelæ of the nasal mucosa. Schwartz has used it to retain a nose of hard rubber, a spring gripping the septum, and some rounded claws taking their *point d'appui* from the lower border of the nasal fossæ.*

Roy†, in a case of partial restoration of the nose, has used an original method of retention. The loss of substance involved all the left wing of the nose; the wing was reconstituted by a stamped metal plate, kept in place by two grooved rods, each one ending in a soft rubber olive. The grooved rods are soldered to the inner face of the metal plate. A rubber ring,

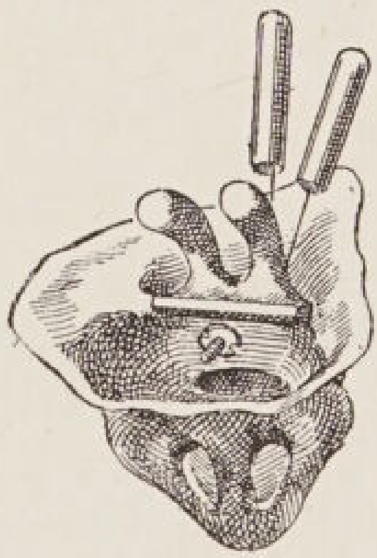


FIG. 95.—Replacement of a Nose destroyed by Lupus. (Schwartz.)

joining the rods by one of their extremities, tends to make them slide in their groove; so that their other ends, covered with soft rubber, come into firm contact with the margins of the dehiscence, thus accomplishing the retention of the appliance. Delair, who

* Schwartz, " Replacement of a Nose destroyed by Lupus " (Cong. dent. de Bordeaux, 1907, in *Tablettes odontologiques*, Déc., 1907, p. 708).

† Roy, " A Case of Nasal Prosthesis " (*Odontologie*, 15 Janv., 1906, p. 5).

recommends the use of soft rubber stiffened by a bar of aluminium, uses as a retention appliance springs which take their support from the nasal fossæ.*

3. **Utilization of the Teeth of the Upper Jaw.**—This plan is indicated when the upper lip has disappeared at the same time as the nose. An upper palatine piece is fixed to the teeth, and carries a vertical rod passing in front of the anterior nasal

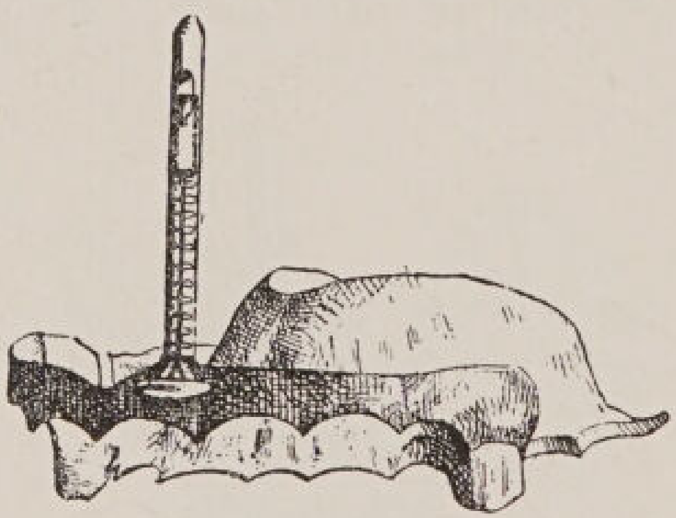


FIG. 96.—Martin's Apparatus.

A vertical rod supported by a vestibular band traverses the gingivo-labial sulcus, and enters the nasal fossæ, where it acts as support for an artificial nose.

spine. On the end of this rod are mounted the nose and the false lip which hides the appliance. This procedure has been applied† several times by Cl. Martin. If the upper lip is intact, Martin perforates the gingivo-labial cul-de-sac, into the nasal fossæ,

* Delair, "Prosthesis of Palate, Face, and Mouth" (Rapport au XIVe Cong. internat. de méd. lég., Madrid, Avril, 1903).

† See p. 144, Fig. 98. Mertens, "A Case of Facial Restoration" (*Dental Cosmos*, Mars, 1906, and *Odontol.*, 15 Mai, 1907, p. 416).

and passes through this hole the sustaining rod, which projects for 1 or 2 centimetres into these fossæ at the side of the anterior nasal spine (Fig. 98). The rod is itself held up by a metal band, placed in the buccal vestibule, and joined behind to a palatine plate which insures its immobility.

Herein we have a neat method of retention; we need not in a suitable case hesitate to make a path for the sustaining rod of the nasal apparatus, by means of a small incision in the vestibular cul-de-sac. The track thus made epithelializes without delay, and presents no inconvenience.

4. **Employment of a Palatine Obturator.**—This system is the best, and gives the firmest *point d'appui;* but it is only applicable when through a palatine perforation the mouth and nose communicate.

According to Martin, it is essential that this fixation should not be rigid; otherwise it immobilizes the false nose in a given position, and does not allow it to follow the face movements in the course of mastication or the various play of the physiognomy.

Pont* has made an apparatus consisting of three parts: (1) A denture supporting the nasal rod; (2) a junction-piece; (3) a painted vulcanite false nose. The denture and the nose exhibit no particular feature, but the junction-piece is difficult to make and adjust. The conception of the mechanism is Cl. Martin's, but Pont has modified it in certain details. The principal pieces comprise—a tube with a screw-thread, an intermediate tube, and a catch.

* Pont and Aveyron, "Concerning a Case of Nasal Prosthesis" (*Journal des médecins praticiens*, Lyon, Mai, 1910).

The junction-piece allows of the performance of the following three movements: a vertical, a horizontal, and a rotary.

Below we give the schema of this apparatus, which gives an appreciation of its ingenuity and value (see Fig. 97).

From the point of view of making artificial noses, we are compelled to limit ourselves to some general indications, remembering that the appliances used are most diverse.

1. **Porcelain Work.**—Cl. Martin has made with porcelain some translucent noses, resembling living skin, which far outstrip the former noses of painted ivory, white rubber, or enamelled metal. To hold them up, these noses require a palatine plate. If there is a perforation of the vault, we profit by it to pass up a vertical rod which reaches the nasal fossæ; if no perforation exists, we create one (*vide* p. 132), in the upper gingivo-labial groove.

The use of spectacles, since they give much less steadiness, should be abandoned. The false nose carries at its posterior part a horizontal rod attached to a spherical joint, which plays on the vertical rod (of the palatine plate) in the nasal fossæ. By means of an ingenious arrangement—a small spiral spring which acts on the horizontal rod and keeps the false nose always snug against the skin—the appliance follows the movements of the soft tissues to which it fits.

With the aid of a small button hidden in the nostril we unhitch and disarticulate the nasal and buccal sections of the appliance.

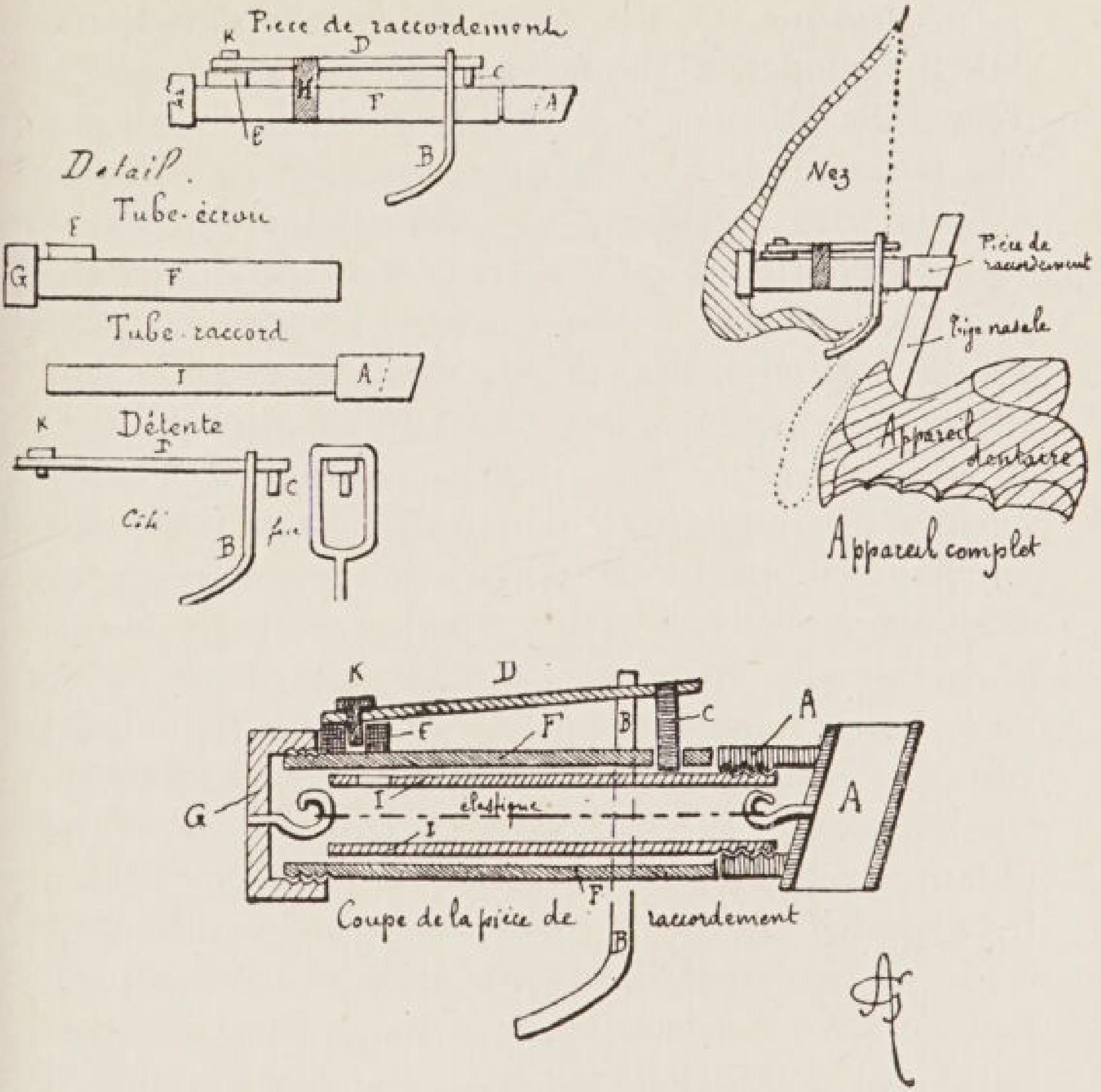


FIG. 97.—Artificial Nose and its Mechanism, by Pont, of Lyons

DETAIL.

Pièce de raccordement = Junction-piece.
Tube-écrou = Tube with screw-thread.
Tube raccord = Intermediate tube.
Détente = Catch.
Nez = Nose.
Tige nasale = Nasal rod.
Appareil dentaire = Denture.
Appareil complet = Apparatus assembled.
Elastique = Elastic.
Coupe de la pièce de raccordement = Section of the junction-piece.

KEY.

A. Screw of the tube which slides on the nasal rod.
B. Trigger.
C. Internal pin of the catch.
D. Horizontal limb of the catch.
E. Shoulder of tube with screw-thread.
F. Tube with screw-thread.
G. Nut fused into artificial nose.
H. Elastic to hold the catch.
I. Intermediate tube sliding in the tube with screw-thread.
K. External pin of the catch.

Construction of the Nose in Porcelain.—Having taken a mould of the face, we stamp out a nose in very thin platinum ($\frac{1}{10}$ mm.), which is to support the porcelain paste. So as to prevent it losing its shape during the fusing, we reinforce this provisional nose by pouring into the interior a mixture of plaster and diamond dust. We place the screws which will fix the horizontal branch, and we apply the porcelain material, which consists of kaolin, feldspath, etc.; it is coloured by Allen's paste, purple of Cassius, spongy platinum, and above all precipitated gold, which gives translucency and live appearance to the false nose. We fuse several times, repair the cracks, and gradually arrive at a thickness of 2 mm. We cool slowly, remove the plaster, and with the utmost care the platinum-leaf; the screws remain fixed in the porcelain. We rub off the bright porcelain, and obtain a velvety surface resembling that of the skin by exposing the piece to the fumes of hydrofluoric acid. It only remains to adapt the horizontal branch, and we have the nasal part of the apparatus. One important detail: it is necessary, so that the line of junction with the soft tissues may be as little visible as possible, for the margins of the artificial nose, much thinned out, to lie on the skin, as it were, quite flat, without a suggestion of any thickness. If there is a loss of substance of the upper lip, we join on to the nose an artificial lip to replace the missing part.

Martin has obtained with his porcelain noses marvellous results, such good imitations that they are mistaken for the real organs.

2. **Hard Rubber** is used much oftener than porce-

lain by reason of its lightness, and above all because, of all materials employed in prosthesis, it is the easiest to work and the most familiar to dentists. Therefore we will not expatiate upon its manipulation. Hard or soft rubber should be painted when it is used to replace part of the integuments. So that the imitation of the skin should be better, it is helpful to paint the appliance after it has been placed on the patient's face, or at any rate to retouch it while *in situ*. In this way we get a more exact harmony between the tints of the face and the tones of the false nose fitted to it.

For making a nose of vulcanite, Pont has remarked that it is advantageous to model the piece in wax, for many reasons which he enumerates:

1. Wax does not retract like dry clay.

2. One can make the modelling in several stages, which is preferable, as the faults leap to one's eye.

3. Glazing the wax with a flame aids us by giving to the lines a softness difficult of achievement with a sketching chisel and the finger.

4. The junction-piece may be adjusted actually on the patient; so also the smoothing of the edges.

5. Once the piece is finished, one can pour a mould; thus one will have pieces the exact counterpart of each other and easily interchangeable. To facilitate the modelling, Pont gives some measurements which enable us to reconstitute the nose almost exactly.

(*a*) Length of nose from root to tip = width of closed mouth.

(*b*) Internal breadth from one nostril to the other = breadth of a closed eyelid.

(*c*) Distance from columella to lip = vertical diameter of interpalpebral opening with eyes open.

(*d*) Width of one nostril = depth of the upper lip.

If we drop two parallel lines from the inner canthus perpendicular to the lips, we define the external breadth of the nostrils.

Painting on Vulcanite.—We can make use of the following colours in oil: Silver white, lake carmine, Naples yellow. It is difficult to suggest the quantities requisite, for the mixture is subordinated to the tint wanted. To make the colour dry rapidly, it will be well to soak the brush in essence of petrol and dilute the colour. In a few hours drying is complete. To make the colouring uniform, we dip the finger in pumice and glycerine and pass it over the dry painting. We rub gently, and finish the operation by washing in running water.

3. **Soft Rubber** has to be used of a greater thickness than hard; it has accordingly the drawback of giving heavier apparatus. Its manipulation is more difficult than that of hard rubber. None the less, Delair shows himself to be a converted partisan to soft rubber. He reduces its weight by using an armature of aluminium; and, thanks to this ingenious combination, he has obtained excellent results by thus ridding himself of one of the gravest disadvantages of soft rubber from the point of view of its use for nasal prosthesis.*

To make these appliances in soft rubber, Delair always employs moulds made of the same metal as printer's type. He prefers metal to plaster, on the

* Delair, Rapport au Cong. de Madrid, 1903.

ground that the mould, once obtained, can serve indefinitely for the subject for whom the prosthesis is destined, at any time when it is necessary to make for him a new appliance.

To vulcanize the soft rubber, we steep the moulds for some hours in a vat of melted sulphur, kept at a uniform temperature on a sand-bath. It is more simple to use the rubber employed in dentistry by proceeding according to the following scheme outlined by Delair: The flask or mould, being stuffed with white or pink rubber, is placed in the vulcanizer, taking care to let this stand on a pedestal of porcelain; an inverted saucer will do. The vulcanizer is now heated slowly, until the thermometer says 155° C. (which corresponds to a pressure of 5·5 atmospheres). At this moment we suddenly allow the steam to escape, open the boiler, and rapidly plunge the mould into cold water until it is cool.

Rubber thus treated by this partial vulcanizing remains soft, all the while keeping the shape given to it; the surface of the piece is smooth and ready to be painted. It is understood that the metal armature sustaining the appliance is enclosed in it at the moment of filling.*

"There is one disadvantage common to all artificial noses, the flow of all nasal secretions and of water (condensed from the water-vapour of expired air) into the hollow on their posterior surface. These fluids now and then trickle down along the tissues beneath the appliance. We rectify this inconvenience by filling the concavity of the false nose by

* Delair, Rapport Congr. de Madrid, p. 20.

a bag of soft or only partially vulcanized rubber. This bag will be moulded on the whole concavity, and also on all the anterior and inferior part of the opening, only leaving two oblique passages. These are, respectively, above, which conveys air to the upper regions of the nose; and behind, which leads to a level slightly higher than the nasal floor. Thanks to this arrangement, the products of secretion are obliged, in order to flow out, to follow the posterior pharyngeal route. And the hollow of the nose, being filled up, cannot act as a reservoir for condensation of aqueous vapour."*

Henning's New Process.—Henning's method seems destined to revolutionize prosthetic restoration. Warnekros has exhibited a patient, treated by this method, at the Odontological Society at the May, 1913, session; and since that time Pont of Lyons has been the first to use it in France.

Appliances constructed with the help of the new process are frankly superior from all points of view to those made up to date with the divers materials which we have reviewed in passing.

The qualities of this new substance appear to answer in a perfect way to all practical demands. Its chief advantages are as follows:

(*a*) Simplicity and rapidity of the process.

(*b*) Æsthetic results approximating to perfection, as much from the standpoint of appearance as from that of shape and consistency. Noses made by this process have almost completely the characters of

* Cl. Martin, Congr. de Madrid, p. 22.

human tissue, and may be dented without deforming them; even to touch them gives a sensation of real tissue.

(*c*) Their fit and adhesion are beyond reproach; and these artificial noses, be their shape, volume, and extent what it may, remain in place without any call for retention appliances. These latter were generally, with the old methods, difficult to put together and make, and were often badly tolerated by the patient.

To sum up the way they are made: An impression is taken, and we proceed as if wishing to construct a nose of wax. We then make a mould suiting as far as possible the general cast of countenance, and pour into this mould Henning's paste. This latter is a plastic gelatinous material, which the patient himself can repeatedly recast and use afresh. To do this it suffices to give him his mould and Henning's paste. Another point of originality of this plan is in the mode of fixing. Once modelled, the false nose is merely closely applied to the skin with the help of a special material.

CHAPTER VII

AURICULAR PROSTHESIS

As regards the material of choice, preference should be given to rubber; for celluloid changes, and wax is too heavy. As in most surgical prostheses, the interest of these lies in the mode of retention.

Two conditions may present themselves:

1. The auricle has disappeared.
2. Part of the ear remains.

In the first case, the steel rod which holds the appliance passes vertically up on to the head. At its lower end it carries a projection which enters the external meatus. In the second case, the rudimentary [or vestigial—TR.] stump is of great assistance. It can be perforated in such wise as to give a passage for a spring, or surrounded by the artificial ear; or simply enclosed in the concavity of the appliance. Henning's method will probably find a happy application in numerous cases of auricular prosthesis.

CHAPTER VIII

PROSTHESIS OF LIPS

THE same remark applies to these organs as to prosthesis of the tongue. From the point of view of their restoration, their mobility constitutes an obstacle which we must conquer if we wish to give the suppleness and mobility which are indispensable to facial expression. It is but rarely that we have to replace these organs alone; in the vast majority of cases their restoration goes with that of the nose, maxillæ, hard palate, or cheek. The materials used are porcelain and soft solid rubber. The mobility of porcelain being nil, and that of solid rubber insufficient, Martin has theoretically advocated that, in making the lip, the soft rubber should be hollow and filled (without tension) with water. We say theoretically, because this authority has not applied his process. The base of the lip, of hard rubber, presents at its least visible part a small orifice by which one fills the cavity with water, without, however, filling it completely, leaving a small space empty. This arrangement would have the advantage of allowing the organ to change its shape under the influence of pressure at any point, thus giving it a more natural aspect. Moreover, occlusion of the lips would be more perfect, and pronunciation would be to a large extent the gainer. Henning's new method would seem indicated for this prosthesis.

CHAPTER IX

EXTENSIVE BUCCO-FACIAL RESTORATIONS

The extreme diversity of cases of this order, the arge number of appliances invented to remedy them, will hardly allow of establishing any method for the treatment of this sort of case. There is, however, a certain number of principles from which one cannot deviate, if good results are to be got. The first may be thus defined: On all occasions when the facial cavities have been involved and laid open, and show a loss of substance, one should strive to fill them as completely as possible, leaving no chasm other than the normal anatomical space necessary for the fulfilment of physiological functions. As a corollary to this, it is necessary to make bulky apparatus.

Accordingly, these latter should be light. To answer to this desideratum of lightness, it is useful to construct, as far as possible, hollow appliances; a combination of aluminium and rubber forms the material of choice in such cases. It is difficult to describe these facial restorations; each case occurs under individual conditions. We may quote the primitive appliances of Delalain, then those of Lecaudey, Dejardin, Préterre, and Goldenstein;

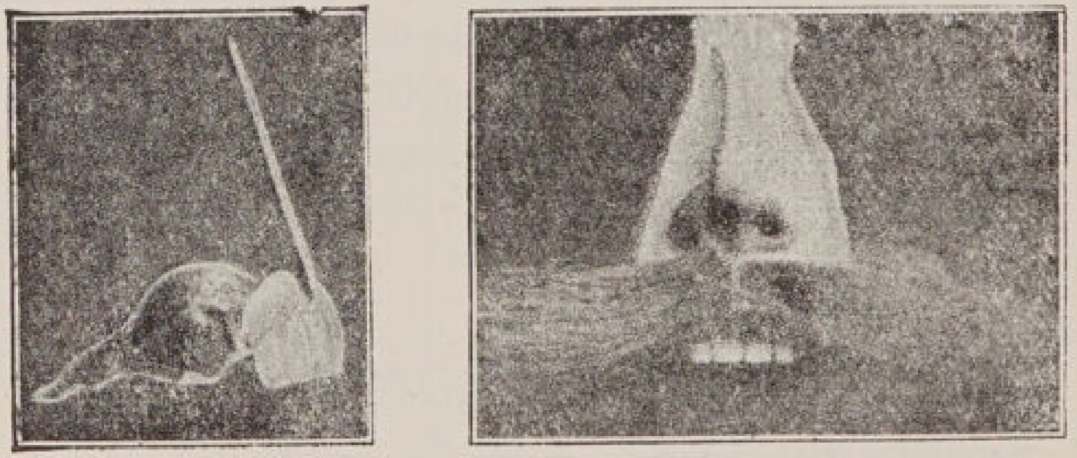


FIG. 98.—Facial Restoration: Mertens' Case.

finally the more modern contrivances devised by Gunning, Kingsley, Haupmann, Michaëls, Ronnet, Martin, and Delair.

Apropos of these extensive appliances for restoration, the most interesting point to study is the plan for their retention; this may vary with the peculiarities of each case which is presented to the prosthesist. As a rule the *point d'appui* is taken from the maxilla, or its remains, through the intervention of a large palatine appliance. When the nasal scaffolding is destroyed as well as the upper lip, the mechanism for attaching the prosthetic mask to the palatine plate passes easily through the gap in the nose. Take the very elementary example of Mertens* (Fig. 98). It concerned a patient for whom the nose, upper lip, and incisive region, had to be replaced. The following is the conception of the appliance:

1. Palatine plate restoring the incisive region and serving as a support.

2. Vertical metal rod inserted into the buccal part and traversing the nasal gap. On this rod a spiral spring like those of dentures, the end of the spring being left free.

3. A mask of painted rubber reconstituting the nose and upper lip, and carrying a false moustache.

The mask is hooked on by a ring to the free end of the spring supported by the palatine piece. The backward pull of this spring keeps the appliance exactly fitted on to the face.

But as a rule the tattered condition of the face is such that we must have recourse to much more complicated processes. Delair† has published many such which we cannot here describe in detail. Among the most ingenious we may mention—

1. Retention by hooking on with a catch. Two levers with catches facing each other close the openings of two pieces of tubing; into these latter are

* Mertens, "A Case of Facial Restoration" (*Dental Cosmos*, Mars, 1906, and *Odontologie*, 15 Mai, 1907, p. 146).

† Delair, "A Case of Bucco-Facial Prosthesis: New Mechanism of Fixation" (*Journ. odontologique de France*, Oct., 1909, p. 247). See also Delair, "Report on Bucco-Facial Prosthesis" (Cong. de Madrid, 1903).

introduced two parallel rods of gold, fixed to the back of the mask and holding it.

2. Retention by elastic traction in an antero-posterior plane. On the incisive region of a palatine apparatus a metal lever is fixed by a hinge; the end of this lever supports a facial mask. By its middle part it is joined to the palatine appliance by a rubber

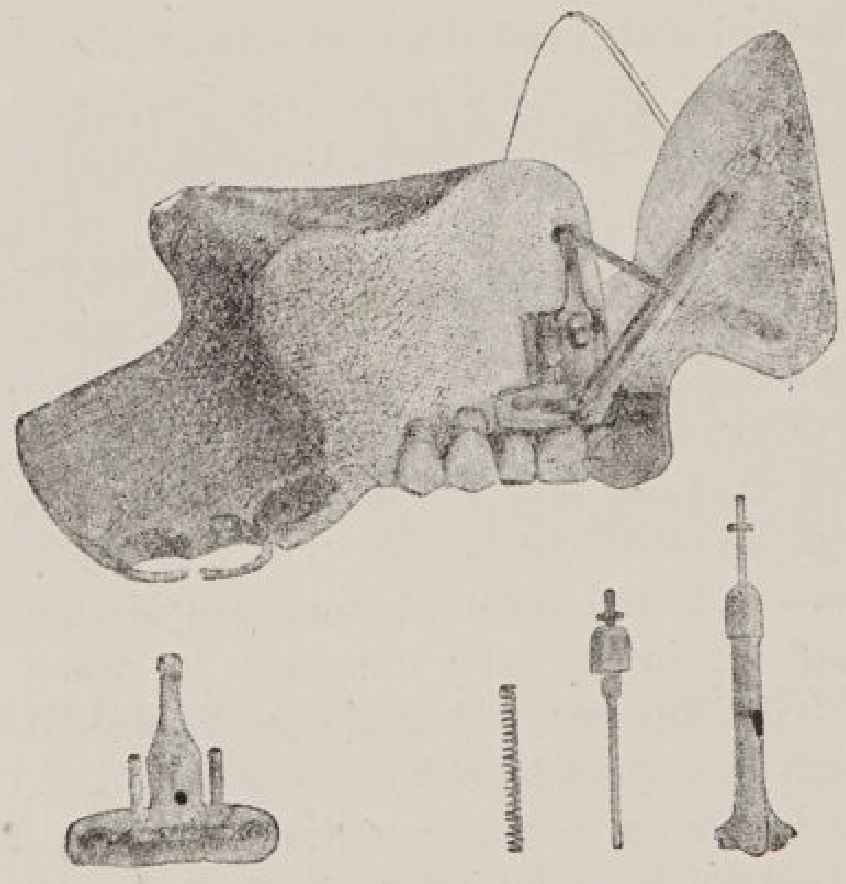


FIG. 99.—Appliance for Bucco-Facial Prosthesis. (Delair's case).

loop. The elastic traction tends to raise this lever and move it backwards, and so it presses all the more snugly against the surface of the painted rubber mask which it supports. People have often sought to use the ears as a *point d'appui* to insure the retention of large bucco-facial restoration appliances.

In such cases they avail themselves of spectacles, which look as if they were doing their real work. But the pressure, sometimes fairly strong, which is thus exercised on the retro-auricular groove, occasionally becomes painful, and patients complain of this frequently.

Lastly, there are other cases where the absence of communication between the mouth and the part of the face to be restored makes the problem of retention very difficult to solve. One of us* found this in the following case, operated on by M. Sébileau for an epithelioma of the cheek. The patient recovered, with a large gap in the malar region. The malar bone had been resected, and the antrum was open externally. The surgical procedure had made no communication between mouth and antrum, such as could be used to pass a retention appliance for holding to the skin a mask to fill the large gap. The invalid, very senile, was entirely edentulous, and with our colleague Geoffroy we adopted the following plan:

1. A support derived from a complete upper denture.

2. A mask of stamped and painted aluminium, covering the facial gap and reconstituting the contours of the malar region.

3. A V-shaped spring turning round the labial commissure; one of its ends is supported by the denture by fitting into a socket made for the purpose.

* Lemerle and Geoffroy, " Late Prosthetic Restoration of the Cheek and Malar Region " (*Odontologie*, 30 Août, 1908 p. 145).

The other end, fixed to the inside of the cheek mask, draws it firmly backwards, thus keeping it close-fitting to the soft parts around.

It is, then, evident that, in the matter of bucco-facial restoration, the most important part lies in the making of a good means of retention for the prosthesis. Each sufferer who consults the prosthesist offers him a new problem to solve, and nearly always this problem turns on the means of retention to be adopted, which varies with each case. Wherefore it is impossible to lay down any law on the subject; that is why we limit ourselves to citing a few general examples.

SECTION II

IMMEDIATE PROSTHESIS

SYSTEMS of immediate prosthesis fall into two groups, having this common characteristic: that we place in the tissues apparatus intended to be temporary, and do not reckon on them being permanently tolerated by the tissues. The two groups are—Immediate prosthesis for subperiosteal resection; and immediate prosthesis, properly so called, when it is intended to oppose cicatricial retraction.

CHAPTER I

PROVISIONAL PROSTHESIS APPLIED IN THE CASE OF SUBPERIOSTEAL RESECTIONS

THIS is destined to act as a guide to the periosteal flaps and to the newly formed bone tissue, so as to aim at regeneration of the portion of skeleton resected. On account of its difficulties, this method has been but little used. Nevertheless, Cl. Martin since 1878 has obtained good results in two remarkable instances. He was concerned with two cases of massive necrosis of the lower jaw. The sequestra had been removed and the periosteal gutter spared. Martin, placing his appliance in this gutter, reduced the former little by little, until the new bone was sufficiently resistant for the artificial support to be removed from the soft parts without risk of deformity. Thus, his appliance answered by instantly checking the functional disabilities consecutive to necrosis and the formation of undoubtedly vicious new bone, disabilities which would occur in the train of the collapse of soft parts and cicatricial retraction.

Applied later by Péan and Michaëls, these authors have published some interesting observations where this class of prosthesis seems to have yielded remarkable results,* especially having regard to the extent of the resection and the region in which it took place. The resection concerned was of the upper two-thirds of the humerus.

We must bear in mind that, in their method, the prosthetic appliance is put in provisionally. When bony regeneration has been obtained, the appliance, in the course of a second intervention, is removed. In this way we shall at least understand the *raison d'être* of this procedure: that the periosteum, spared during the surgical attack, has been fixed by the operator to the prosthetic appliance with the idea of obtaining bony regeneration.

* Michaëls, "Demonstration of Appliances intended to repair Losses of Skeletal Substance" (Cong. dent. nat., Nancy, 1896, p. 22).

CHAPTER II

IMMEDIATE PROVISIONAL PROSTHESIS DESTINED TO OPPOSE CICATRICIAL RETRACTION

According to this plan, we preserve, in the depth of a wound undergoing epithelialization, a space which shall later be filled by a removable appliance intended to replace the resected portion of the skeleton.

This method was used for the first time, and with success, by Cl. Martin,* April 13, 1878, on a patient whose horizontal mandibular ramus had been resected by Letiévant. Certain surgeons, struck by the inconveniences resulting from resections of any part of the lower jaw, tried to remedy them either, like Rigal of Gaillac, by placing in the wound a piece of lead, or, like Stanley, a plate of ivory, or, like others, a piece of gutta-percha. But these divers efforts gave only mediocre results. Verneuil, in 1874, fixed between the fragments a metal loop to support the tongue and prevent it from falling down after a resection of the region of the symphysis. This was the only object, and this procedure gave no relief to the other functional troubles nor to the facial deformity. So we can really say with perfect justice that Cl. Martin thought out the principle of immediate prosthesis, and was the first to regularize the technique. Therefore it is his which we are

* Cl. Martin, "On Immediate Prosthesis applied to Resection of the Upper Jaws," Paris, 1889.

proposing to study, especially because of its fairly frequent practical application.

Immediate prosthesis* consists essentially of two stages:

1. Immediate replacement of the bony segment resected, by an appliance fixed in the depth of the tissues before suturing the soft parts.

2. When cicatrization is complete, the temporary appliance is removed and replaced by a final movable appliance.

The aim, then, of immediate prosthesis is to oppose a preventing or prophylactic action to the cicatricial contraction which follows a bony resection. Such retraction can lead to serious sequelæ at the level of the lower jaw. It is, maybe, for this reason that immediate prosthesis constitutes a method which is used almost exclusively for such resections of the lower jaw, which can be followed by various accidents which we will rapidly enumerate.

CHAPTER III

ACCIDENTS FOLLOWING RESECTIONS OF THE LOWER JAW NOT FOLLOWED BY PROSTHESIS

SUCH accidents may be divided into—

1. Primary accidents, supervening during the first fifteen days after operation.
2. Secondary accidents.

1. **Primary Accidents.**—In the days following the resection, the invalid complains of not being able to

* Martin, "On Immediate Prosthesis," Paris, 1889; Masson, editor.

masticate, because the teeth are no longer in contact the remaining segment of the lower jaw being drawn inwards and backwards. Soon this deviation, caused at the beginning by the upset of muscular balance only, becomes more and more accentuated under the influence of the cicatricial retraction.* The infra-hyoid mass of soft parts, ceasing to be kept up by the mandibular horseshoe, sinks down and slides downwards and backwards. Out of this arises a lot of dysphagia and dysphonia. When the resection has involved the front part of the jaw and destroyed the bony origin of the genio-glossi, the tongue, not being kept forward by these muscles, is dragged backwards and closes the laryngeal passage by inhibiting the raising of the epiglottis—hence asphyxia.

2. **Secondary Accidents.**—Under the influence of cicatricial retraction, the bony fragments approach one another. The facial deformity is considerable, and the situation of the unfortunate subject pitiable. Dysphonia is aggravated, words being replaced by unintelligible grunts. The dental arches no longer correspond, and any solid feeding is impossible. Swallowing is difficult, and fluids (the only nourishments the patient can take) escape from the mouth and soil the face and clothes. When at rest, saliva flows in a continuous trickle between lips powerless to keep it back.

These accidents, more especially the secondary ones, are grave and intractable. The appliances

* Billing has published an interesting study on the causation of deviations secondary to partial resections of the lower jaw. (See Billing, on "Prosthesis for Resections of the Mandible," Stockholm, 1910.)

employed in late prosthesis for reducing cicatricial bands cannot prevent the primary accidents. Immediate prosthesis has their prevention for its specific object; it is a prophylactic method. The end in view of the science of immediate prosthesis is to replace the resected bone at once by an appliance (roughly a replica of the part removed). As a fact, it is unnecessary to reproduce exactly the skeletal details. Above all, one must devote oneself to copying the general form of the bone, all the while taking care (to borrow a term used in moulding) to construct a prosthetic piece which will be easy to cast off. This provisional appliance is fixed to the remaining portions of bone, resists retraction, guides the scar tissue, and prevents the primary accidents of which we have just been speaking.

After the lapse of a certain time—Martin says as soon as possible—when scarring is finished, this provisional appliance is replaced by a more finished article, furnished with artificial teeth. This is the second or permanent apparatus, which prevents the secondary accidents already enumerated.

CHAPTER IV

CONDITIONS TO BE FULFILLED BY AN APPLIANCE OF IMMEDIATE PROSTHESIS

THE apparatus which is to replace any part whatever of the mandible should always be larger than the part to be resected. It is preferable always to make a complete jaw, from which we cut off portions corresponding to the bony parts which the surgeon has spared. For the jaw may be affected by more extensive resections than at first anticipated; and if we make an appliance on the original data, it might be insufficient, and so become useless.

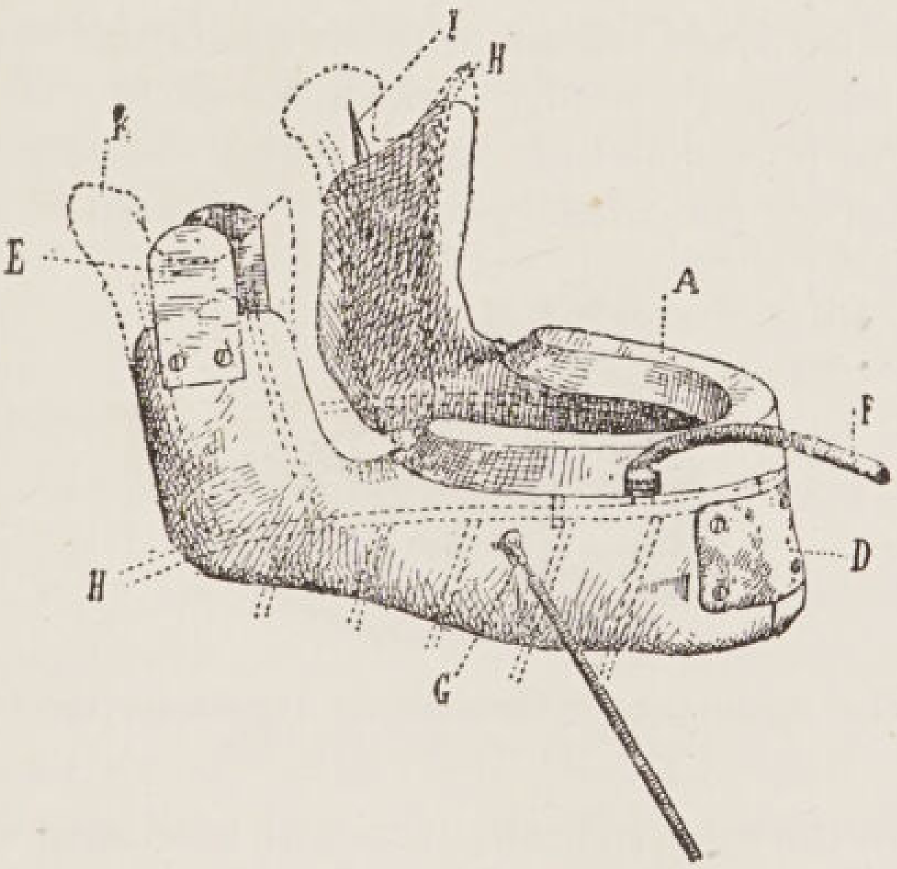


FIG. 100.—Appliance for Immediate Prosthesis for Subtotal Resection of the Mandible. (Martin.)

Moreover, the appliance must be joined to what remains of the original skeleton so intimately that the latter and the appliance, in their general contour, together represent a similar form and fulfil a similar function to that of the entire jaw before the appear ance of pathological processes.

The appliance must present enough solidity to resist the cicatricial tissue. Lastly, the appliance must not undergo any alteration by the contact of scar tissue, or of the pus which may itself engender. Thus, the material used to make it should fill two most important conditions: it must be aseptic and not liable to corrode.

The substance which best fulfils these conditions is pure hardened rubber, without admixture of other materials except sulphur, which serves to vulcanize it. The provisional appliance, which should remain in place for the whole period of cicatrization, must

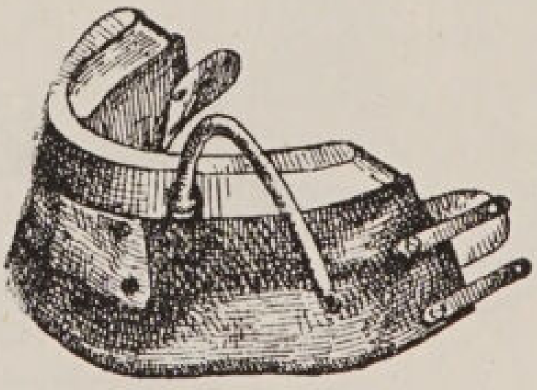


FIG. 101.—Appliance for Immediate Prosthesis for Partial Resection of the Mandible.

allow of the most rigorous antiseptic treatment of the operative field. To this end Martin's appliances are provided with an extensive system of canalization, destined to make possible easy and frequent lavage of the raw surfaces, so as to hasten their cicatrization. But experience seems to have shown that their action was entirely theoretical, and that, on the contrary, they offer to pus, food débris, and calcareous salivary salts, a shelter from which it is difficult to dislodge them. So their use has been discarded for some years already.

Since the provisional appliance is replaced, at the end of a certain time, by a final appliance of greater finish, it must of necessity be easy of removal. To obtain this result, the appliances should be divided into two parts for the mandible and three for the maxilla. One of the most useful precautions to expedite the removal of the appliances is to make them easy to cast off, as we said above—that is, they should be carefully shaped without any constrictions. For instance, we should not imitate the natural constriction at the neck of the condyle, for the scar tissue will tighten on the neck with a resistant sheath which will resist the exit of the larger condyle. For that, instead of imitating the natural condyle, it is more valuable to leave nothing but a small cylindrical stump which will easily slip out of the cicatricial sheath.*

The final apparatus should have the same shape as the first, except in the case of the posterior aspect of a piece representing the upper jaw.

If Martin's method has been welcomed with favour in France, this does not apply to Germany. In fact, the surgeons and dentists of the German school, with certain exceptions, either seem ignorant of its existence, or, like Boennecken (of Berlin) have launched the most violent criticisms against it.

The idea of placing in the very depth of bleeding tissues a bulky foreign body runs counter to all admitted dogmata on the treatment of surgical

* Maurice Roy, "Contribution to the Study of Immediate and Late Prosthesis in Resections of the Mandible," Thèse de Paris, 1894.

wounds. Martin's method has, then, been condemned at the outset for the sake of a purely dogmatic idea, that a foreign body in a wound can only lead to infection and various complications. Martin has answered this adverse verdict by facts, and during thirty years that his method has been adopted by him and his pupils it has yielded nothing but success. In reality, there is no danger in applying an aseptic appliance to a well-drained wound.

Again, Martin's prosthetic method has been reproached with the excessive bulk of the appliances used. Nevertheless, a bulky appliance is necessary to preserve, after the intervention, the integrity of the shape of the region. If the appliance has not the shape of the piece of bone removed, and a mass at least equal, if not greater, a secondary deformity will occur which will be most stubborn to rectify. This principle is all the more indispensable if more extensive resections—notably if these include the ascending ramus—are involved. These deformities, which only massive appliances can check, are easier to prevent than to correct. People have cast on immediate prosthesis the grave stigma that it favours infection of the operation wound, especially in such a septic locality as the mouth. However, appliances for immediate prosthesis, if provided with many canals, allow frequent irrigation of the whole wound surface, and of all anfractuosities, by injecting antiseptic solutions under a good pressure. These irrigations have been accused of encouraging secondary hæmorrhages. This is hardly probable, if we take care not to carry out the lavage until twenty-four hours after operation. In about 150 observations of his own, Martin has only once encountered this accident, which seems, indeed, rather to depend upon a dyscrasia.

Finally, people have formulated against immediate prosthesis one last criticism, which, if it were justified, would undoubtedly be the most serious. Prolonged irrigation of the tissues being regarded as one of the occasional causes of malignant tumours, it has been said in reproach of such appliances (immediate prostheses) that they favour the recurrence of neoplasms by the irritation of the wound in whose depth they are fixed. Experience does not seemingly confirm this idea; and, for our part, in our personal practice we have never seen recurrences clearly to be blamed on a prosthesis. It is with justice that Cl. Martin declaims forcibly against this notion:

"I have done justice to these accusations in showing by the facts that, when a recurrence occurs, it is not manifest any sooner than in the case where we have not placed a prosthesis; and that after two, three, or even four recurrences the immediate prosthesis has had a full success, since the tumour in these cases has not recurred. What encourages the recurrence is a not bold enough resection, extending not widely enough beyond the apparent limits of the tumour. At this day several surgeons of Lyons, whom I have been able to convince of the advantages and harmlessness of the method, are persuaded that, thanks to it, one can without inconvenience increase the extent of the loss of substance without being afraid of going very wide of the limits of the growth. And experience has shown that with large excisions recurrences are much less frequent. So that the prosthetic appliances not merely do not encourage recurrences, but, on the contrary, often help to prevent them by enabling one to make large bony gaps without incurring any disability."*

In Germany, immediate prosthesis used after resections involving the mandible do not as a rule have any relation to Martin's method, and depend on a quite different principle.

Instead of replacing the resected piece of bone by a foreign body of the same size and shape, and leaving the wound open, they strive, on the contrary, in Germany, to maintain the fragments with the help of the smallest possible appliances, which have been named "bandages." These splints constitute, indeed, retention appliances rather than restoring prostheses. The fear of infection which rightly holds sway in the practice of German surgeons, but which is hardly justified in this particular case, causes them to deprive their patients of the advantages of immediate prosthesis according to Cl. Martin's method.

Sauer's appliance is the first of which the application has been published in Germany. It consists of a metal arc interposed between the fragments, and fixed at either end to the remaining teeth. When there are no teeth, the extremities of this splint, altered to a forked shape, sit astride the cut ends of the bone. The two branches correspond to the anterior and posterior faces of the fragments, to

* Cl. Martin, Rapport au Cong. de Madrid, 1903, p. 82.

which they are fixed by metal wires. The wound is then treated by swabbing until cicatrization is complete. At this moment the metal bandage is removed and replaced by a permanent apparatus. If only one fragment remains, Sauer adopts the wearing of an inclined plane (see the volume on Orthodontia) to prevent its deviation. Hahl, Boennecken, Tenison-Lyons use splints similar to those

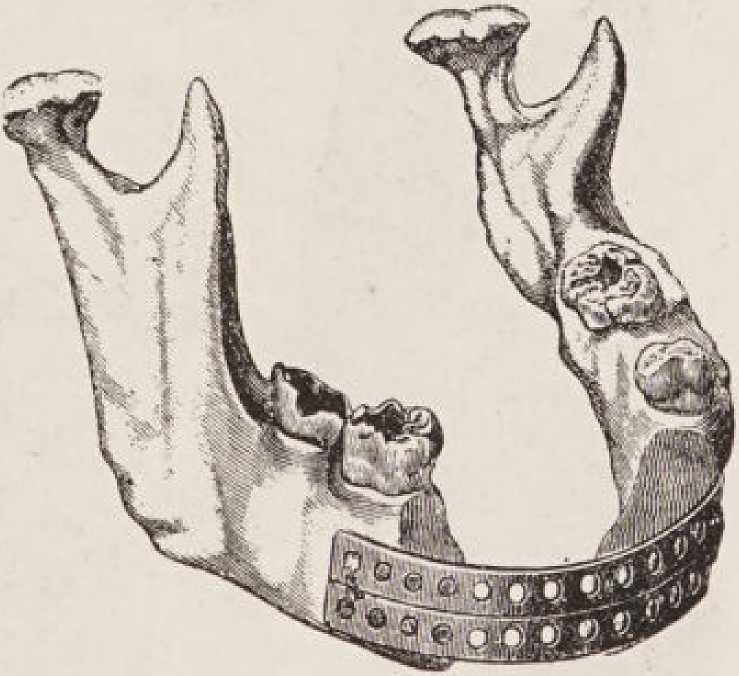


FIG. 102.—Hausmannsche's Appliance.

of Sauer, and formed essentially of a simple metallic wire. They cannot be fixed to the teeth when there are very few of these remaining; one molar, for instance, acting as *point d'appui* on each fragment, cannot resist the pull of the scar tissue. But the most serious criticism which one can level at these appliances is that they offer no resistance to the down-sinking of the soft parts between the two fragments, when these are kept at a distance only by a simple metal wire.

Deformity is inevitable, for iodoform gauze packed into the wound can only remedy it to a very slight degree. Moreover, prolonged tamponage of operation cavities in communication with the mouth or

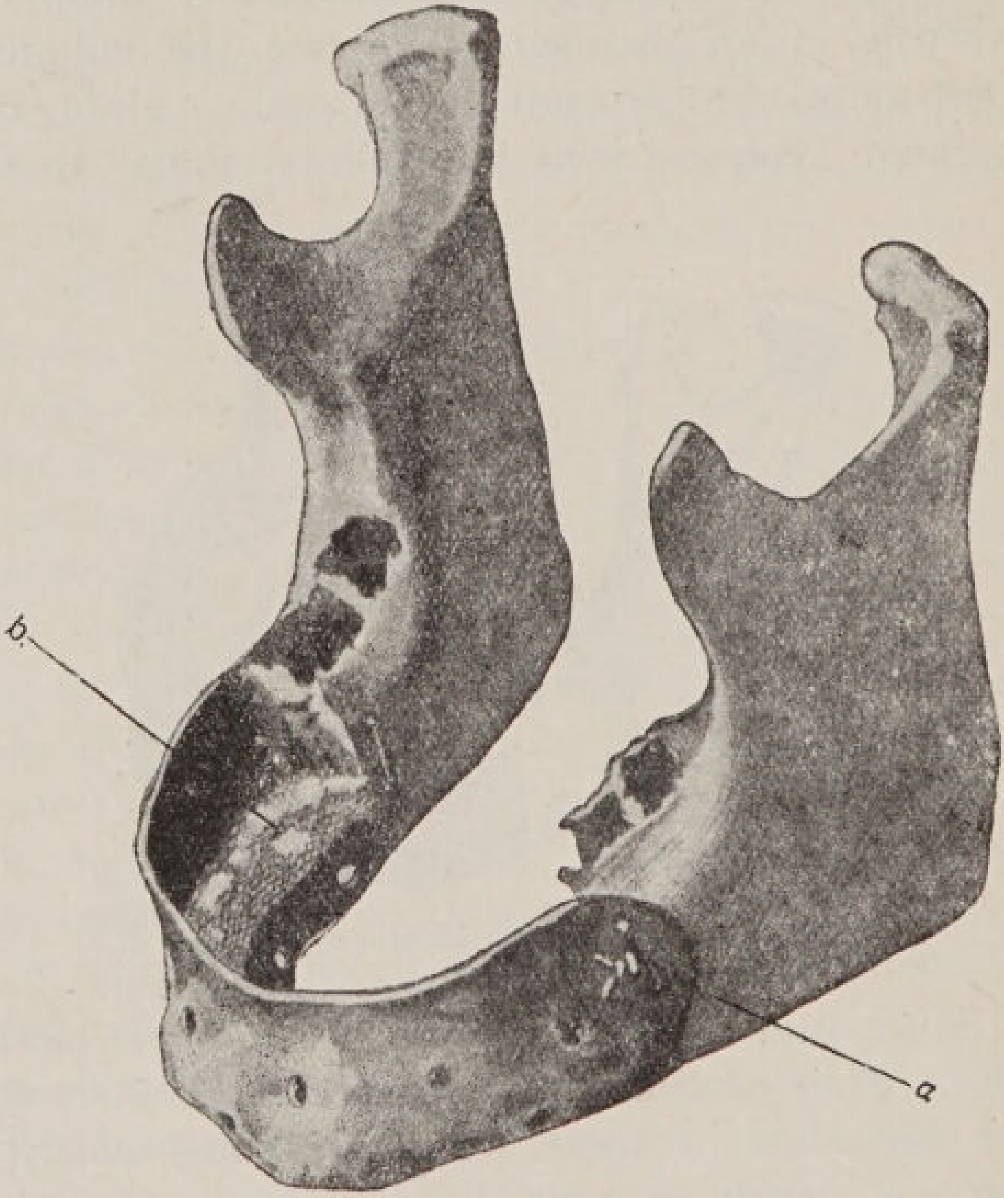


FIG. 103.—Stoppany's Appliance.

nose constitute a detestable plan of treatment; for nothing can more encourage its infection and prolong the period of its epithelialization. The use of temporary splints instead of bulky appliances, so far from being a guarantee against infection, tends therefore to the opposite result, if simultaneously one goes in for prolonged swabbings of the wound with gauze, whether iodoform or plain.

Hausmannsche's appliance consists, not of a wire, but a band of metal, pierced by holes and fixed to the fragments by silver wire ligatures. It is clear that this band is better than Sauer's wire, for the former gives to the soft parts a support in the antero-posterior plane (Fig. 102). With the idea of holding

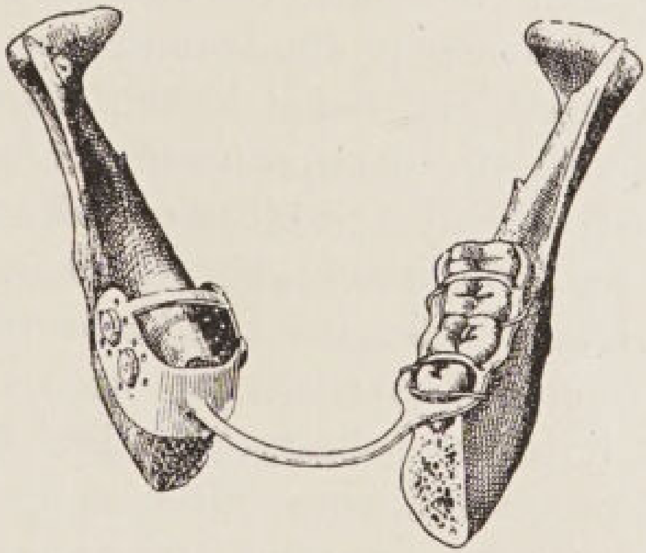


FIG. 104.—Boennecken's Appliance.

up the tissues equally in the coronal plane, Partsch has modified the splint of Hausmannsche by covering its edges with vulcanized rubber.

Stoppany has made an appliance of a metal gutter of the size and shape of the lower jaw, pierced by holes. This gutter, opening upwards, is fixed at its ends to the bony fragments, and its concavity is packed with iodoform gauze (Fig. 103). Here, then, we have a bulky appliance, which, however, presents all the drawbacks caused by prolonged tamponage of buccal wounds. Fritzsche* used a piece of cast tin fixed to the jaw by the intervention of supports implanted in the bone; the tin block and the supports were linked together by pins, so that the piece of tin could be removed and replaced at will, for washing out. In any case, Fritzsche thus approximates in general principles to Cl. Martin's method.

Delair has recommended the use of porcelain to make appliances for immediate prosthesis of the jaw.† Delair's porcelain block has the twofold disadvantage of preventing lavage of the wound (for the piece is not canaliculized, and is not in this case removable, as is Fritzsche's tin block), and of not being able to be retouched as easily as a block of vulcanized rubber (porcelain being infinitely harder than vulcanite). Moreover, Delair fixes his appliance with bolts, a system of retention excellent for internal prosthesis, because of its great solidity, but less desirable for immediate prosthesis, since after a few weeks the appliance must be removed to give place to its permanent successor. Now, a contrivance fixed by bolts is vastly more difficult of removal than is one fixed by screws on only one surface of the jaw.

Finally, let us conclude this rapid review of the various attempts at immediate prosthesis by quoting

* Curt Fritzsche, "Study of Various Mandibular Prostheses, and Description of a New Artificial Jaw" (Rapport à la xvii[e] assemblée des dentistes de Saxe à Leipsig, 16 Juin, 1901; *Deutsche Monatsschrift für Zahnh.*, p. 262, Juin, 1902, et *Deutsche Zeitschrift für Chirurgie*, 1901, lxi.).

† Delair, "Prosthesis for Bony Parts in Porcelain" (*Odontol.*, 30 Janv., 1903. p. 49.)

Martin's opinion on one of the most recent, Schroeder's gutter:*

"The most recently described in Germany, and in my opinion one of the best appliances, is that which was published in 1901 by H. Schroeder. It has several points of resemblance to Stoppany's, but, instead of being in metal, it is made of gum-elastic. It is like a gutter, opening this time, not upwards, but backwards; and its concavity is packed with iodoform gauze. It forms a sort of shell, of which only the outer and lower aspects reproduce the shape of the jaw, holding out the integuments. The upper border of the piece is perforated with holes for attaching the alveolar segment (of this plan Schroeder is still a partisan). The arrangement is kept in place by bilateral ligatures. Schroeder, in the construction of his appliance, has been dominated, like his German colleagues, by the notion of being able to watch the surface of the wound, in view of a possible recurrence. Now, this latter as a rule does not occur, or is not recognizable until after some weeks—that is, at a period when provisional apparatus is commonly removed. The final appliance gives every guarantee as regards this supervision. The caution of the German school in this regard seems, then, to me overdone, as also the fear lest the appliance come into contact with the cut surfaces; for this latter condition is not at all often realized."†

* Schroeder, "Facial Prosthesis: Mode of applying Dental Prosthesis to the Face, with Special Reference to Immediate Prosthesis of the Jaws after Resection" (*Correspondenz Blatt für Zahartze*, Juillet, 1901).

† Cl. Martin, Rapport au Cong. de Madrid, 1903, p. 90.

To sum up: appliances for immediate prosthesis of the lower jaw fall into three groups:

1. Appliances constituted by a hoop or arc, holding the fragments apart, but offering no support to the soft parts (Sauer, Boennecken, Tenison-Lyons). They have the fault that they only correct the deformity to a moderate degree, and do not resist cicatricial contraction.

2. Appliances consisting of a sheet of greater or less thickness (Hahl, Hausmannsche, Partsch). They have the advantage over the first group that they sustain the soft parts better, but their bulk is insufficient to keep the necessary space for the permanent apparatus.

3. Appliances made in the shape of a fenestrated gutter (Stoppany, Schroeder), or in a solid form: tin (Fritzsche), porcelain (Delair), rubber (Martin). They have the advantage of replacing the segment of bone removed as exactly as possible in size and shape, and of thus preserving the space necessary for the permanent apparatus.

Among this latter group, appliances made according to Cl. Martin's principles are certainly the most perfect. They have given, in the course of a long experience, the most constant results; for they satisfy the following conditions, which should always be our aim in immediate prosthesis:

1. The appliance should correspond in shape and size to the piece of bone resected.

2. It should be fixed with sufficient firmness to prevent spontaneous movement, but meanwhile sufficiently lightly to enable it to be removed easily.

In this case the best mode of retention lies in screws applied to the external table of the jaw.

3. The appliance should be made of a substance as compact as possible, easy to sterilize, and resistant enough to oppose cicatricial retraction. This substance must be tolerated by the tissues and unaffected by organic fluids. Its consistence must allow the piece to be pared down and altered quickly and easily at the very moment of operation, so that its application does not entail for the patient the inconvenience and danger of a prolonged intervention.

Vulcanized rubber, in fulfilling all these conditions, constitutes at the present day the material of choice for immediate prosthesis.

CHAPTER V

APPLIANCES FOR IMMEDIATE PROSTHESES FOR THE LOWER JAW

Description of Appliances.—According to the cases and views of the surgeon, there will remain, after operation, either—

1. The greater part of the bone, comprising the posterior portions and the ascending rami;

2. Only one ascending ramus; or

3. Nothing. The mandible has been sacrificed in its entirety, and the appliance thereafter rests only on the soft tissues.

Condition 1: *Partial Resection.*—The appliance has only two parts, the body and the alveolar border.

The fixation to the remaining bone is accomplished by means of metal plates (sheet steel, platinum); the internal plate, fairly large, bears no screw, and serves to prevent the inward displacement of the fragments. The external, narrower, takes small screws, which are inserted into the body of the bone.

Condition 2: Extensive Resection.—The posterior parts of the bone, the ascending rami, or at least the condyles, remain. The appliance is made to represent a whole mandible, and then reduced to the extent of the bone spared. Springs are indispensable; in placing them we allow for the irregular movements of the lower jaw. If one end of the appliance is pointed to fit into the condylar notch, the other end will consist of plates to grip the ascending ramus of the other side.

For appliances of a considerable length, we divide the artificial jaw at the symphysis as soon as it is vulcanized, so as to be able to remove it. To insure the union of the separate parts, we place on the front part of the piece a metal plate, which is fixed into the rubber by means of a screw. If the insertion of the genio-glossi has been destroyed, we pass a metal wire through the tongue and attach it to the appliance.

Condition 3: Complete Resection.—There has never been a case of immediate prosthesis applied after total resection of the mandible. Nevertheless, Martin published one observation where nearly the whole jaw was affected (except one condyle and one coronoid process), and, basing his opinion on this, considered that the placing of this class of apparatus should not present much greater difficulties than in other cases.

The alveolar border of the provisional appliance carries no teeth. In the final apparatus, on the contrary, these are provided. It is of hardened rubber, and carries at its lower border two rods, sliding with hardly any friction in the lower jaw.

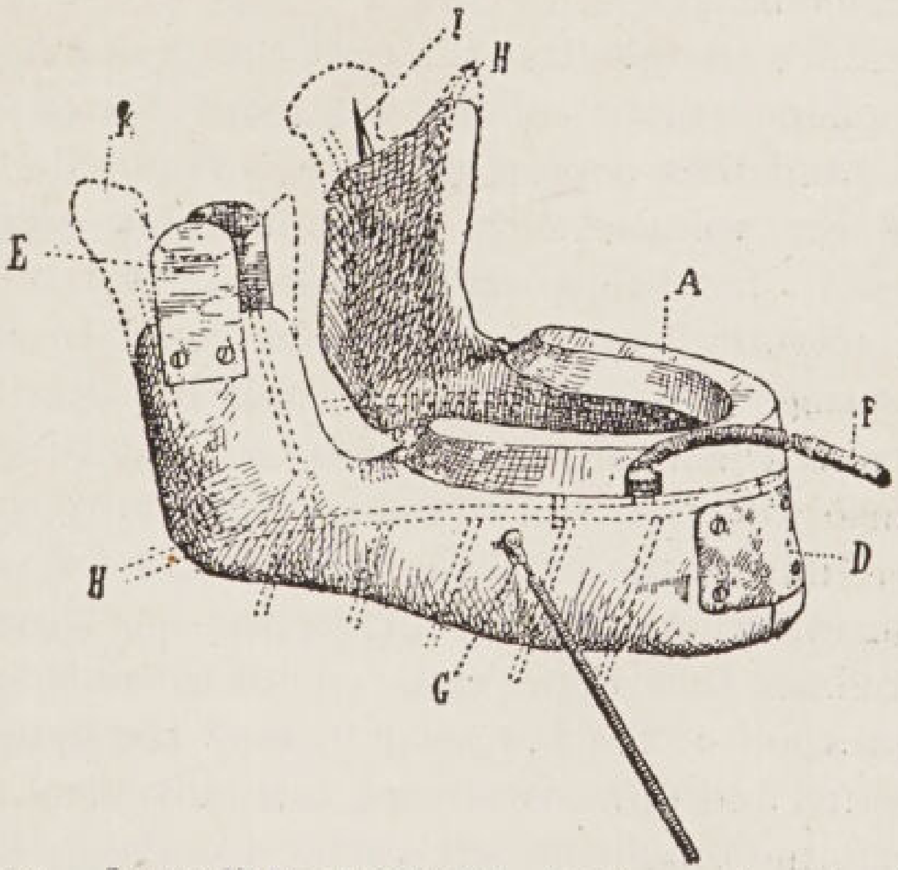


FIG. 105.—Immediate Prosthetic Appliance for the Lower Jaw. (Martin.)

Thus it can be removed and modified according to the requirements of the articulation.

Means of Retention.—These vary with the case and the parts involved. We can thus divide them:

(*a*) Methods of fixation which immobilize the apparatus: screws, pins, platinum rods.

(*b*) Means of *retention* properly so called, which act by simply reinforcing: hooks, wings, springs.

Screws, pins, and platinum rods, which by their head penetrate the jaw through and through, and at their tail end are curved or fixed with a nut, have been used. We have just seen that the apparatus should carry two external plates pierced by holes through which pass screws fixed into the bone, and one internal plate placed against the inner side of the fragment.

To assure the good working of the jaw and hold the appliance more solidly, we avail ourselves of springs, and then a palatine plate is required; these springs are spirals, such as we use for ordinary prosthesis, fixed by spring-holders. Martin has altered certain features in their action. In fixing these springs to the dentures, one usually places them on a point which forms the centre of gravity of the appliance; their rôle consists in keeping the apparatus in place during the movements necessary for speech and mastication. Martin made use of them by immobilizing their upper end, to limit the movements of depression of the jaw, and to urge the appliance backwards and upwards during this movement.

When the fragment left intact by the resection carries teeth, it is well to use them as a point of attachment, by fitting thereto hooks, sheets, or crowns. In certain cases it may happen that the appliance, only resting on soft tissues, may be insufficient to resist the lateral displacement of the remaining fragment. We remedy this with the help of two vertical wings fixed, the one to the upper, the other to the lower appliance. [The author here implies that the hooks, sheets, or crowns, or else what we call a "cap-splint," have been fixed to both upper and lower teeth on the side of the remaining mandibular fragment—Tr.] These wings generally have the shape of a quarter-circle, and are arranged so as to glide one on the other in the up-and-down movements of the jaw; the lower passing outside the upper, the inner face of the former is in relation with the outer face of the latter (see Figs. 22, 23, 24).

Their height must be adequate; for when the mouth is open, the juxtaposition of the two wings, near their free edges, is to check all movements of lateral displacement and guide the lowering movement. To prevent too great friction against the whole surface of the plane, we can stamp on the upper plane (*i.e.*, wing) a boss representing the segment of a circle whose centre is the temporo-maxillary joint; so that friction is limited to the surface of this boss, which is about 1 mm. wide (Gillard).

Martin has lately published a new process, which he employs when the resection affects the body of the mandible, including part or all of the ascending ramus. In his case, only one end could be fixed to the remaining fragment; the other free end was uncomfortable, and could have even hindered the movements of the lower jaw. He altered his plan of fixation as follows: To that part of the appliance which had to fit against the remaining fragment he fixed three plates. One, attached to its inner aspect, simply rested against the bony fragment. The other two were attached to the outer aspect of the appliance. Of these two plates, that which was screwed to the upper part of the bone had to be screwed on to the lower part of the appliance; whereas that attached to the lower part of the bone joined the upper part of the appliance. This simple contrivance of crossed plates enables one to dispense with the gutter to enclose the teeth remaining on the fragment—such a gutter had until then been employed—and makes the retention of the apparatus much firmer.

As in all cases where appliances of this sort are not placed between two fragments, and where they are held by one solitary fragment, it will be wise to employ the small wings previously described. They play their part of preventing the displacement of the fragment and keeping it in its normal position. After we have found a sufficiently firm support in the means of attachment, the means of *fixation* must be dispensed with; and it is not always easy to remove the screws, owing to the condensation of bone. It is no good thinking of unscrewing them; we must force them out by leverage on the metal bands with an instrument introduced under the mucosa—a strong rugine, for instance (Maurice Roy).

When the surgeon has respected the periosteum and left it adherent to the muscular tissue, we must arrange in the apparatus a sort of sheath for this periosteum and for the new bone which will be formed. Step by step with this new formation we must modify the appliance.

Construction of the Appliances.

The fashioning of appliances for immediate prosthesis has certain characteristics common to that of all prosthetic dental appliances. None the less, there are certain original details which it is useful to emphasize.

A. First or Provisional Appliance—*Taking Impressions.*—Strictly speaking, our concern is to take measurements; for an impression of a part not yet exposed cannot be taken. The measurements should give approximately the shape of the appliance which is to replace the bony segment removed. For this, we procure a jaw from a skeleton having nearly the same shape and size as that of the subject. We then measure the width of the upper dental arch of the patient and the height of the healthy portion of his mandible. Thus we get sufficient data to make the provisional appliance.

Mould in Wax.—On these measurements we make, in wax, a jaw resembling the model chosen. We mould in several parts the natural jaw; these parts give the hollow (or negative) mould. In this we cast wax, thus obtaining a jaw of the type selected.

Modifications.—This jaw in wax is then altered, according to requirements and measurements. The alveolar border, which, after the moulding, is furnished with teeth, is assembled into one piece. By separating the alveolar margin from the body of the jaw with a steel spatula (preferably heated), we get the two pieces of the mandible.

Internal Canals.—If we wish to furnish the appliance with these, so as to irrigate, we proceed in the following manner: The body of the jaw is traversed throughout its whole length, when it is in wax, by a zinc tube placed in the midst of its thickness; the tube exits at the two ends of the piece. In fact, it should project beyond the latter for about 2 cm. These two ends of the tube must be sunk in the plaster, so as to keep the whole tube in a settled position during the removal of the wax and the substitution of rubber. At the level of the ascending rami we add to the vertical tube two vertical prolongations, also tubular, which, with the same object, emerge at the end of the condyle and coronoid process. The zinc tube should be treated with Spanish white on its inside, to prevent during its vulcanization the penetration of rubber, which would choke the tube and make irrigation impossible.

Flasking.—Having thus prepared the piece, we flask it as for an ordinary apparatus. Only, in view of the bulk of the appliance, we require a special flask. Martin uses a series of washers, 2·5 cm. in height, one on top of the other; according to the size of the apparatus, he puts in fewer or more of these. M. Roy employs a more simple flask consisting of a metal block, fairly large, with a cover similar to that of an ordinary flask.

Filling.—To prevent the porosity of the appliance, we make fragments of rubber permeate it as far as possible. These tiny pieces should be of hardened rubber, carefully cleansed; and their object is to fuse intimately with the rubber which we shall vulcanize.

Vulcanization.—A most important procedure in making these appliances. As they are very bulky and surrounded with much plaster, one must raise the temperature slowly, and take an hour to arrive at 145° C. This point reached, do not exceed it, and keep the vulcanization at this degree of heat for four or five hours. Having finished the vulcanization, let the flask cool in the vulcanizer.

Repairing.—The piece is repaired; then we cut it in two in the middle line. After that we remove the zinc tubes by placing the piece in water to which sulphuric acid has been added. There now remains, in the place occupied by the tubes, a canal traversing the appliance from one end to the other. The two segments are then joined by means of a steel plate screwed on to the appliance. We re-establish the continuity of the irrigation canal (previously divided by a vertical saw-cut, as just mentioned) by means of a metal tube, which joins the two cut ends of the canal, and simultaneously helps to support the two parts of the piece. At the upper part of the appliance, at a point corresponding nearly to one of the canines, where the central canal lies near to the alveolar border, we place a small metal tube which has a gentle slope from above downwards and from without inwards. Its lower end enters the central canal. To its free end is fitted the rubber tube, which emerges from the mouth and facilitates irrigations.

On the lower border of the appliance we make, with a drill, a series of holes communicating with the main canal; by these openings the adjacent raw surfaces will receive antiseptic washes. Later, when the irrigation canals become useless, one can block them up by injecting into them a little iodoform wax.

B. Second or Permanent Appliance.—Whatever this may be, it is less beset with difficulties than the provisional appliance. It should have the same dimensions, based on the mould which has served for the former. But since cicatrization has modified the buccal floor, it is useful, while taking the impression, to keep the fragments apart by an apparatus.

There are no longer irrigation canals, for the appliance is removable and can be cleaned. There is no longer a vertical division, at any rate in the

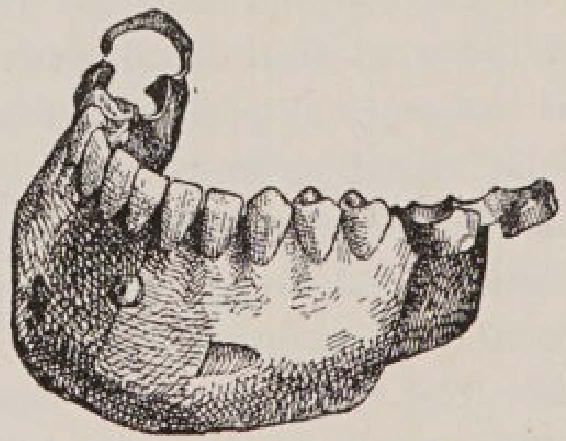


FIG. 106.—Final Apparatus for the Lower Jaw. (Martin.)

less considerable appliances. But if the piece is bulky, it is useful to make a vertical median cut, closed by a spring resembling the catch of a bracelet. The points for bony attachment are dispensed with. The internal prolongations are kept, but they are made of the same substance as the appliance. Instead of natural brown rubber, one can use rubbers variously coloured, so as to harmonize the colours from the æsthetic point of view. The alveolar border is furnished with teeth which articulate with those of the upper jaw (Fig. 106).

CHAPTER VI

APPLIANCES OF IMMEDIATE PROSTHESES FOR THE UPPER JAW

I. Generalities.

THE advantage of immediate prosthesis for the upper jaw are fewer and less important than for the lower jaw. However, in giving a *point d'appui* to the soft parts, the appliance prevents the deformity consecutive to scarring. It permits of feeding directly after cicatrization, and facilitates speech. One should, accordingly, make a practice of immediate prosthesis in all cases of resection of the upper jaw.

We proceed as for the mandible. That is to say that, immediately after the resection, we fit an apparatus made beforehand according to certain data provided by the parts to be replaced, and obtained before the operation. As a rule this mould only gives rough indications of the exact dimensions which the appliance should have, but in such resections as are only unilateral the lower dental arch and teeth of the sound side are used to obtain the necessary measurements. If the upper jaw carries no teeth, the bare dental arch suffices to indicate the dimensions of the appliance. The height is indicated by a line drawn from the necks of the teeth (or the alveolar margin) on the opposite side, to the orbital floor, without reckoning the soft parts.

II. Description of Appliances.

They are less numerous, and admit of fewer modifications, than the appliances described for the mandible. The points of attachment are less complicated and play a less important part, since the apparatus is fixed in immovable masses, which make it easier to fasten them. Owing to the height which they may have, a transverse division into two parts is sometimes necessary. Just as in the case of the mandible, one can equip them with a system of central canalization with multiple openings, which, at any rate in early stages, allows of rigorous antisepsis and the omission of dressings. The appliance is of hardened rubber, and represents a greater or less segment of the maxillary structure. It is divided into two parts. One constitutes the velum, the hard palate, and dental arch; it is horizontal. The other, vertical, includes the whole anterior surface of the upper jaw, the nasal and malar bones, and the orbital floor.

The portion corresponding to the dental arches is of hardened rubber, so as to be able to be altered according to the needs of the articulation. The palatine vault and the velum, when the latter is concerned, are in all cases complete [*i.e.*, bilateral, a replica of the whole roof of the mouth—Tr.]. This horizontal part is destined to replace the portion removed on one side; and, on the other side, to cover the remains [*i.e.*, the remains of soft and hard palates on the sound side—Tr.], so as to have no solution of continuity. For the rest, the margin on the healthy side is furnished with hooks to fix the appliance to the remaining teeth (see p. 20, Figs. 9 and 10, for the type of hooks to be used); if these are not enough, we can supplement them with springs taking

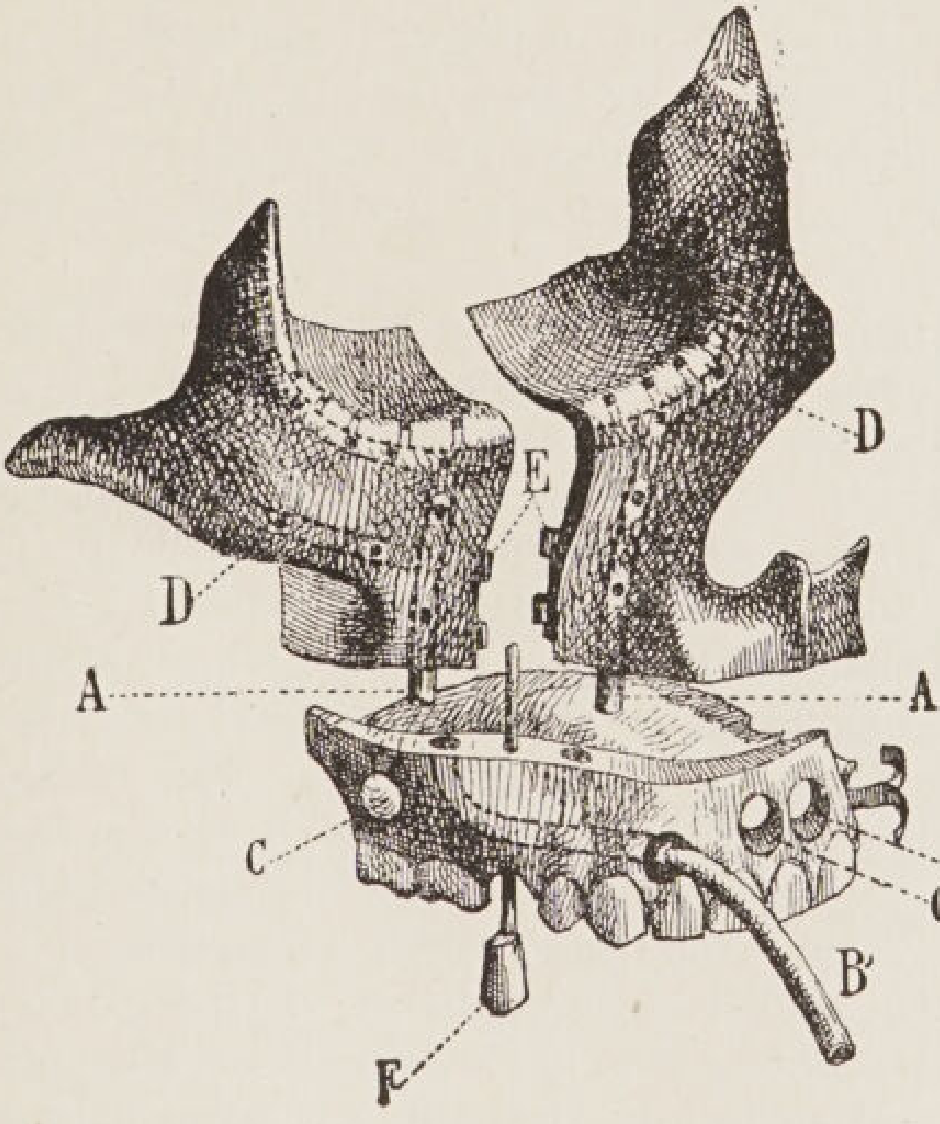


Fig. 107.—Provisional Appliance for the Upper Jaw. (Martin.)

their purchase from the mandible. The hindmost part of the horizontal portion always ends in a sheet of soft rubber, which lends itself better than hard rubber to the movements of the palatine velum. At the foremost part of the horizontal portion, representing the dental arch, we arrange an opening, to which is fitted the tube to serve for lavage, supposing that the appliance possesses a canal system analogous to that described for the mandible. Some large lateral openings allow of the exit of the fluids. The horizontal part fits on to the vertical portion of the piece representing the external face of the bone. A pair of tubes suffices to join up the canals of the two pieces, simultaneously contributing to their firmness.

The parts corresponding to the ascending ramus of the maxilla, and to the malar bone, being larger than the part below, and therefore not easy of removal, we divide this upper portion into two, by a vertical saw-cut joining the middle of the orbital floor to the first or second premolar. These two segments of the upper piece are hinged at their line of intersection. Then, by a metal rod passed through them, they can be kept in close relation, not only with each other, but also with the lower piece. By withdrawing this rod, nothing is simpler than to remove the three parts of the appliance.

All that portion of the appliance which corresponds to the posterior region of the bone is left wide open, because it suffices to keep the soft parts in place, leaving the deeper tissues to cicatrize in their own way. Thus, there is no necessity, as there is in prostheses for the lower jaw, to make an appliance equal in volume to the piece of bone resected.

"The anatomical conditions presented to us," writes Martin, "after a resection of the maxilla, are utterly different from those which exist after resections of the mandible. Whereas the latter, very mobile, tends, under the influence of muscular contraction and cicatricial retraction, to deviate, the upper jaw, deeply embedded in the bones of the face and of the cranial base, leaves after its ablation a vast cavity whose fixed bony walls cannot come together and scar over. This cavity can only shrink by the depression of the facial integuments. For the rest, the roomy communication between mouth, nasal fossæ, and pharynx, involves in its train grave functional troubles—disabilities of mastication, swallowing, and speech. *Often the æsthetic deformity is but little marked, and it is above all the functional changes which predominate.* [The italics are the Translator's.] Hence the paramount importance of prosthesis for these patients. The arrangement in front of the vertical part leaves free the cavity produced by the bony ablation. The latter can thus cicatrize freely without any obstacle to its occurrence. It should be added that the facial integuments are sufficiently held up for the deformity to be perfectly corrected. The horizontal part of the apparatus allows mastication and pronunciation to be started afresh without delay."*

Fixation.—The apparatus is fixed in its cavity with the help of springs; or to these may be added rings adjusted to the remaining teeth. If such means be inadequate, we may have recourse to spikes buried in neighbouring portions of bone.

* Cl. Martin, Cong. de Madrid, 1903, p. 96.

III. Construction of Appliances.

A. Primary Appliance.—As in the case of the lower jaw, we must obtain a natural maxilla corresponding approximately to the age and development of the subject. We take the mould of the parts to be replaced, but also take the impression of the teeth of the lower dental arch of the opposite side. The height is arrived at by a line drawn from the neck of the teeth or the alveolar margin to the middle of the orbital margin, due allowance being made for soft parts by subtraction.

If we have to make an apparatus to replace the two upper jaws, we make from moulds the whole anterior mass of the maxillæ, plus a part of the neighbouring bones [malars, nasals—Tr.]. This part of the apparatus should be made of pure hardened rubber, but should not exceed 1 mm. or 1·5 mm. in thickness, except where it covers the irrigation canals (which are made by the same process as for the lower jaw). The canine fossa should be more shallow than normal, so as to give the apparatus a slightly greater bulk.

Hinges.—These are placed on the wax model so as to take exactly the place which they will occupy in the vulcanite. They are kept in place by zinc wires, so as not to become displaced during the filling. The appliance is made in two parts, upper and lower, in wax. It is not until the baking is finished that the upper part is divided into two parts by a vertical saw-cut. The thickness being minimal, one need not take precautions against porosity.

B. Final Appliance.—In distinction to the former (A *supra*), the appliance is in a single piece, and has a posterior wall; its cavity is entirely filled up. All the buccal part, except the velum, is of hardened rubber. All the remainder (destined to fill the cavity left by the bony ablation) is of soft rubber The aim of this is not to irritate the deep parts, although obliterating the chasm; if this point be neglected, the patient will have a nasal and defective pronunciation. After the final appliance, which fills all the cavities flush, has been placed, pronunciation becomes normal.

In order to reduce its weight, we make this apparatus entirely hollow.

If the resection, involving both maxillæ, has destroyed the vomer, we make an artificial one, with a space each side of it to imitate as closely as may be the arrangement of the nasal fossæ.

The final appliance is attached to the teeth near-by with gold plates or springs. Cases occur in which, owing to the irregularities of the cavity, the piece holds steady of its own accord.

Composite Impression.—Supposing the mould is unsatisfactory on account of the depth of the cavity. We make use, for choice, of Stent's or godiva. Begin by moulding the deepest parts and letting them cool; take this segment of the impression out and trim it, then mark it with a few points, oil it to prevent adhesion, and apply another layer of godiva. Three or four superposed partial impressions constitute the complete mould of the hollow. When the successive layers have arrived at the edge of the palate, we take an impression of the palatine vault with the softest godiva obtainable, so as not to soften the other impressions, and proceed as for an ordinary model. We can just as well even use plaster for the last impression. With the help of the points previously made as landmarks, we withdraw separately the partial impressions, reconstitute the total impression, and cast the model in plaster.

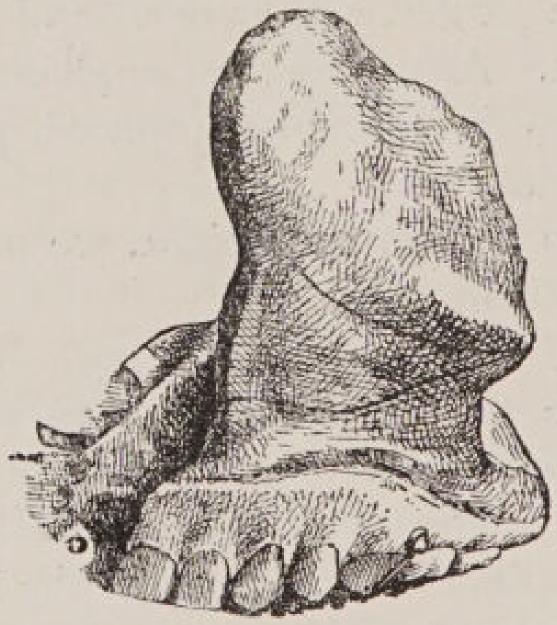


FIG. 108.—Final Appliance for Upper Jaw.

Pont,* recognizing the difficulty of retaining the partial impressions without displacement, has quite lately indicated a process to keep them in place. "After moulding the buccal cavity in blocks of Stent's, we perforate each block through its centre. We try to make this hole in the same direction for each cylindrical piece, so as to arrange a lumen through the blocks. Thus we have a veritable little

* Pont, "Process to facilitate Impression-Taking in Surgical Prosthesis" (*La Province dentaire*, 1913).

tunnel in the mass at its centre of gravity, and directed obliquely from above downwards and from before backwards. Having done this, and before replacing the blocks in the nasal cavity, we introduce a Belloc's sound, or, if it be preferred, a soft rubber sound, into one nostril, and pass it in until its end is clearly visible in the buccal cavity.

"This little manœuvre is all the easier to execute as the velo-palatine fissure is larger; we introduce into the eyelet at the end of the sound a little silken cord or a string, and extract the sound. We have now a string which enters by the mouth, and, passing by the nasal cavity, exits by the nostril. While the patient catches hold of that end which emerges from the nose, the operator passes the other end into the hole made in the blocks of Stent's. These are then put well into place; and when the last occupies its proper position, we fix to the end of the string a little wooden rod which forms a stop-catch, and prevents the string from being dragged out, when we pull on it by the nostrils."

Base.—We make in the first place the horizontal part of the appliance in hardened rubber, rose pink like an ordinary denture. This part is equipped with teeth. "On its upper surface, at the circumference of the orifice, we make a narrow edge (always of hard rubber) with a height of 5 mm., which comes into exact contact with the area surrounding the orifice, and can be welded on to the upper part of the appliance. The lower face of this lower piece, which should lie on the tongue, represents the palate and the alveolar margin. We flask, vulcanize, and trim, and on the upper unpolished surface we fit the superior part of the appliance" (Martin).

Upper Part.—This should fill up all the cavity left by ablation of the maxilla. It is very thin, and through almost its whole extent is of soft rubber. To obtain it, we cork up in the mould all the points which we do not want filled up; and at the points corresponding to the nasal fossæ we place several thicknesses, so as to contrive the opening necessary for respiration. Next we overlay all the internal surfaces with a sheet of wax of 1·5 mm. thickness. Thus we get the shape of the whole cavity. We then fit it on to the margin of the corresponding palatine piece. We flask it and cook it separately. Care must be taken that it keeps its shape. One must use sifted plaster, very fine, to get a smooth surface, and take care not to have air-bubbles. One may also cover the plaster surfaces with tin-foil.

The filling is done with soft rubber. Only those parts which should resist cicatrization will be of hard rubber; that is especially the anterior and antero-lateral surfaces. However, towards its lower edge, at the level where it joins the horizontal part, it is good to place 2 or 3 mm. of hard rubber to make more sure of the union of the two parts of the appliance, also to resist losses of shape which may occur at this point (Martin).

Vulcanization.—This should be slow; the piece is then removed. Guided by the model, we fit and weld together the two parts, by means of rubber slowly dissolved in chloroform and spread along the borders with a spatula. With a drill pierce a small hole through the hard rubber into the hollow of the piece. Fill this cavity with water, then close the hole with a rubber peg. The piece is again flasked and heated.

The soft rubber which enters into this class of appliance should always be pure "para" with 6 per cent. of sulphur; it should be vulcanized for four or five hours at 145° C. One can later hide its black colour by covering it with a thin layer of rubber coloured with a solution of red or rose. Having cooled the piece in the flask and removed it, we take out the peg and pour out the water. The piece has kept its shape. We fill up the hole with rubber or a screw. If the piece includes any springs, we shall have selected the place of the spring-holders for this hole. The soft rubber is trimmed with a heated spatula which is applied to the rough points. We clean the appliance by washing it with chloroform.

CHAPTER VII

PLACING THE PROVISIONAL APPLIANCE—TREATMENT—PLACING THE FINAL APPLIANCE

To negotiate the placing of the provisional appliance, the prosthesist should equip himself with the following instruments: A dental engine; a slip-joint and some drills; some files for rubber and for metal; a saw-handle and some saws; a screw-driver and some screws; a mallet and some wedges; some bolts, and a spanner for nuts, according to the mode of fixation which we have elected. All instruments destined to come into contact with the wound or the operator's hands should be sterilized. That is why one must possess oneself of a slip-joint, which can be sterilized, whereas a hand-drill all in one piece, with its flexible arm, can at best be made questionably sterile. For the same reason one should reject any instrument not provided with a metal handle. A rubber prosthetic appliance can be sterilized by boiling. These preparations being effected, the intervention will take place in three stages which are sharply distinct from each other, and during which the surgeon and prosthesist alternately help each other.

First Stage.—The surgeon, helped by the prosthesist, performs the resection of the jaw as decided upon, and attends to hæmostasis of the wound.

Second Stage.—The prosthesist, helped by the surgeon, fits the appliance between the bony fragments. By means of saw and file he prunes away the excess of rubber (which he has had the foresight to leave), so as to facilitate its adjustment. He satisfies himself that this adjustment is exact, by verifying the correct interdental articulation of the jaws on the opposite side. Having once reduced the appliance to suitable proportions, he makes holes in the bony fragments with a drill and a dental engine, or the hand-drill which we have described on p. 242, Fig. 117. If he uses screws or wedges, the holes involve only the outer table of the bone; if he uses bolts, the jaw will be perforated through and through. Having made these points of retention, he next proceeds to place the screws, wedges, or bolts.

Third Stage.—The surgeon finishes the operation by suturing the soft parts. The second stage, which belongs to the dentist, is far the longest. The adjustment of the appliance, and especially its fixation, are always fairly difficult; for the things must be placed all in a moment with speed and precision. The prosthesist must always arm himself with calmness for every attempt, and with a large stock of patience for such intervention.

After-Treatment.—The bony fragments solidly joined, and the maxillary arc reconstituted, the skin incision as a rule unites by first intention. But sometimes a fistula persists, and is encouraged by the presence of the appliance; the buccal wound persists, and all the surgeon's care from that moment must be directed, not to make the wound fill up, but to make it epithelialize as quickly as possible. More or less suppuration is established. There is nothing surprising in this, since it occurs in a wound communicating with a septic focus in the mouth. We should make every effort to drain this anfractuous cavity by the mouth, to prevent the pus finding tortuous paths outwards by making one or more cutaneous fistulæ. So as to obtain this drainage, constant irrigations must be made in the depth of the mandibular chasm through canals which permeate the prosthetic appliance in every direction. Thus we bring to bear on all surfaces weak antiseptics intended to cleanse them. This drainage should be made continuous; therefore we must multiply the irrigations, and *carry them out about once an hour*. [The italics are the Translator's, and signify that this idea is strongly supported by his personal experience.] If we do not practise them regularly, we encounter infective phenomena at once.

In proportion as cicatrization advances, we progressively diminish the number of irrigations, and when the former is complete we arrive at their nearly complete cessation. This cicatrization is very long, because the wound must be covered with an epithelial clothing, and this despite the unfavourable conditions created by the presence of a septic foreign body. We know the difficulties encountered by otologists to prevent petromastoid excavations from filling up, and to obtain a good epithelialization. This takes at least two, often three, months of methodical dressings. Maybe, however, we can hasten healing by borrowing from oto-rhinology some of their methods of coaxing epithelial growth, notably dressings with boric acid or peroxide of zinc, slid in between the appliance and the granulating surface of the wound. [No such method as this is in common use by British oto-rhinologists for mastoid cavities or for nasal operations—Tr.]

The primary appliance must stay *in situ* a long time, eight months at least (Martin), which facilitates the application of the final appliance. The older the scar, the less its tendency to retraction. It is better to mobilize the appliance as soon as possible after the first few weeks, so as to facilitate lavage and thereby hasten epidermization. To mobilize the apparatus, we remove the screws which attach it to the jaw, and plug the internal canals with wax; but it is not until a long while afterwards that the final appliance is fitted. The substitution of the second for the first appliance should be done without delay. If not—if we leave the mouth without any appliance for some days—the final appliance, as a result of the cicatricial contraction, cannot be fitted, and must sometimes be a good deal modified. The final appliance possesses no canals for irrigation, and should be frequently removed for cleansing. But it should shortly be replaced, so that there should be no retraction. For this same reason the invalid wears it constantly, and does not remove it at night.

CHAPTER VIII

CONCLUSIONS

Advantages of the Method.—Thanks to prosthesis, one can easily oppose the retraction of the tongue by passing through it a metal wire and fixing it to the artificial jaw, instead of attaching it, as formerly, to the remaining fragments of the jaw, to skin, or to pieces of dressing. These latter mentioned methods do not render it very firm, and do not place the patient out of danger of asphxyia.

By means of immediate prosthesis we guide cicatrization. The appliance resists any deformity of soft tissues or approximation of the remaining bony parts. Since its bulk and shape are the same as those of the jaw removed, the result, from an æsthetic point of view, is perfect. The patient has the same cast of countenance as before the operation, instead of the hideous deformities which follow resections of the lower jaw not followed by immediate prosthesis. Swallowing is made easy; the appliance gives to the tongue a *point d'appui* sufficient to urge the bolus towards the pharynx. By means of this appliance, mastication of semi-solid food is possible a few days after operation, and little by little solid food follows in turn. Fluids can be taken by the patient himself quite soon after the operation; the œsophageal tube is not called for. Speech is equally made easier; the invalid expresses himself almost perfectly in an intelligible way, which is nowise comparable to the incomprehensible jabbering which goes with jaw resections not followed by prosthesis. Lastly, thanks to the reconstitution of the natural dam formed by the lower jaw against the trickling of saliva, the invalid, at the end of two or three days, retains it, and is not still further exhausted by endless salivation. These functional results cannot fail to improve with time. In proportion as the appliance settles down into place, it renders increasing service, and cannot be discarded without a considerable upset of the subject's conditions of life.

Disadvantages. — Boennecken has formulated against Martin's immediate prosthesis certain objections which we may recapitulate thus:

1. Martin's appliance is a crime against asepsis, for it constitutes a cause of infection.

2. Foreign bodies are only well tolerated if they are small. Now, Martin's appliances are bulky and give rise to irritation of the tissues.

3. Martin's appliance favours the recurrence of

the tumours on account of which one has intervened.

4. The apparatus is complicated and difficult to make.

Of these criticisms against Martin's method a certain number may be thrown aside. The size of a foreign body has no influence on its tolerance by the tissues. Experimental researches by one of us* allow us to deem the volume to be a negligible factor in its tolerance. Besides, as regards Martin's system, the question is irrelevant, since the appliance replaces a bony part already existing, and does not create anew for itself a place in the midst of the tissues. Nevertheless, this idea seems to have met with the approval of some practitioners who use immediate prosthesis; for they seem unanimous in seeking to reduce the volume of the appliances to a minimum, and to replace vulcanized rubber by metal. The contrivance suggested by Boennecken is a metal hoop, keeping the two fragments separated. Verneuil and Michaëls had already made use of it. Michaëls' invention was a metal bridge (iridium-plated platinum) formed by two wires, placed parallel for the length of the part resected. Metal rings are soldered to, and so connect, the two platinum rods, of which the lower is twice as strong as the upper. This metal bridge is fixed by screws to the fragments of the natural jaw. The underlying principle of this combination is the easy occlusion of the divided tissues and the re-

* G. Lemerle, "Contributions to the Experimental Study of Internal Prosthesis," Thèse Paris, 1907.

establishment of the soft parts across the rings of the appliance. In the middle of the appliance is a nut, "tapped" with a female screw-thread; into this fits a male screw, 2 cm. long, which will later on give a purchase for the fitting of an artificial denture. This appliance was well borne for seven or eight months; at this moment a recurrence of the neoplasm discounted its permanent success.*

Gillard is yet another who has used a metal appliance consisting of a rod with clasps and catches which fit the bony fragments; he alters the dimensions of his appliance at the time of placing it by a most simple scale of measurement. Lastly, Partsch of Breslau,† so as to keep the spread of the bony fragments without hindering the recovery, applies to their inner surface two bands of aluminium bronze, furnished with openings. These divergent ideas have brought about a regrettable confusion between prosthetic methods. The truth is that, just as the method invented by Martin is consistent with the end at which he aimed, so also those authors who have followed him have worked on his lines, and have made prosthetic attempts which are strictly speaking neither immediate nor internal prosthesis. By his immediate method Martin seeks to prevent a wound from filling up, and to make it skin over; so that he may later restore the loss of substance by means of a mobile appliance put into the breach, which has become covered with mucous membrane like an

* Michaëls, *Odontologie* et *Revue internationale d'odontologie*, Mai, 1894.

† Congrès de la Société allemande de chirurgie, Avril, 1897.

alveolus. In fixing metal hoops to the bony extremities, the authors just quoted have abandoned immediate prosthesis; for these metal arcs, although holding the fragments in place, no longer hinder the wound from filling up. Such metal splints, then, should not later give place to final and movable appliances, as in Martin's method. They are placed to stay permanently; thus we are here concerned with internal prosthesis, not immediate provisional prosthesis. These attempts at internal prosthesis applied to the lower jaw are destined to inevitable failure, being made immediately after resection, and therefore in a septic area.

The first rule to observe, to obtain a tolerance to a foreign body, is rigid asepsis. This is not obtained in the prosthetic experiments which we enumerated above. Michaëls, for instance, passes into the mouth a metal rod, which is later to support a denture. This rod makes a communication between the maxillary bed and the septic buccal region; infection is inevitable, intolerance certain. Martin's method does not depend on the principle of asepsis. His immediate apparatus involves a longer or shorter suppuration, and can cause cutaneous fistulæ. But these drawbacks are fleeting, since the immediate appliance is provisional, and all these happenings vanish at once on its removal. The methods of immediate permanent prosthesis applied after resection of the mandible are in just the same way a crime against asepsis. They entail the same suppuration and fistulæ, *but these accidents are as final as the appliance,* and persist until the latter is removed or expelled by the tissues. In any infected area, immediate permanent prosthesis gives failures; only immediate *provisional* or *late* internal prosthesis can succeed. Immediate prosthesis is indicated in the event of a resection which oversteps the horizontal part of the jaw. Late internal prosthesis, on the other hand, finds its application after partial resections of the horizontal ramus; for it is impossible to fix firmly an internal appliance to a point beyond the angle of the jaw.

Boennecken stigmatizes Martin's contrivances as complicated and difficult to make; but this objection carries little enough weight, if the results obtained are favourable. More serious is his accusation against this method that it encourages recurrence of the neoplasms for which the operation has been done. On this point we will quote the words of Ollier:* "It is in the case of recent or old traumatic lesions, of necrosis of the jaws, and of benign growths, that the new scheme of prosthesis will render the greatest help. For malignant growths it is otherwise, notably in cases where the spread of the lesions has not allowed of a very wide extirpation of the suspected tissues. In such circumstances any local irritation cannot fail to encourage the neoplasms of which a nidus has been left in the midst of the tissues."

Many writers absolutely reject this criticism, which they consider unfounded.† It is better,

* Ollier, Préface, p. 5. "Traité de Prothèse immédiate," par Cl. Martin, Paris, 1889; chez Masson, éditeur.

† Martin, "Some Remote Results of Immediate Prosthesis in Resections of the Mandible," Thèse Lyon, 1893.

perhaps, to take up an agnostic attitude as regards the potential influence of immediate prosthesis on the recurrence of neoplasms. In a general way, we believe that a long uninterrupted irritation might become at one point a predisposing local cause of incidence of epithelioma. This notion is old. Epithelioma of the lip or tongue was christened "smoker's cancer," by which it was inferred that we attributed an important rôle to the irritation engendered by tobacco smoke or the repeated contact of the pipe-stem. This local predisposing cause has to-day taken second place, and there is a tendency to ascribe much less importance to factors of local irritation in the etiology of cancer. Be this as it may, no one can as yet state that a suppuration of prosthetic origin, prolonged for several months, plays no part in the recurrence of malignant tumours of the jaws. But this part, if it exist, should probably be appraised as small. For it does not seem that recurrences are much more frequent after jaw resections for epithelioma, when these are followed by immediate prosthesis, than when this method has not been applied. The advantages of immediate prosthesis cannot be denied; they are insistent in the observations of Martin, of which several date back ten to fifteen years.* In particular, we should have recourse to immediate prosthesis in resections of the lower jaw extending to beyond the horizontal ramus; in such cases it is absolutely indispensable,

* Amoedo, "Contribution to the Study of Immediate Prosthesis of the Jaws" (Cong. dent. internat., Paris, 1900, iv., p. 477).

for late internal prosthesis is inapplicable at the level of the ascending rami. The results obtained fully repay the trouble and the difficulties of execution.* "*Only, let us warn any who undertake such a piece of work against what seems, on reading, to be its simplicity. In the course of its execution, one recognizes that this operation—by which we do not mean only the placing of the appliance—is not always as simple as it seems.*"† [The italics are the Translator's.]

* Cl. Martin, "Some Remote Results of Immediate Prosthesis," 1893.

† Maurice Roy, Thèse de Paris.

SECOND PART

INTERNAL PROSTHESIS

INTERNAL prosthesis is widely divergent from the methods of late or of immediate provisional prosthesis. The aim of these latter is to replace losses of tissue (most often skeletal parts) by apparatus remaining in communication with the exterior. Conversely, internal prosthesis buries in the depth of the living tissues appliances destined to stay there permanently, as long as the patient lives. In a series of observations, Cl. Martin has striven to get bony regeneration by adopting, as guides for the periosteal flaps, metal apparatus which he left in the tissues. To his method Cl. Martin has given the name "internal prosthesis," in contradistinction to immediate provisional prosthesis; the latter might be called "external prosthesis," because in these cases the appliance retains its communication with the outer world. This term, "internal prosthesis," strikes us as clear and precise, so we shall retain it. But we shall extend its meaning to embrace all methods of which the object is to replace lost substance by means of an appliance fixed permanently in the tissues, and destined to be a functional substitute for an indefinite time.

Internal prosthesis includes two methods:

1. Internal prosthesis as a guide to bony regeneration.

2. Internal prosthesis replacing missing substance.

SECTION I

INTERNAL PROSTHESIS

(Intended to guide Bony Regeneration, whether by Subperiosteal Resection or Graft)

An appliance is permanently abandoned in the tissues. It consists of a metal cage fixed to the ends of two bony segments, and destined to contain the fragments of periosteum-covered bone, and to serve as guide to the new bone arising out of this graft. This process we owe to Cl. Martin, who has published an experimental study made on dogs.*

Michaëls has applied to man an enarthrodial joint acting as a prop to the periosteum, after subperiosteal resection.

"It concerned a patient aged thirty, who had a very characteristic history of infections. In May, 1891, he came into Péan's clinic in hospital for a cold abscess of the antero-superior quarter of the arm. In June an incision evacuated pus. He had there a fistula. His scapula movements were limited. In February, 1893, a fistulous track was found,

* Cl. Martin, "On Bony Regeneration over an Internal Prosthetic Appliance," Paris, 1899 (Institut. internat. de bibliogr. scientif.).

down to the humerus. The shoulder-joint was globular, and the articular surfaces sticky with purulent lymph. Movement was impossible. The patient refused disarticulation, and Péan, having previously agreed with Michaëls, reopened on March 11 the previous incision, divided the soft parts, and came upon a purulent focus which he evacuated. He forthwith disarticulated at the shoulder-joint, and resected the upper quarter of the humerus, taking care to preserve as much periosteum as possible. Then, having made the toilet of the wound, Michaëls placed his prosthetic appliance. This consisted of three chief pieces:

"1. A straight rod 8 cm. long, to represent the resected part of the humerus.

"2. Another rod, which continued the first to a length of 2 to 3 cm., replacing the neck.

"3. An irregular sphere of 3·5 cm. diameter, which made up the humeral head.

"The first piece was a little thinner than the humerus which it replaced. It was cut transversely at the level of its lower end, which was fixed to the remaining part of the humerus by four short prolongations, in pairs. The longer pair measured 1·5 cm., the two others 7 mm. They were each of platinum-iridium, 1·5 mm. thick. They were free at the lower ends, where they formed a small loop; whilst at the upper ends they were approximated, and soldered to a metal ring which was immovably fixed so as to encircle the lower part of the prosthetic apparatus. The small loop formed by this wire was to give passage to a platinum screw which traversed the bone through and through, and passed across the small loop of the prolongation of the other side, and even a little way beyond it. So we were able to place around the terminal extremity, which was projecting, a little bolt which enabled us to couple very intimately the external surface of the humerus and the internal surface of the two prolongations opposed to it. A second screw and bolt fixed in the same way the other two prolongations.

"At the upper end of this first piece a second was coupled, which expanded slightly in the transverse plane from below upwards. The lower part of this second piece was cut transversely, like that of the first, whilst its upper part was concave. Moreover, this piece was hollowed at its centre into a canal 4 mm. in diameter, in which a screw was engaged; and the lower end of the screw was inserted 4 cm. into the rod below. Thus the lower end of the screw was entirely robbed of its mobility, whilst its upper part allowed the second piece to revolve around it, giving an almost complete circle of rotation. And, as the screw-head was bigger than the screw itself, the lumen of the piece which lodged it had been enlarged at the level of the screw-head, to facilitate the movements of rotation. It was, in fact, the head of the screw which, thanks to its enlargement, prevented the two rubber rods from separating from each other in a vertical direction.

"The upper concave part of the small rubber rod was intended to come into contact with the third piece, representing the humeral head. Meanwhile, instead of being spherical, this piece was hollowed antero-posteriorly for 1 cm., and in the antero-external direction for 1·5 cm. These little canals lodged platinum-iridium wires of 3 mm. diameter, which were arranged to join the artificial head, below to the second segment of the appliance, above to the scapula. The wire which encircled the head ensheathed it from above downwards, following the lateral canal; while its free ends descended below the head with a gentle bend, and fitted tightly with a slight eccentric push for a depth of 3 cm. into two small canals made specially in the piece below, on either side of the screw-head. From this arrangement it resulted that the head was solidly joined to the second piece, while remaining movable on it. It was an easier matter to fix the head to the glenoid surface, all the while preserving its antero-posterior movements.

"For this purpose, a second platinum-iridium loop surrounded the antero-posterior canal (which was deeper than the other by 0·5 cm.) in such a way as to pass below the first loop. Whilst the middle of this new loop ensheathed the head, its free ends pointed to the glenoid cavity. There one of these ends, arranged as a screw, buried itself in this cavity and in the scapular neck to a depth of 3 cm. It took its purchase from a much finer platinum wire, which passed on alone into the infraspinous fossa, along the axillary scapular border.

"The other free end of the wire curved, left the centre of the glenoid cavity, and encircled the neck to divide into two small loops which embraced the spine of the scapula; one lay on the upper, the other on the lower, surface of the spine near its base. Thanks to this arrangement, the artificial head preserved all the movements of the normal articulation in relation to the scapula. It must be added that, to facilitate the adherence of periosteum and muscular insertions to this artificial humerus, I arranged in the latter some small ridges, perforated here and there, which allowed us, by means of catgut sutures, to suture the periosteum. Similarly, to fix the joint capsule, two small platinum rings were placed on the outer surface of the head, to keep capsule and ligaments in their normal relations.

"In the construction of this apparatus, hardened rubber and platinum-iridium are the only materials which should be used. And to render the organic fluids innocuous to the rubber, the pieces of rubber are boiled for twenty-four hours in paraffin." [This description is so involved, and the appliance evidently so complicated, that illustrations would seem necessary in order to understand it—Tr.]

It has been possible to watch the remote results of this attempt at internal prosthesis to guide periosteum.*

Michaëls exhibited at the 1900 International Dental Congress a certain number of patients on whom surgical or prosthetic intervention had been essayed. Among these he showed the subject to whom had been applied the enarthrodial articulation of which we have spoken above. And it was possible to prove that the apparatus had been pretty well tolerated

* Michaëls, "On Prosthetic Restoration" (Congrès dentaire international de 1900).

by the tissues, despite a fistula persisting at the site of the wound, two and a half years after the apparatus had been placed.

"In July, 1895, we probed this fistula, which satisfied us as to the mobility of the lower segment of the apparatus. The skin was divided in such a way as to reach the apparatus, and we cut the metal wires which fixed it to the original humerus. After energetic pulling we removed the apparatus, and curetted the fleshy granulations. Deep to these we found a semilunar piece of bone of new formation. It took two and a half months for the wound to heal. After this lapse of time—that is, five years after the reopening of the wound, and seven years after the original adaptation of the apparatus—the invalid made good use of his arm, which had kept its normal length. The shoulder-joint could perform all its movements except elevation. The patient used his right just as well as his left arm, and daily devoted himself to difficult manual labour without fatigue. From the skiagram one noted that on its posterior surface the bone appeared normal, although less smooth on its other side. Thanks to radiography and radioscopy, no one could contest (1) the legitimacy of the intervention, or (2) the results, and the help given by the surgical prosthesis."

Michaëls adds the following general indications for apparatus of this order:

"The prosthetic piece should be a replica of the bone, or of that fragment of bone which it replaces. The measurements must be strictly the same. The piece must fit with precision. Apropos of this, we must keep a watchful eye on the grip which the attachments of the foreign body have on the bone with which the former joins to comprise the complete limb; these attachments should grip without pressing too hard, so as to avoid mortification. The attachments must be filiform, never by means of plates, in that all that part of a bone covered by a plate (and to this extent deprived of periosteal contact) tends to necrose. Now, the area of bone covered by a wire is negligible; this does not apply to the area covered by a plate, which is the greater by as much as the plate is greater. This explains why, in the skiagrams which I have the honour to submit to you, my platinum attachments take the form of a cage. Lastly, the prosthetic piece is, as I said at the outset, only a guide called forth to direct the growth of new bone which the periosteum is about to throw out."*

"We should take it for granted that we shall be able to remove this piece on the day when the newly formed bone is firm enough to allow of this. And, with this idea, we must not enclose the prosthetic piece with the periosteal sheath, but rather place it as if it were a wedge; that is to say, we leave one aspect of the prosthesis uncovered by periosteum. The result is that the appliance, not being enclosed in new bone, allows the latter to develop freely, and can itself be lifted out at the right moment. That explains on the one hand the semilunar form affected by the new bone, on the other hand the absence of a medullary canal on radioscopy; in looking at the back of the arm the bone appears normal. Seen

* Michaëls, Congrès dentaire de 1900.

from the other side, it appears to us not quite so smooth. Thanks to the combined verdicts of radiography and radioscopy, no one can any longer doubt that our intervention is warrantable; people must admit the services rendered by surgical prosthesis."

On the foundation of his theories Martin has shown some patients, which has allowed him to establish that his appliances were well borne, and that at the end of six or seven years his patient made easy use of his arm.

SECTION II

INTERNAL PROSTHESIS PROPER

(Replacing Missing Tissues, and Preserved in the Depths of the Organism)

As far as the skeleton is concerned, the prosthetic appliance is fated to accomplish in their entirety the functions of the portion of tissue resected, of which it will take the place. With this method any bony regeneration is discounted; it is based purely on the permanent tolerance which the organism can offer to a foreign body fixed in its depths.

It presumes, then, the possibility, on the part of the tissues, of an absolute tolerance, and a familiarity of the conditions necessary to obtain such tolerance. It must be insisted on that as yet we know hardly anything of this subject, and the majority of the efforts to apply this method have been followed by failure. Cl. Martin himself,* the enterprising pioneer of immediate provisional prosthesis, gives it but scant praise. We think it fitting to quote at length the exact words of this master from Lyons, whose name dominates the science of modern prosthesis:

* Cl. Martin, "On Bony Regeneration over an Internal Prosthetic Appliance," Paris, 1899.

"I made the first trial of this sort of prosthesis in 1878, on a patient from Letiévant's clinic. On this man, about thirty years old, I fixed a false phalangeal joint to the little finger of the left hand; and, union occurring by first intention, I had the satisfaction of seeing the invalid leave the hospital with a platinum joint which worked admirably. The result remained excellent for two months, and the tissues were displaying a perfect tolerance *vis-à-vis* with a foreign body. Unfortunately, this man, who was a labourer, often undertook muscular work; and one day, in lifting a heavy load, his joint came apart and made its appearance partly outside the skin.

"Later, in a resection of the mandible made by Professor Polosson, I tried to leave as a permanency a bulky prosthesis of hardened rubber. The patient kept it eighteen months, but, despite anything I could do, a fistula persisted, which compelled me to remove it. Other efforts of the same sort have since been made by Glück, who announced his observations at the Berlin Congress; then by Péan in 1894. But these results showed that, if the application of this method has amounted on the whole to a noteworthy advance, the method is none the less far from perfect. As a rule, in fact, these pieces are badly tolerated by the tissues; fistulæ are obstinate; the appliances get out of position, and must be removed if they are not spontaneously thrown out.

"It is, then, patent that the prosthetic appliances, bulky and clumsy, employed up to date, can play their part of skeletal substitution for only a limited time. And, more than this, that they are never absolutely tolerated by the tissues, in which fistulæ always persist. I do not think that, with this type of appliance, we shall be able to arrive at results noticeably better than those which have been published of late years. These pieces are too massive, too large, to be well borne, and they fulfil very poorly the rôle of skeletal organ which had been expected of them."

However, already in 1893, Weinlechner and Eiselberg restored cranial dehiscences by means of celluloid plates. In four cases infection caused two failures, but they publish two cures.*

In 1904 Hermann applied an internal prosthesis for loss of cranial substance; he publishes one success.† In reality he had a failure as regards prosthesis, since suppuration compelled him to take out the aluminium plate which he had placed.

In 1903 Sébileau and Delair applied a facial internal prosthesis after total resection of the anterior wall of the frontal sinus. They obtained a success which is maintained to this day. In 1904, for a gap in the skull, they fixed a metal plate on the same plan as

* Weinlechner, "Restoration of Losses of Skull by Means of Celluloid Plates" (1 case of cure).—Eiselberg, *ibid.* (3 cases, 2 unsuccessful owing to infection). Soc. Imperio-Royale de Vienne (*Deutsche medicinal. Zeitung*, Mars, 1893; *Odontologie*, Avril, 1893).

† Hermann, "Fracture of Skull: Separation of Frontal, Sagittal, and Coronal Sutures; Trephining; Metal Prosthesis; Recovery" (*Annales de la Soc. belge de chir.*, et *Annales de la Soc. méd. d'Anvers*, Oct.-Dec., 1904, p. 120).

internal prosthesis. They obtained a fresh success, which has lasted satisfactorily up till now.*

In 1907 Delorme and Delair, in a case of a large bony loss in the temporal region, succeeded similarly with an internal prosthesis.†

More recently Sébileau and G. Lemerle successfully repaired a large parietal gap with a metal plate; the metal chosen in this case was silver, for reasons which we shall see later. The employment of paraffin injections as a prosthetic aid has consolidated the hopes which we justifiably found on internal prosthesis, and enables us to classify this method into two systems, of which the technique is quite different:

1. Internal prosthesis by appliances.

2. Internal prosthesis by plastic materials injected into the tissues or pressed into normal or pathological bony cavities.

To differentiate these two systems we will call the latter "plastic prosthesis." Paraffin has now become the only plastic prosthesis in common use. The use of other plastic materials and appliances is still but little known, and one may say that internal prosthesis is still in its infancy.

To succeed by this attractive method implies the possibility of indefinite tolerance of the tissues to a foreign body. The tolerance and reactions of each particular tissue (periosteum, bone, neighbouring

* Sébileau, "Metallic Facial Prosthesis after Total Resection of the Anterior Wall of the Frontal Sinus" (*Revue de stomatologie*, 11 Nov., 1903, p. 514).

† Delair, "A Case of Cranial Prosthesis" (Soc. d'odontol., Nov., 1907).

structures), the nature, shape, mode of fixation, and size, of the foreign body—all these are just so many questions to which we must have a clear-cut answer before we dogmatize as to the practical value of this kind of prosthesis. [Moreover, plastic prosthesis has the grave and well-known disadvantage that, if the substance is ill-tolerated or changes its shape, it is impossible to remove it completely.—TR.]

As we said just now, we know next to nothing of this subject; the laws which should govern internal prosthesis are not yet precisely defined. None the less, some of the conditions necessary to obtain a tolerance of the tissues towards foreign bodies already begin to crystallize out. One of us has attempted an experimental study.* In a handbook we cannot dilate at length on a question which is still most controversial. Meanwhile we are setting ourselves to expound briefly some of the general laws which seem to govern internal prosthesis. We shall now enter upon the study of the application of this method.

CHAPTER I

TOLERANCE OF THE TISSUES TOWARDS FOREIGN BODIES

I. Reactions of Periosteum and Bone in the Presence of Foreign Bodies.

NICOLAS described periosteum as follows: "A fibro-elastic membrane, rich in cellular elements, vessels,

* Georges Lemerle, "Contribution to the Experimental Study of Internal Prosthesis," Thèse de Paris, 1907.

and nerves, which invests the whole surface of the bones except the parts covered with cartilage. This membrane plays a paramount rôle in development; by the vessels which it encloses (nearly all of them destined for the bone) it assures the bone's nutrition."*

Theoretically one might deduce that any part of the bone robbed of its periosteum for the fitting of a prosthetic appliance becomes necrosed. One might equally conclude that an appliance placed deep to the periosteum, and exercising on it a certain amount of pressure, will entail atrophy thereof, and, as regards the vitality of the subjacent bone, such consequences as are the logical outcome. Practically this is not the case. Metal plates placed beneath the periosteum, and sutured through and deep to this membrane, after a stay of a year, have not caused any functional or trophic disabilities in the periosteum or the bone of the animals experimented upon. To obtain fixation of a foreign body in bone, the best tissue reaction for which the prosthesist can hope is osteitis which is of the condensing or hyperplastic type from the beginning. The chief cause of failure to be feared is a rarefying osteitis where the retention appliances are fixed to the bone. Even if it may sometimes occur that a happy phase of condensing osteitis follows an early rarefying osteitis, one sees much more often that the latter involves the displacement and elimination of the prosthetic appliance. In the presence of a foreign body

* P. Poirier, "Treatise of Human Anatomy": "Structure of Bone," by A. Nicolas, p. 101.

rarefying osteitis may be due to three principal causes:

(*a*) The most important is infection; an infected foreign body, fixed in the bone, will always involve rarefying osteitis, and will as a rule be eliminated with some sequestra.

(*b*) In all cases where the bone is not cleanly cut, or where it is shredded and crushed (as in a badly performed trephining for the placing of a prosthesis), the damaged zone is absorbed aseptically, and ceases to lend support to the apparatus fixed there.

(*c*) When the foreign body fixed to the bone is not rigorously immobilized, it soon entails a zone of rarefying osteitis round about its retention-points, which also are eliminated at the same time.

On this subject Martin's experiences are very conclusive. He studied bony regeneration on the dog, in the presence of an internal prosthesis, and found many of his appliances a good deal displaced, owing to defective immobilization. Some of the facts which we have just shown enable us to draw the following practical conclusions:

1. Periosteum offers an unlimited tolerance to foreign bodies; there is no fear of producing points of bony necrosis by the application of prosthetic appliances. From a practical standpoint, it is quite useless to strip a bone of its periosteum, at the level of its contact-points with the appliance, at the time of fitting the latter; not that such denudation would be risky if of only limited extent, but because it is so much time lost during a procedure which is already quite lengthy.

2. Bone tolerates quite well a foreign body, as long as it is aseptic, absolutely immobile, and fixed by some means to cleanly cut uncrushed surfaces of bone. In trephining we should therefore use very sharp drills.

It is on these conditions that we shall get an osteitis which is from its inception of the condensing or hyperplastic type, to which is subordinated the perfect fixation of an appliance of internal prosthesis

II. Reactions of the Tissues according to the Nature of the Foreign Bodies.

(*a*) **Vulcanized Rubber.**—The rubber ordinarily used for making appliances is brown. It is used in preference to other coloured rubbers (usually employed for making dentures) because, as regards its purity, it is considered to be unaffected by organic fluids. This is a fact; but other rubbers, coloured (by vermilion and zinc oxide) red, pink, and white, are no less resistant. If all the rubbers in common use for dental prosthesis do not possess the mechanical qualities of black rubber, they are at all events perfectly tolerated, and unaltered in a chemical sense, by the tissues.

(*b*) **Metals.**—Except platinum, gold, tin, and aluminium, metals change when in contact with the body fluids. But the changes are very gradual, and the various salts thus formed have no apparent influence on the vitality of the tissues. Iron and copper, for example, are very well borne; all the metals commonly used for dental prostheses are easily tolerated. Some remain unchanged, others oxidize here and there, but always very superficially and with no sort of loss of tolerance.

Maybe these oxidations are even favourable in certain cases. Silver deserves, in this connection, special attention. We know already, from the recent work done on the use of silver salts in therapeutics, how well this metal is borne by the organism. The researches carried out on collargol are a further proof of this. The use of silver in constructing apparatus for internal prosthesis presents a particular interest. In fact, if all the metals of which we have spoken, and also all the vulcanized rubbers, are well tolerated, silver seems to enjoy something beyond a mere tolerance. It becomes, if one may so express it, the object of a sort of adoption by the tissue in whose depth it is fixed. Cellular tissue envelops on all sides and penetrates the smallest crannies of a silver plate; if the latter is pierced by holes, cellular strands pass through these. If a silver plate has stayed some months in a dog's body, it is established, when one dissects the region, that connective tissue enwraps it so closely that it seems to stick to the surface of the metal. Other metals and vulcanized rubber, though equally well borne, do not present this remarkable peculiarity. The connective tissue envelops it less closely; and if there is a plate pierced by holes, it never passes through them. Silver alone enjoys this privilege.* These qualities of extreme

* Billing of Stockholm recommends, for the same reason, the use of silver for making internal appliances. *Vide* J. Billing, "Von der Unterkiefer, Resektions Prothèse,' Stockholm, 1912; Isaac Marcus, éditeur.

tolerance seem to be limited to this connective tissue, and the *bone* reacts no differently with silver than with other metals. None the less the fact has a great importance, since in practice the tolerance of a prosthetic piece concerns only two kinds of tissue, bone and connective tissue. As a fact, a foreign body placed, for instance, primarily in muscular tissue is found later at the same spot, but encircled, somehow encased, by connective tissue. This later plays a protective part in enveloping any apparatus placed within the body, so thoroughly that we can resolve the problem of tissue tolerance in general towards internal prosthesis into the simple question of tolerance by these two tissues—connective and bony.

III. Tolerance as affected by the Shape of the Foreign Body.

In his memoir on the tolerance of foreign bodies by the tissues, Weiss makes the statement that irregular-shaped bodies with sharp projections are not so well borne as smooth ones with rounded contours.* But Weiss was studying the tolerance of bodies usually septic. If there is a difference in the tolerance of smooth and rugous bodies, this is undoubtedly because the latter, in the event of their being septic, bring with them into the tissues more micro-organisms than bodies with smooth surfaces. A foreign body bristling with projections, but aseptic, is perfectly tolerated; for the connective tissue before

* Weiss, "On Tissue Tolerance of Foreign Bodies," Thèse d'agrégat, Paris, 1880.

long enfolds it and protects neighbouring organs against its rugosities. However, we do see intolerance, in spite of asepsis, in certain clearly defined conditions:

(*a*) If the foreign body opposes sharp edges to tissues which are on their way to cicatricial retraction, the latter get cut where they make contact; and by this mechanism the foreign body is eliminated.

A good example of this type of intolerance has been published by Sébileau,* apropos of a sufferer who had undergone rhinoplasty, the new nose being fixed on to a metal scaffolding on the circumference of the nasal skeleton. This scaffolding, in tripod form, consisted of three branches whose surfaces of junction were not rounded off, and thus presented fairly sharp edges. Having been placed under good conditions of asepsis, this internal prosthesis was perfectly tolerated by the bony tissue, in whose depths it had been implanted and firmly retained. But the flap which covered the framework underwent, during scarring, a slow retraction; and cutting itself on the edges of the metal framework, the flap somehow buried itself between the three limbs of the tripod, which soon began to make its way to the outside. The apparatus had to be removed, and this not without some trouble, for it was solidly implanted in the bone. Thus, the intolerance was not due to bone, neither was infection to be blamed for it; but it depended on purely mechanical reasons,

* Sébileau, "Metallic Nasal Prosthesis: Mechanism of Elimination of the Appliance" (*Bull. et Mêm. Soc. de Chir. de Paris*, 1903, n.s., xxiv., pp. 546-549).

and was limited to the soft tissues. This is a noteworthy case of intolerance due to the shape of the foreign body.

(*b*) If a foreign body, rough with irregularities, is movable, it will not be tolerated, because of the mechanical lesions which it produces all around it. But let the same body be immobilized against a bone by a ligature, and the connective tissue which shortly encloses it in its meshes protects neighbouring organs against its cutting edges. As moss will not grow on a rolling stone, so connective tissue will by no means envelop a movable foreign body. If the latter offers sharp angles and cutting borders, it promotes by its presence a brisk reaction which involves its rapid elimination.

IV. Tolerance depending on the Mobility of the Foreign Body.

We have said, apropos of foreign bodies garnished with projections, that it is solely their mobility which calls forth intolerance on the part of the tissues. We can extend this remark to all foreign bodies, whatever their shape.

The study of gunshot wounds gives data for interesting observations as regards the tolerance of bullets by the tissues. For instance, a ball having damaged no organ of importance, and not having caused any suppuration, is abandoned in a mass of muscle. This foreign body, not fixed in the depth of the tissues, travels to their middle, obeying the various factors of migration, of which the most important is gravity. After a varying period (it may be several years), the ball arrives under the skin, and always ends by being eliminated in a region often far removed from the initial point where it was arrested in the tissues.* The only cause of its elimination lies in its mobility. Firmly fixed to the skeleton, it would have continued to be tolerated indefinitely. One of us has been able to make experimental study of this migration of foreign bodies left, mobile, in the body.†

Two silver plates, enclosed in the parietal region of a dog, were retrieved a year later, one from the right hypochondrium, the other from the temporal fossa. They had migrated in conformity to the inclined planes which the anatomical arrangement of the part offered to them. Four plates of various metals placed in the supraspinous and infraspinous scapular fossæ of a dog were recovered a year later near the shoulder-joint. They had followed the inclined planes presented by the bony surfaces. The spine of the scapula being directed (in the dog) from above downwards and from behind forwards, foreign bodies, sliding in the gutters formed by this apophysis with the scapula, had emigrated in the same direction.

It seems, then, clear that movable foreign bodies roam according to the laws of gravity, and along the inclined planes provided for them by the anatomical

* Weiss, "On Tissue Tolerance of Foreign Bodies," Thèse d'agrégat, Paris, 1880.

† Georges Lemerle, "Contribution to the Experimental Study of Internal Prosthesis," Thèse de Paris, 1907.

arrangement of the region where they are buried. To this (far the most important) passive factor in migration we should probably add another, active one—that is, the movement of the foreign body initiated by the contractions of the muscles in propinquity to which they find themselves. In a supraspinous fossa, for instance, we believe that a foreign body, free, and situated between bone and muscle, will travel along the inclined plane offered by the bony framework, passively by gravity, and actively under the influence of the contractions of the supraspinatus. It is likely that the weight of the foreign body will have an influence on the rate of travel. If a body fixed in the skeleton is secondarily mobilized, it will be eliminated by the bone just the same as if it had been freely left adrift in the soft parts. These are a few facts of paramount practical importance for the formulation of general ideas which should regulate the construction of an appliance for internal prosthesis, and the choice of means for its retention.

CHAPTER II

THE VARIOUS MODES OF RETENTION OF INTERNAL PROSTHESES, AND THEIR TOLERANCE BY BONY TISSUE

ONE of the salient causes of failure often encountered in internal prosthesis is the mode of retention chosen for maintaining the appliance *in situ*. These retention methods are numerous enough; we use, in particular, screws, catches, wedges, bolts, ligatures, and hooks.

1. **Screws.**—This is the means of retention used most often by Cl. Martin for fixing his appliances of immediate temporary prosthesis. It has given him great success; nevertheless, the screw does not fulfil all the conditions which we postulated just now. In fact, if we trephine and then put a screw into the bone, the screw-thread applies a tearing force therein; thus we create the zone of contusion to which we referred above, and the absorption of this zone is a potential cause of elimination of the screw. None the less, apart from immediate prosthesis, screws have yielded good results in the treatment of certain fractures by making certain that the fragments are kept in place.* To apply them in operating is at all times much easier than to fix bolts.

2. **Catches.**—The catch consists essentially of a barbed rod buried tightly in the bone, previously bored by a trephine. Theoretically these barbs are destined to hold the metal rod in the bone.

3. **The Wedge.**—This system of retention is executed by wedging, into a hole bored into the bony table, two smooth metal rods, which are buried so as to fit very tightly. These metal plugs are semicircular in section. The surface touching bone is rounded, and that by which each glides on the other is plane. They are usually made in two pieces; such is the model employed by Delair (see Fig. 110). We find it more handy to have them joined at their

* Lambotte, "Operative Interference in Recent and Old Fractures," vol. i., 1906.

ends. One can easily make these wedges with pieces, by bending a piece of the metal wire, called "demi-jonc," into the shape of a U, with its branches very close together (see Fig. 112). [Jonc is a cane resembling malacca; in section it is circular. Demi-jonc therefore means "half-round"—*i.e.*, one-half of a circle.—TR.] Whatever type of wedge we employ, this method of retention is excellent for the rapidity of its application and the perfect tolerance shown to it; for it never injures the bone.

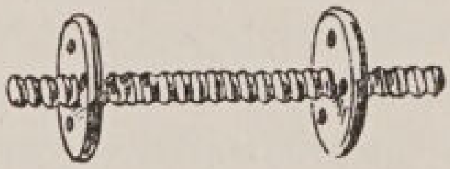


FIG. 109.—Delair's Bolt.

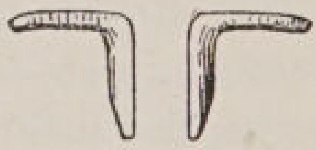


FIG. 110.—Separate Wedges of Delair.

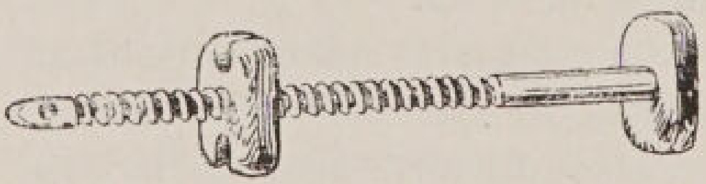


FIG. 111.—Bolt with Large Nut. (G. Lemerle.)

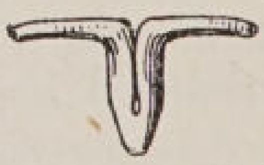


FIG. 112.—Wedge obtained by bending a Demi-jonc Wire on itself. (Lemerle.)

4. **Ligatures** are a mediocre method of fixation. They have the merit of simplicity; for they demand neither preparatory manœuvres nor a special armamentarium of instruments. The weakness of a ligature is its lack of firmness. It is liable to slip, to become displaced. It is an easy and well-borne method of fixation; but its lack of precision and solidity renders it an untrustworthy method which

should be only exceptionally employed in internal prosthesis.

5. **The Bolt** has the advantage of not requiring a thread to be tapped in the bone, which, being unhurt, tolerates it perfectly. Taking its *point d'appui* from the opposed bony tables which it traverses, the bolt, by this double purchase, offers a remarkable steadiness coupled with an extreme precision. Thus, it resists admirably any movement, and constitutes the best retention arrangement which we can employ for internal prosthesis. But, to make good use of it, it should conform to certain conditions. Thus, it will always be found best to employ two incisions opposite to each other, so as to place conveniently a bolt through a diaphysis. In this way we can use a bolt with a fixed head, which is much preferable from the standpoint of firmness. In fact, it is the difficulty encountered in placing a bolt, when only one skin incision has been made, which has led the prosthesist to screw on the two nuts after he has placed the bolt in position. This plan, although rendering feasible the use of a single incision, still offers various difficulties, for to twist a nut in the depths with a bent spanner, without seeing it, is always slow and tedious. The fear of finding that a bolt is poorly tolerated by neighbouring tissues, owing to the undue projection which the nuts may make on the surface of the bone, has always led those who have written on this subject to reduce the thickness of the nuts to a minimum. These have finally been cut out of a very thin metallic plate, so as to require only one or two turns of the screw.

Thus the grip of the bolt becomes a good deal weakened, and this is, according to our way of thinking, robbing this method of one of its sterling qualities. We spoke at the beginning of this chapter of the tolerance enjoyed by irregular foreign bodies, if only they are immovable.

The same applies to nuts which make a projection on the bony surface. There is, then, no reason to reduce the bulk of the nuts. We considerably enfeeble their grip thereby, and this makes them more likely to become movable. For this loosening is a real cause of intolerance, whereas the influence of shape and bulk of the nuts cannot constitute any cause. Thus, the bolt is an excellent means of fixation provided that—(1) there is enough room to place it—that is, with two opposite incisions if necessary; (2) it has, whenever possible, its head fixed as a part of it; (3) it has nuts of sufficient thickness, so that their thread can have a grip for an adequate length of the bolt.

6. **Hooks.**—These are employed above all in bone surgery to maintain the fragments after certain fractures (Dujarrier and Jacoël). The sole defect of this method lies in the difficulty which may occur in boring in the bone two points exactly corresponding to the ends of the hook.*

* *Vide* Potherat, " A Case of Tolerance by Bone of Metallic Foreign Bodies " (two grafts by Jacoël in a tibia lasting eight years, uneventfully and without mobilization) (*Gaz. méd. de Paris*, 11 Mars, 1914, p. 74).

CHAPTER III

PLASTIC PROSTHESIS

INTERNAL prosthesis includes, as we have said, all the artificial restorations which are finally abandoned in the depth of living tissues. These restorations are brought about, now by various appliances fixed to the skeleton, now by plastic materials enclosed in the body. To this latter method we give the name of "plastic prosthesis," in contradistinction to prosthesis by apparatus. Paraffin injections have given an unexpected scope to the plastic method. These injections now constitute a prosthetic intervention which comes into the domain of modern practice of numerous specialists, and their technique has been evolved by much labour. But the dentist's province comprises especially prosthesis by apparatus; the study of paraffin injections seems to us not to come within the scope of this manual. Without dilating at length on paraffin prosthesis, it occurs to us in any case to point out its chief fault.

This method is blind, and serious accidents have followed the eruption of the paraffin into the vessels of the region involved.* [The sudden and permanent blindness from embolism of the central artery of the retina has occurred at least sufficiently often for it to be a danger to be reckoned with; and the risk

* Lee, Maidment, Hurd, Ward, and A. Holden, "Paraffin Injection followed immediately by Blindness from Embolism of the Central Artery of the Retina" (*Med. Rec.*, July 11, 1903, p. 53).

is a great price to pay, for instance, for the possible correction of a saddleback nose. I say possible, because the method is not even technically accurate; the paraffin may spread uncontrollably beneath the skin. Lastly, should the result be unsatisfactory, it is practically impossible to remove the paraffin. —TR.]

Remote trophic disturbances also are frequently observed after paraffin injections.*

Side by side with paraffin injections, which affect the cellular tissue, we may carry out, in plastic prosthesis, other manœuvres whose chief aim is skeletal restoration. This is what various writers, using a term which is bad, but consecrated by custom, call "plumbing" the bones. These restorations, in contradistinction to paraffin injections, are made through open incisions. They are indicated in cases of loss of bony substance, most often osteomyelitic in origin. In the neighbourhood of the face, there occur cases of frontal sinusitis which involve bony lesions; and these lesions are at times widespread enough to invite the surgeon to resect the whole anterior wall of the sinus during his trephining. [Gouges and chisels, not trephines, are now practically always used for the frontal sinus.—TR.] After cicatrization, the loss of bone induces a grave facial deformity; the skin is strongly retracted down to the

* Dionis du Séjour, "Trophic and Circulatory Disturbances of the Skin resulting from Paraffin Injections" (*Gaz. des hôp.*, 19 Avril, 1904). Morestin, "Accidents caused by Æsthetic Injections of Paraffin" (Soc. de chir., 29 Janv., 1908; in *Presse méd.*, Févr., 1908, p. 79).

level of the gaping sinus, and the forehead remains branded with a deep notch. In such cases the indication is to strive to fill up the supra-orbital chasm by means of a plastic substance.

In this connection various authors have related their attempts. The materials employed have been the most diverse: plaster, iodoform,* mastic made of calcined bone,† and so on. The results have sometimes been inconstant, and the question appears far from being solved. In some experiments made on dogs, one of us has obtained the best results by using an amalgam of tin and silver, such as is used for dental stoppings. We consider that the best substance one could use in plastic prosthesis for bony restorations is this amalgam. It owes its chief virtue to its ready sterilizability, which can be carried out without any anxiety as to whether the boiling will produce any change in it.

CHAPTER IV

PRACTICAL CONCLUSIONS

THE conclusion which we should draw from these general ideas on the tolerance of foreign bodies by the tissues is, first and foremost, that internal prosthesis is feasible. This postulate will not seem useless, if we reflect how recent this method is, and

* Dreesmann, "Plumbing Bones" (*Beiträge zur klin. Chir.*, iv., 3, in *Semaine méd.*, Mars, 1893).

† Mosetig-Moorhof, "Plumbing Bones with Iodoform" (*Centr. Bl. f. Chir.*, 18 Avril, 1903).

how little research it has provoked up to date. All efforts at prosthesis are, then, possible and legitimate, but they must be subordinated above all to a rigorous asepsis. Prosthetic interventions infringing this law are doomed to failure. That is why an *open* internal prosthesis—that is, one maintaining communication with the air—is an impossibility; for the direct result of such an arrangement is infection.

It is neglect of asepsis which is responsible for the majority of the failures met with in internal prosthesis; these mistakes may occur in the placing of the appliance, or be due to the scheme of its construction. A distinguished prosthesist, describing some years ago an internal prosthetic contrivance for use after resection of the mandible, expounded his idea as follows: A metal rod was fixed to the piece which replaces the piece of bone resected, and was passed through the buccal mucosa to give a basis of support to a denture. [One would have thought, rather, that it was the denture which supported the rod, and so, indirectly, the prosthesis. —TR.] Thus the rod made an internal prosthesis communicate with the septic external world. According to our view, such an apparatus, in communication with the buccal region, is destined to certain elimination due to unavoidable infection. Any appliance of internal prosthesis should be aseptically buried in the tissues and entirely cut off from the outer world.

Indications for Internal Prosthesis.—Internal prosthesis may be immediate or late. The necessity of always placing the appliances with rigorous asepsis almost always forbids the immediate variety. A resection of the mandible, for instance, cannot be absolutely aseptic, since in the course of the operation saliva bathes the operative field. An attempt at immediate internal prosthesis would be followed by a certain failure, from suppuration. If, on the contrary, we wait after operating until cicatrization is completed, we shall be able during a second operation to fix an appliance of late internal prosthesis.

The bony ends to which it is proposed to fix a false metal skeletal appliance to re-establish the continuity of the jaw are to be exposed by a skin incision. *It is by this route only, and by sedulously avoiding any communication with the septic mouth area, that the apparatus should be inserted; and beneath it the tissues are sutured in successive layers, eschewing any drainage.*

Thus, internal prosthesis for the lower jaw can only be late, so as to remain aseptic and to preserve its best chance of success. In such a case it is obviously indicated to prevent cicatricial contraction, which would tend, after the resection, to carry the distal fragment of the jaw inwards and backwards. For that one must make the patient wear, soon after the first operation, a contrivance to prevent or correct retraction.* Internal prosthesis for the lower jaw is only indicated when the resection has not been carried higher than the angle. In the other

* Sébileau and G. Lemerle, "Prophylactic Appliance to check Cicatricial Retraction after Partial Resection of the Mandible" (Soc. de. chir., Févr., 1907).—G. Lemerle, "Appliance to reduce Cicatricial Retraction after Partial Resection of the Mandible" (*Le Laboratoire*, Janv., 1908).

event the ascending ramus is difficult of access, and the submaxillary incision gives a very inadequate

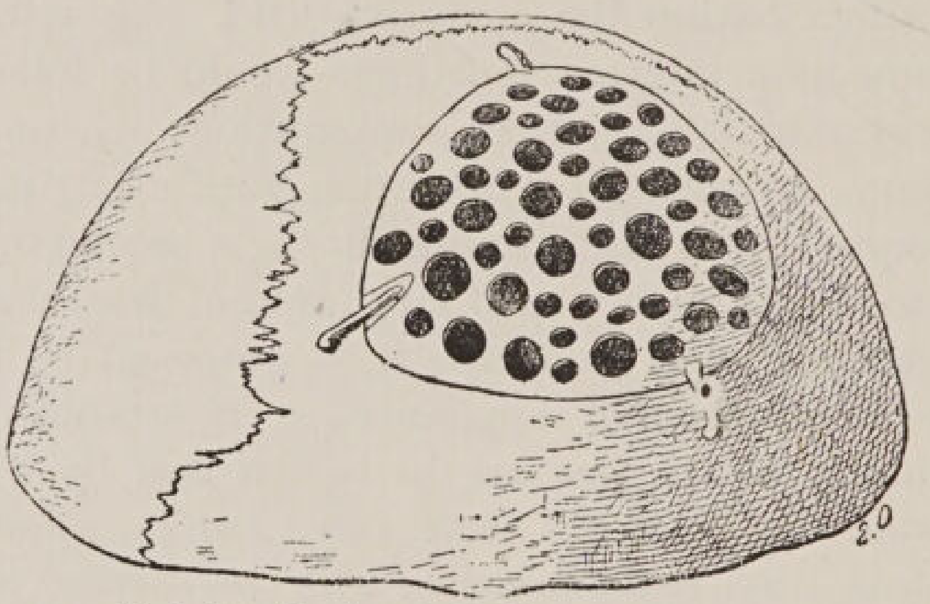


FIG. 113.—Delair's Perforated Plate applied to the Cranial Wall.

exposure for fixing bolts to the piece. Now, this incision should be kept below the mandible, and not

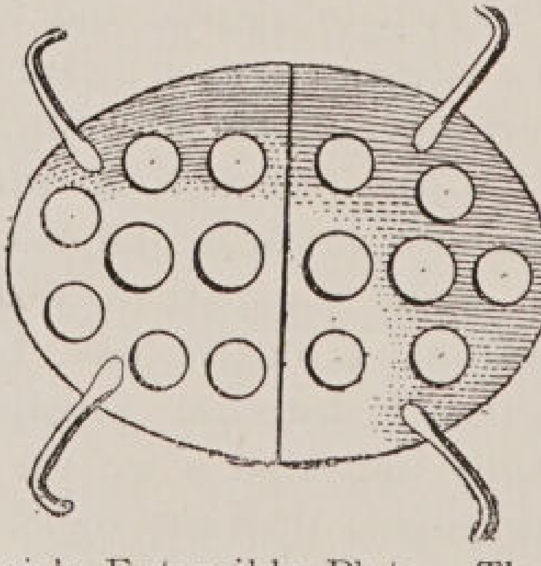


FIG. 114.—Delair's Extensible Plate. The two parts are in contact.

prolonged upwards, lest the facial nerve be involved; thus, internal prosthesis for the mandible must be limited solely to restoration of the horizontal ramus.

The upper jaw is available only for late prosthesis and internal prosthesis may be said to have no applicability to it.

The cranial vault is the most propitious region for applying internal prosthesis (Figs. 113, 114). We are concerned, as a rule, with the restoration of bony losses consecutive either to trauma or to an osteitis followed by large sequestra, or, again, to surgical intervention—for instance, a trephining of the vault for epilepsy. There again the prosthetic application is late. It is almost always followed by the happiest results, for the metal plate fixed to the edges of the bony gap can be introduced with an easy and perfect asepsis, and later on is not exposed to any movement. For the limbs, screws and bolts are used more and more for bolting the fragments in the treatment of certain fractures. There have been no real attempts at internal prosthesis for the limbs; but there might be indications and good results. Apparatus for immediate provisional prosthesis, as a guide for periosteal flaps, placed by Michaëls, show to what length we may hope to extend the restoration of long bones. Internal prosthesis, again, is indicated in certain cases of autoplasty, as a help to hold up the skin flap, and may thus render great service in finishing a rhinoplasty. Lastly, Delbet* has quite recently used rubber sheeting as internal prosthesis. In one case he successfully enclosed a thin sheet of rubber to isolate the extensor tendon of the first phalanx,

* Delbet, "Rubber Grafts" (Ac. Méd., 10 Mars, 1914; *Presse méd.*, 11 Mars, 1914, p. 199).

after dissecting up its adhesions to the bone. In another case, for a large hernia, he remade the indented abdominal wall with a thin leaf of rubber enclosed in the tissues. These various efforts, attended with success, allow us to look forward to a constantly increasing number of applications for internal prosthesis in the future.

CHAPTER V

RHINOPLASTY OVER A METAL APPARATUS*

I. Generalities.

RHINOPLASTY over a prosthetic appliance has for its object the remodelling of an autoplastic nose, by providing as a scaffolding for the flaps a metallic internal prosthesis which reproduces the nasal skeleton.

Total rhinoplasty has been tried for a long time. We get the flaps from the forehead (Indian method) or from the arm (Italian method). The results are very mediocre; the flap, lacking support, sinks down, and the operation only "substitutes a ridiculous for a disgusting infirmity." Total rhinoplasty was

* We place this chapter in the part of this manual devoted to internal prosthesis. Thereby we adhere to custom. But we consider that rhinoplasty over a metal frame communicating with the exterior does not constitute an internal prosthesis. We regard it as something between internal and external prosthesis, and as in opposition to all that we know regarding the tolerance of the tissues towards foreign bodies.

accordingly given up, only artificial noses were used, until Letiévant, seconded by Martin, exhibited in 1878 the first case of rhinoplasty on a prosthetic appliance.* MM. Martin, Ravanier, de Marion, and Goldenstein, have since treated and exhibited many cases of this sort with varying results.

The metal frameworks are borne very well, causing no suppuration nor pain; they re-establish the respiratory function, very difficult without this appliance. The nose is almost normal. One can use them in all cases of loss of substance of the organ, or of collapse due to syphilis, tuberculosis, trauma, or neoplasms, even malignant (Martin). The flap to cover the false nasal framework can be taken either from the soft parts of the nose (if any still remain), or from the forehead, or, when the former have quite disappeared, from the skin of the arm (Italian method).

MM. Ravanier and de Marion recommend this latter method. In fact, the lack of rigidity in the skin of the arm, which caused it to be given up for rhinoplasty by surgeons, loses its importance, since the flap is sustained by a prosthetic appliance. Moreover, the Italian method avoids the frontal scar, also any sloughing of the pedicle by torsion. And it gives all the material necessary to cut out a big flap and give a generous covering to the metallic scaffolding. [I have found that a forehead flap containing a previously grafted piece of rib cartilage gives the best result for total rhinoplasty.—TR.]

* Martin, "On Immediate Prosthesis," Paris, 1889; Masson, édit.

II. Construction of the Appliance.

Martin, after trying aluminium, recommended platinum, which does not undergo any changes. Ribbons of platinum are used, with a thickness of 0·4 to 0·5 mm. and a width of 5 to 6 mm., folded

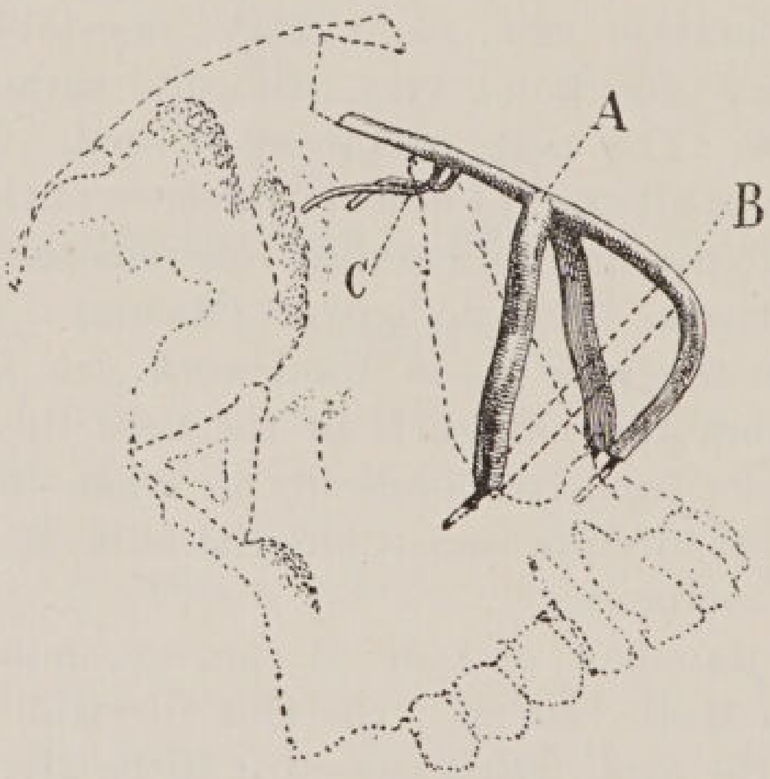


Fig. 115.—Metal Framework for the Nose. (Martin.)

gutter-wise and soldered to form a cross, in such a way as to give them the shape of a normal nose (Fig. 115).

It is well to take a mould of the face so as to make this nose of normal size, and harmonizing well with the patient's other features. We solder to each end some platinum points, which bury themselves in the bone to a depth of 5 to 6 mm., and thus insure the fixity of the appliance.

III. Placing the Appliance.

The appliance is adjusted, and reduced if necessary, according to the extent of the resection or the loss of substance. We fix it, first, to the upper part of the nose, by piercing holes with a drill in the thickness of the frontal bone; second, to the base of each ascending process of the maxilla in the same way. We smooth down the flap and sew it. It is advised not to tighten the dressing, many cases of extensive sloughing being traceable to too tight bandages. We explained above, apropos of tissue tolerance towards foreign bodies, the mechanism by which internal prostheses are extruded in certain cases of rhinoplasty. If the appliance has too sharp edges, the skin involved in cicatricial retraction becomes cut where it touches them; so that the metal skeleton rapidly comes to the surface, all the while remaining perfectly fixed to the bony circumference of the nasal fossæ.*

IV. Goldenstein's Apparatus.

Goldenstein, so as to facilitate the application of the appliance, and its more perfect adaption according to the indications of the bony substance resected or cast off, has made a combined apparatus which is movable in the vertical and transverse directions —that is to say, it can elongate or shorten, and widen or narrow down. This apparatus consists of two parts:

* Sébileau, "Metallic Nasal Prosthesis: Mechanism by which the Appliance is eliminated" (*Bull. et Mém. Soc. de Chir. de Paris*, 1903, n.s., xxiv., 546-549).

1. An upper segment ending above in a small plate fixed to the forehead, and carrying on its lower aspect two rods.

2. A lower segment which holds up the nasal lobule, and divides into two lateral branches. At the back of each of these branches are two rods, fixed at one end, but compressible at the other like a pair of pincers. These two latter rods form a fork, and

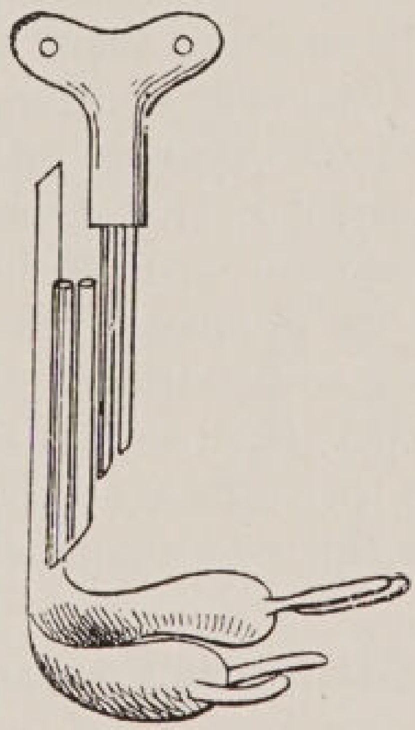


FIG. 116.—Nasal Framework perfected. (Goldenstein.)

grip the sharp edges of the ascending (nasal) process of the maxilla, to which they couple the lower segment.

In the upper part of the lower segment two sheaths receive the two rods of the upper segment and join up the whole contrivance (Fig. 116).

Thus the appliance is movable in a vertical direction; and also in a horizontal direction by its posterior "pincers," which can carry it to right or left as required.

V. The Elevation of Collapsed Noses.

Related to rhinoplasty on a prosthetic appliance is the elevation of collapsed noses by a metal scaffolding and without surgical operation.

First Case.—There is a palatine perforation. The appliance is then held up by a palatine plate, joined to the nasal framework by a pivot. So as to have the exact shape of the nose, one can push out the collapsed organ little by little by means of reinforcing pieces of godiva, until one has obtained the shape and size requisite (Aeyrâpââ).*

Second Case.—There is no palatine perforation. The appliance is, then, introduced after elevating the fleshy parts of the nose down to the bones. It is fixed by means of points in the bones, or by using metal forks which grip the sharp margin of the bones and thus assure the desired fixity (Martin).

CHAPTER VI

CONSTRUCTION AND FITTING OF APPLIANCES FOR INTERNAL PROSTHESIS

I. Generalities.

THE appliances of internal prosthesis must as far as possible be made of metal, preferably silver. These will be very simple, and capable of being retouched during the surgical intervention. If we are dealing with a cranial restoration, we make a

* Sjoberg, Congrès de Nancy, 1896.

metal plate having the contour of the gap in the bone, but a little larger; for although it is always possible, during the operation, to reduce the plate, it is quite another matter if we wish to enlarge it. The plate, of a sufficient thickness to bear the pressure to which it will later be exposed, will be slightly concave to facilitate a more exact adjustment. The plate is pierced by holes, to make it lighter, and also to allow the connective tissue (especially if we are dealing with a plate of silver) to penetrate, and so the easier to adapt itself to the foreign body imposed on it. Wedges, easily obtained by bending on itself a "demi-jonc" wire, constitute the means of retention indicated for the cranial vault.

If we have to deal with a restoration of the mandible, the appliance will consist essentially of a simple metal splint, resistant enough to bear the traction forces which will play on it. This splint will reproduce the curve of the jaw, and will be noticeably longer than the segment which it is to replace; for its precise adjustment can only be made during the operation. For the lower jaw, bolts are the best mode of retention. These have nuts of sufficient thickness to take a good purchase on the thread of the bolt. If the latter has a movable nut at *each* of its ends, we devise a curved key to fit and screw up the nut which lies against the deep surface of the jaw.

To resume: The attempts at internal prosthesis are as yet too few for it to be possible to formulate precise rules defining the construction of the appliances. Their scheme must be altered according to the cases (always widely differing from each other) with which we are confronted. But, speaking generally, these appliances must be extremely simple and amenable to swift and easy alteration at the moment of operation. *The difficulty of internal prosthesis lies, not in the construction of the appliances in the laboratory, but entirely in the operating theatre, when they are adapted and fixed to the skeleton.*

II. Instrumentation.

The application of an internal appliance necessitates various manipulations, and often numerous retouches; so that the prosthesist must needs use, in the operating theatre, some of the instruments ordinarily used in his laboratory. Thus it behoves him to adapt these instruments to the new rôle which they have to fill. They will have to be always entirely of metal, and as far as possible plated, so as to facilitate their cleansing and sterilization.

These instruments not being on the market, the prosthesist will himself have to make all this special outfit; and that is by no means one of the smallest difficulties inherent in internal prosthesis. Thus, one can mount some files (for gold) in plated handles, a "universal holder" for forceps, some flat and curved forceps, straight and curved scissors. Generally speaking, the outfit employed for working on gold tooth-crowns finds in this work a useful application. To these add a small mallet fitted on to a metal handle. For piercing the holes in metal plates and for trephining bones, we make use of drills and burrs mounted in a dental machine. In such cases we should always use a slip-joint. This instrument, being detachable, can always be sterilized, whereas to a hand-drill—not detachable from the flexible

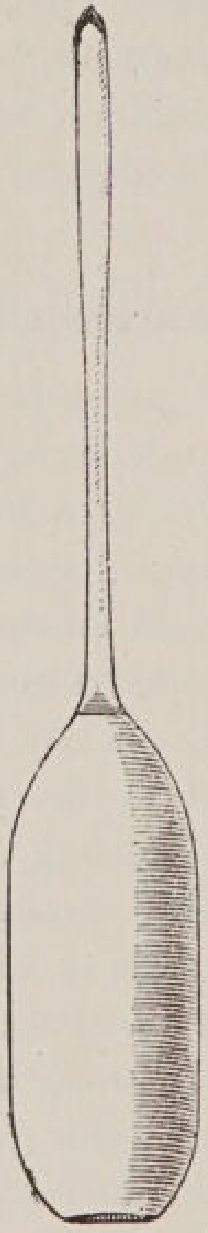


FIG. 117.—Hand-drill.

arm—this only applies with a lot of trouble, and in a way which is not above suspicion. But the dental drill and the various perforators used in surgery may be readily supplemented by drills and reamers mounted on large metal pear-shaped handles. On these lines M. Delair has constructed some excellent instruments, easy to handle, by means of which it is simple to trephine the bones and enlarge the holes (which have previously been nibbled out with forceps) in metallic plates. So as easily to get these instruments, one may with advantage use handles such as are fitted to "root screws." That is to say, interchangeable conical screws fixed by a nut on to the end of metallic handles are employed in dentistry to extract certain teeth having only one root. By replacing the screws by drills and reamers we get perfect implements. The bolts or wedges which we are going to use to fix the appliance should be got ready in greater number than those actually used, so as never to be in want of one when operating.

All this outfit, arranged in a special box, should be sterilized in the autoclave, as well as the appliance and its retention apparatus. When the time fixed for the procedure arrives, the prosthesist, having made his hands aseptic, will arrange on a specially designed table all the instruments he may want. Everything being prepared and the patient anæsthetized, an intimate collaboration begins between prosthesist and surgeon, each helping the other in turn.

Let us take for example the fixation of a late internal apparatus for restoration of a partially resected lower jaw. The prosthesist, who must be familiar with matters surgical, carefully wraps up the operative field with aseptic compresses so as to isolate it from any septic contact, especially of the hands and mask of the anæsthetist. The surgeon makes an incision following the lower margin of the jaw, and while the prosthesist helps by holding retractors to give him room, he strips with a rugine the bony ends which are to support the appliance, and he attends to hæmostasis.

In the second stage the surgeon, playing the part of assistant, in his turn holds the retractors. The prosthesist applies the apparatus to the bony ends, and adjusts it rapidly, here shortening one end of the splint with a blow of the chisel, there correcting a faulty curve with the squeeze of the pincers. The appliance being fitted, the bone is to be trephined, always passing the drill through the holes made in the metal splint so that the trephining should correspond exactly to them. We place for choice two bolts at each end of the splint, so as to insure a greater firmness. The rods of these bolts being engaged in the holes made in the appliance and in the bone beneath, we proceed to screw on, as fast as possible, the nuts. This is certainly the most worrying and difficult stage, for the blood which hides the view of the mass of muscles above the hyoid, and handicaps the free movements of the fingers, sometimes greatly hinders the fixing of the button which is to be applied to the deep surface of the jaw. It is a question of fumbling—and of patience. Whenever possible we shall strive, so as to minimize this difficulty, to pass from within outwards the rod of a bolt furnished with a fixed head. Then we have only to screw on the outside nut, and shall avoid the slow and tiring manœuvres required to fix a nut on the inside of the mandible.

The appliance having been firmly fixed to the bony ends, the prosthesist resumes the part of assistant. In this third and last stage of the procedure, the surgeon stops bleeding points with particular care so as to prevent the formation of a hæmatoma, which can easily collect around a foreign body placed between the jaw segments. Then he sews up the soft parts, preferably in several layers. The skin will, of course, be sutured without providing any drainage. Union should be obtained by first intention. If suppuration ensues, even the slightest, it is better at once to remove the appliance, rather than wait for the impossible healing of fistula formation. The latter inevitably causes the extrusion of the foreign body, which cannot conceivably be tolerated after it finds itself in an infected region. If, on the other hand, we have succeeded in avoiding the slightest error in asepsis, we shall have the satisfaction of obtaining a perfect restoration and a lasting tolerance.*

* Sébileau and Delair.

THIRD PART

TREATMENT OF FRACTURED JAWS

FRACTURED jaws can only be treated with the help of special appliances, the construction of which calls for technical processes related to the art of dentistry. Although in such cases we are not concerned with prosthetic appliances properly so called, the study of the treatment of fractured jaws none the less finds a place in the scope of this book; for this treatment is a branch of our speciality.

SECTION I

FRACTURES OF THE MANDIBLE

Simple Fractures.

THE treatment of fractured mandibles is very variable, according to whether we are dealing with fractures of the body, the ascending rami, the coronoid process, or the condyle. Fractures of the ascending rami are rare. They do not show much displacement, because on the one hand the masseter, and on the other hand the pterygoids, constitute natural splints; and the mere tonic contraction of these muscles assures bony coaptation. Fractures of the coronoid, the condyle, or the condylar neck, share with fractures of the ascending ramus the advantage, from the point of view of treatment, of being simple fractures. [This statement, as also that fractures of the ascending ramus are rare, does not apply so much to gunshot injuries.—TR.]

Fractures of the alveolar margin and those of the body of the mandible present, on the contrary, this common characteristic: that they are usually, if not invariably, compound, and therefore infected. This complication depends on the peculiar anatomical features of the region—namely, that the gingival mucosa in the latter situation is as a rule torn when the fragments are displaced, because of the adherence of mucosa to periosteum. The focus becomes infected all the easier because this fracture is compound on the buccal aspect, which is essentially septic. These considerations are of the greatest interest when we have to choose a mode of treatment for a fracture of the lower jaw.

The fracture of the ascending rami, of the condylar neck or condyle itself, simple fractures with little or no displacement, heal easily and with very little bony loss. The wearing of a chin bandage for a few days, with rest, constitute, in fact, in many cases the whole treatment.

Compound Fractures.

It is quite otherwise with fractures of the body of the jaw, compound fractures, infected, and sometimes presenting considerable displacement. In fact we know that, although a fracture in the mid-line may not produce any displacement, it is not the same with lateral fractures, simple or comminuted. In such cases the fragments are drawn in opposite directions by the muscles inserted into them. In a lateral fracture of the body of the jaw, the posterior fragment is displaced upwards and backwards; the anterior fragment, on the contrary, is directed inwards, backwards, and downwards. In a double lateral fracture of the horizontal portion there is a median segment which swings very freely downwards and backwards.

Thus, fractures of the body are often difficult to keep reduced, and it is doubtless for this reason that we owe the legion of opinions as to their treatment. The various treatments proposed can meanwhile be classified under three heads:

1. Suture and ligature of fragments.
2. Bandages, slings, and dental ligatures.
3. Appliances proper.

CHAPTER I

SURGICAL METHODS

I. Suture of Bone.

To carry out this operation we can approach the bed of the fracture by two routes—buccal and cutaneous. Holes are drilled through the fragments, taking care to avoid tooth roots. Wires, engaged in these perforations, assure reduction and good coaptation of the pieces thus drawn together. As a rule we use metal wires, for preference silver. The two ends of the wire can be twisted together (Carter's method), or each one twisted separately in a spiral, after they have passed through the bone (method of Hughes Thomas). By this we succeed in re-establishing the continuity of the broken mandibular axis, but the functional results obtained after union are often far from satisfactory. In fact, it is just to level two serious criticisms against suture of bone (which is considered by some surgeons the treatment of choice for fractures of the body of the jaw): (1) Risks of infection; (2) inability to re-establish with certainty the functional integrity of the jaw from the point of view of the interdental articulation.

1. *Risks of Infection.*—They are obvious. We are dealing with a fracture in an infected focus, open into the mouth. To suture is to put a foreign body

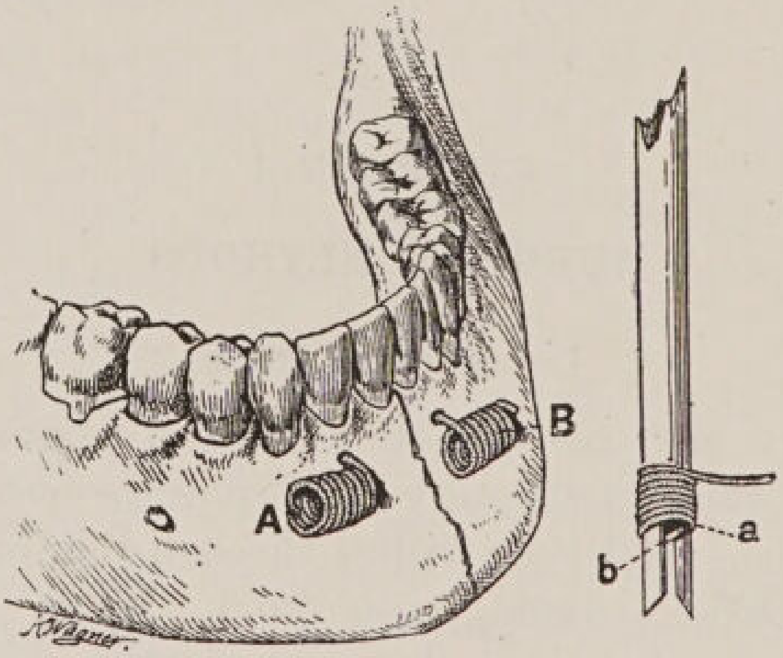


FIG. 118.—Hughes Thomas's Method. (Heath.)

A, B, Suture wire twisted at its ends; *a*, *b*, rod, split at the end, for twisting the wire.

into this septic area. This is, therefore, a certain way of insuring an indefinite suppuration to the extent of the extrusion of the foreign body.* It is running an ever-present risk of forming a large or small sequestrum, involving (after it is cast off) a shortening of the dental arch. One of us has ob-

* G. Lemerle, "Contribution to the Experimental Study of Internal Prosthesis," Thèse Paris, 1907.

served two accidents of this sort in cases of suture for fracture of the horizontal ramus. Bony suture, then, simply on account of its septicity, constitutes a bad operation.

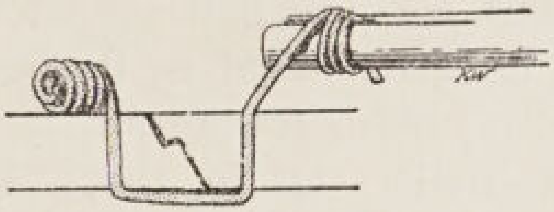


FIG. 119.—Hughes Thomas's Method: Mode of tightening the Wire. (Mahé.)

2. *Bony suture is incapable of re-establishing with certainty the functional integrity of the jaw from the point of view of the interdental articulation.* The treatment of a limb fracture should be directed, not

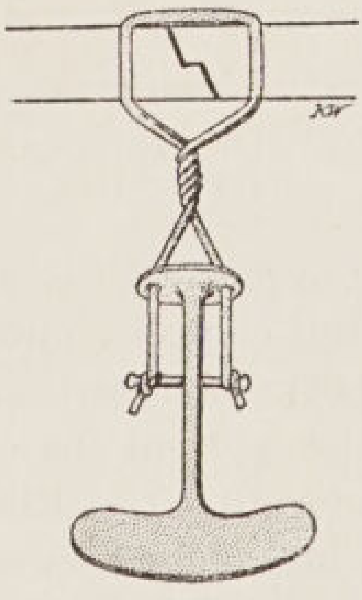


FIG. 120.—Wire Tightener of Carter. (Mahé.)

merely to reform the continuity of the broken diaphysis, but also to assure the preservation of the functional value of the wounded member. This applies to a fracture of the leg, when the surgeon's efforts should concentrate on preventing any limp. If this result is not attained, the patient after recovery still remains maimed.

The same reasoning applies to fractures of the mandible. Thus, we must make an effort to preserve its functional integrity—that is, its power of masticating well. To obtain this result, it is of cardinal importance to make certain that the interdental articulation is exactly reconstituted.

"If it eventuates in a deformity of one of the dental arches, this deformity—howbeit limited to

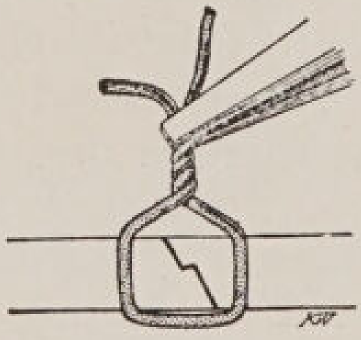


FIG. 121.—Tightening the Wire with an Ordinary Pair of Forceps.

one point, with an arch intact as regards the number of teeth—upsets the complex and delicate articulation of the two jaws; mastication is hindered, and the feeding of the patient handicapped. And *a fortiori*, if the deformity consists of an alteration in the parabolic intercuspid curve of one of the dental arches (the active line of mastication), or in a horizontal torsion of the plane of mastication of this arch, the same results are even more noticeable. Of this argument the logical conclusion, at which we wish to arrive, and which seems clearly to have been scorned by most surgeons, is: That a fracture of the mandible, being practically a dislocation of the dental arch, is, as regards prognosis, dependent *less on the operative than on the functional result.* [The italics are the Translator's.] And that the 'surgical procedure'—that phrase to which so much is sacrificed—should consist, not in preventing pseudarthrosis and obtaining a healed and solid jaw,

FIG. 122.—Sling Bandage.

but in reconstituting a dental arch conforming as nearly as may be to its antagonist, *so that the invalid may eat.*"* [Translator's italics.]

Bony suture cannot insure this functional result, for though it can recreate bony continuity, it is mani-

* Mahé, "Critical Essay on the Treatment of Fractured Mandibles," Thèse Paris, 1900, p. 25.

festly insufficient to establish exactly the interdental articulation, and we have seen that on the integrity of this latter depends, above all, the function. A septic operation and one offering certain chances of infective sequelæ, an operation incapable of assuring the functional restoration of the damaged jaw, bony

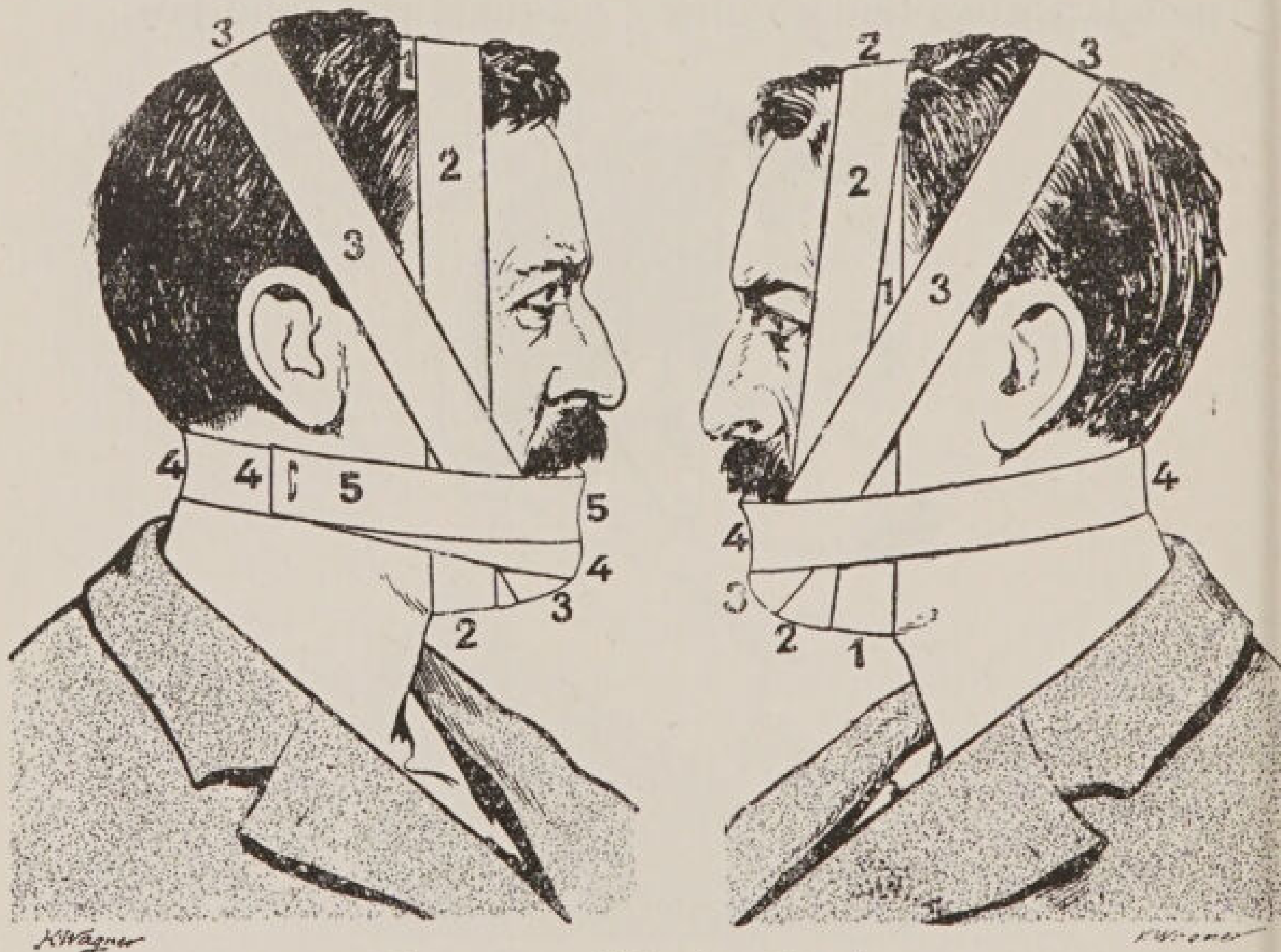


FIG. 123.—Chin Jaw Bandage.
The numbers show the order in which the turns of the bandage should be made.

suture should be relegated to the past or only used rarely and exceptionally in treatment. In all cases we can do better than suture. We consider that the use of metal splints screwed on to the bone will give better results than wires, and that silver is always the metal of choice.

II. Ligature of Bone.

This was practised for the first time by Baudens who passed a wire loop round the fragments, in immediate contact with them, and tied them to the teeth within the mouth. Béranger-Féraud later recommended this plan.* It is liable to the same criticisms as bony suture, and we will not repeat them.

CHAPTER II

PROVISIONAL APPARATUS

I. Bandages.

THE lower jaw is bandaged with a linen bandage about a yard long and 4 inches wide. In its middle we remember to make an opening into which the chin fits. Also each end is torn lengthwise to within 4 inches of the chin window. The bandage being applied to the chin, the two strips at each end are knotted, one pair over the vertex, the other over the neck; then they are again tied together in the middle line to prevent them from slipping (Fig. 122).

The "chevestre" is a more complicated bandage, of which the annexed figures give a better idea than any description (Fig. 123).

Gosselin, and more recently Ponroy,† advocated

* Béranger-Féraud, "Treatise on Direct Immobilization of Bony Fragments in Fractures," Paris, 1870.

† Ponroy, "Treatment of Fractured Mandibles by Elastic Bandages," Thèse Paris, 1903.

an elastic bandage instead of linen for the "chevestre." At the present time these bandages are an inferior mode of treatment for broken jaws, and quite inadequate. And, apart from median fractures without displacement, we cannot regard them as a means of splinting which will comfort the patient or temporarily retain the fragments.

II. Slings.

The simple sling consists essentially of a chin-band provided with four ends cut out of the same material. If the chin-strap and ends are not of the same material, we call it a "compound sling." Leblanc* uses for the chin-band plastered muslin, and strips of rubber as retaining straps.

Hamilton,† whose method is still followed in England, adopts a chin-band of leather, maintained by traction on a head-band fixed on to a circular strap which passes round the head, encircling the forehead and occiput.

Bouisson‡ fits to his chin-band two traction straps. These straps are elastic; one leaves the chin-strap and is fixed to the headpiece in front of the ear, the other starts from the same point and is fixed behind the head.

* Leblanc, "Contribution to the Treatment of Fractured Mandibles," Thèse Paris, 1897.

† Hamilton, "Practical Treatise on Fractures and Dislocations," Poinsot translation, 1884, p. 415.

‡ Bouisson, "Description of a New Appliance for the Treatment of Fractures of the Mandible" (*Journ. de la Soc. de méd. pratique de Montpellier*, 1843, vii., 106-116).

Roy* modified Bouisson's sling by improving the traction staples of the chin-band (see Fig. 124).

Dubreuil† has made use of a curious appliance consisting of a metal circle applied to the auriculo-bregmatic line of the head. It has two branches taking their purchase from the sides of the lower jaw. The ends of the branches are joined by a screw which permits of their approximation to maintain

FIG. 124.—Bouisson's Sling modified by M. Roy.

coaptation, in cases of fractures round about the symphysis. More complicated than bandages, slings do not, however, give any more security, as a method of treatment of fractured jaws accompanied by displacement of the fragments.

* Roy, *Revue internat. d'odontol.*, 1892, p. 114.

† Dubreuil, "New Method of Treatment of Fractures of the Mandible, when the Fracture passes through the Symphysis or in its Neighbourhood" (*Gazette des hôpitaux*, 1872, xiv., p. 154).

III. Interdental Ligatures.

The interdental ligature can be contrived in two ways:

1. A metal ligature joining the teeth immediately abutting on the fracture, from one segment of the

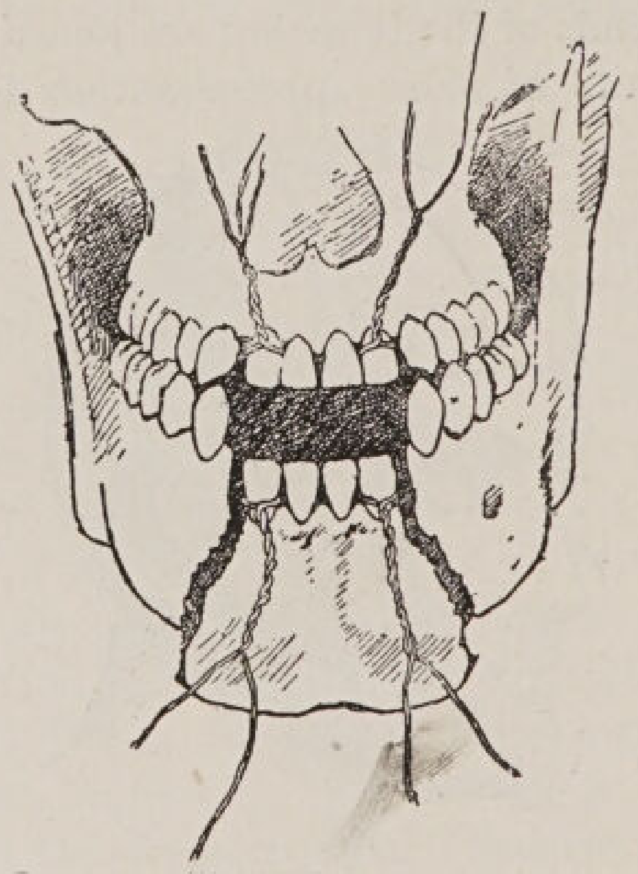


FIG. 125.—Intermaxillary Ligature: Leblanc's Process.

jaw to the other. This type of ligature approximates the extremity of the fragments, but is a poor corrective of vertical displacements.

2. A ligature joining the lower to the upper teeth, the upper jaw being thus regarded as a splint. The fracture, immobilized and corrected, heals in this position, the mouth being kept in a state of occlusion.

Guillaume of Salicet, Italian surgeon of the thirteenth century, already used this method. Some years ago Leblanc* renewed this mode of treatment, and published an interesting memoir on the subject. To describe the principle of this ligature, let us suppose ourselves concerned with a wounded man in possession of all his teeth, and exhibiting a double fracture which isolates a median fragment.

"It is quite simple to place," says Leblanc, "at each end of the fragment, a silver wire around a tooth, to repeat this on the homologous teeth of the

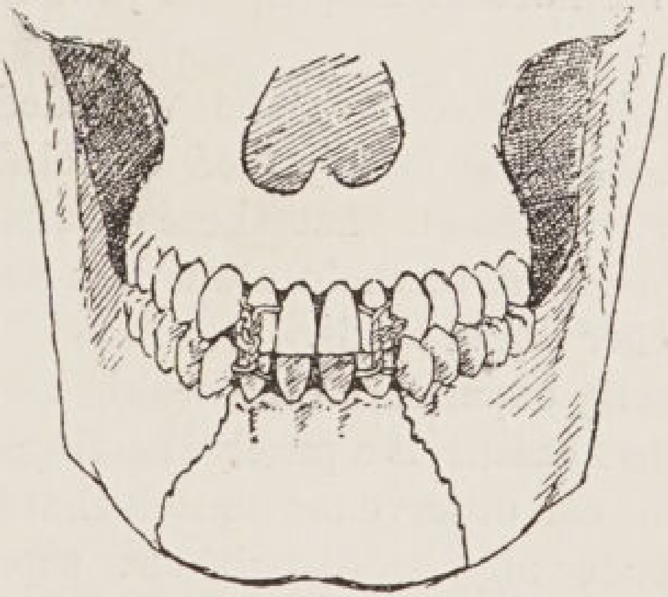


FIG. 126.—Intermaxillary Ligature: Leblanc's Process.

upper jaw, to approximate the lower segment so that it articulates very exactly with the upper teeth, and to join up in pairs the wires previously placed."

Angle† has treated many cases of fractured mandibles by a similar process, but he uses, as a *point*

* Leblanc, "Contribution to the Treatment of Fractures of the Mandible," Thèse Paris, 1897.

† Angle, "Some of the Principles to be considered in the Treatment of the Teeth and Fractures of the Maxillary Bones" (*Dental Rev.*, Chicago, 1890, pp. 380-383). See also *Med. Rec.*, New York, 1890, pp. 611-613.

d'appui on the teeth, metal bands cemented on. A metal wire then joins (by the bands as intermediaries) the upper and lower teeth, and puts the dental articulation in a state of occlusion. Thus we obtain immobilization and correction of the fragments. Various objections have been made to Leblanc's method, which, for that matter, are not always justified. We may examine them in turn, for they will recur again to some extent later, apropos of all the methods of keeping the jaws in a state of occlusion.

1. Difficulty in feeding the wounded man. In reality, the invalid is deprived of solid food; but experience has shown that there is always enough room between the teeth to allow him to take soup, milk, or other liquid foods.

2. Difficulty experienced in speaking. Here again, according to Leblanc, is a purely theoretical objection, for everyone can observe for himself that it is possible to pronounce any word without separating the teeth.

3. The ligature loosens the teeth. This is only strictly true in ligaturing to teeth of the *same* jaw.

4. The metal wires irritate the gum, and soon provoke a local infection. This is only true when the ligatures are malplaced.

5. The metal wires cause pain. The practice of orthodontia, in which ligatures are constantly used, proves that there is nothing in this objection.

6. Finally, the same answer (see No. 5) may be made to the last accusation, that the ligature wears away enamel and initiates caries.

In our opinion, there is only one objection carrying any real weight, and that is the following: The patient thus ligatured stays for forty or fifty days without opening his mouth, of which for weary weeks any toilette is impossible, since the state of forced occlusion of the jaws only allows the vestibular surface of the teeth to be brushed. This is a very real drawback to the method, all the more so in that we are generally concerned with a compound, infected fracture, demanding a strict hygienic ritual.

In any case, Leblanc's method happens to be excellent in that its execution is very simple, it requires no special outfit, and it is available for any practitioner not a specialist. For these reasons, and if we imagine a patient provided with all, or nearly all, his teeth, far from any prosthetic resources, this treatment of fractured jaws deserves to be retained. It has at least this immense advantage over bony suture, that it assures a consolidation with preservation of a good interdental occlusion, and as a result a recovery with functional integrity of the jaw.

CHAPTER III

FRACTURE APPLIANCES PROPER

THEY are extremely numerous, and for this reason difficult to classify. We shall divide them as follows:

1. Appliances fixed without previously taking an impression.

2. Appliances requiring an impression and made to a corrected mould.

These latter fall under three subdivisions:

(*a*) Appliances consisting of double splints (one for the chin, and one dental).

(*b*) Appliances consisting of double splints (upper dental and lower dental).

(*c*) Appliances consisting of a single dental splint.

I. Appliances fixed without previously taking an Impression.

These have a special historical interest, and present the common feature of taking their support from the dental arch and lower part of the jaw. According to Malgaigne,* the idea of using a double splint belongs to Choppart (1780), who proposed an apparatus comprising a dental splint formed of a plate of cork or lead, joined by metal hooks which curve round to the outside to a submental splint. This idea was taken up by Ruthenick in Germany. He perfected an appliance in which he utilized a metal dental gutter equipped with two rods which were attached to a submental plate, gutter and plate being covered with absorbent bark. Kluge, Lonsdale, Jousset,† employed the same principle.

Houzelot's original arrangement enabled the surgeon to regulate the splint as he liked. His apparatus has for a long time been classical, and on this ground deserves a more detailed description.

* Malgaigne, "Treatise on Fractures and Dislocations," i., p. 371, 1847.

† Jousset, *Gazette médicale de Paris*, 1833.

Houzelot's Apparatus (**1827**).*—This consists of a chin splint and a dental splint, and we shall find this principle of a double splint (internal and external) in numerous appliances since invented. Houzelot himself gave the following description of his invention:

"This apparatus comprises—1. A metal rod, which I call 'maxillo-dental,' formed of two parts. The first, vertical, presents in its lower two-thirds a longitudinal window or groove. The second, horizontal, is soldered at right angles to the first, and directed backwards and forwards, lying in the mouth.

"2. A small upper plate, dental, because it takes its *point d'appui* from the teeth. It is soldered transversely to the free end of the horizontal part of the maxillo-dental rod. It is plane on both surfaces, semicircular to accommodate itself to the arrangement of the dental arch, and pierced by holes.

"3. Corks are placed on the surfaces of the plate. The lower has deep recesses to receive the teeth. The upper, of very slight thickness, prevents the immediate contact of the mucous membrane on the metal of which the appliance is formed.

"4. Some small wooden pegs pass through the cork, and are received in holes of the dental plate, on which they thus fix the corks.

"5. A lower or maxillary plate. It is, in fact, on the lower border of the maxilla that it acts. Slightly

* Houzelot, "Some Considerations on Fracture of the Body of the Mandible, and a Description of a New Appliance to retain the Fragments: with Notes on Supports," Thèse Paris, 1827, p. 15.

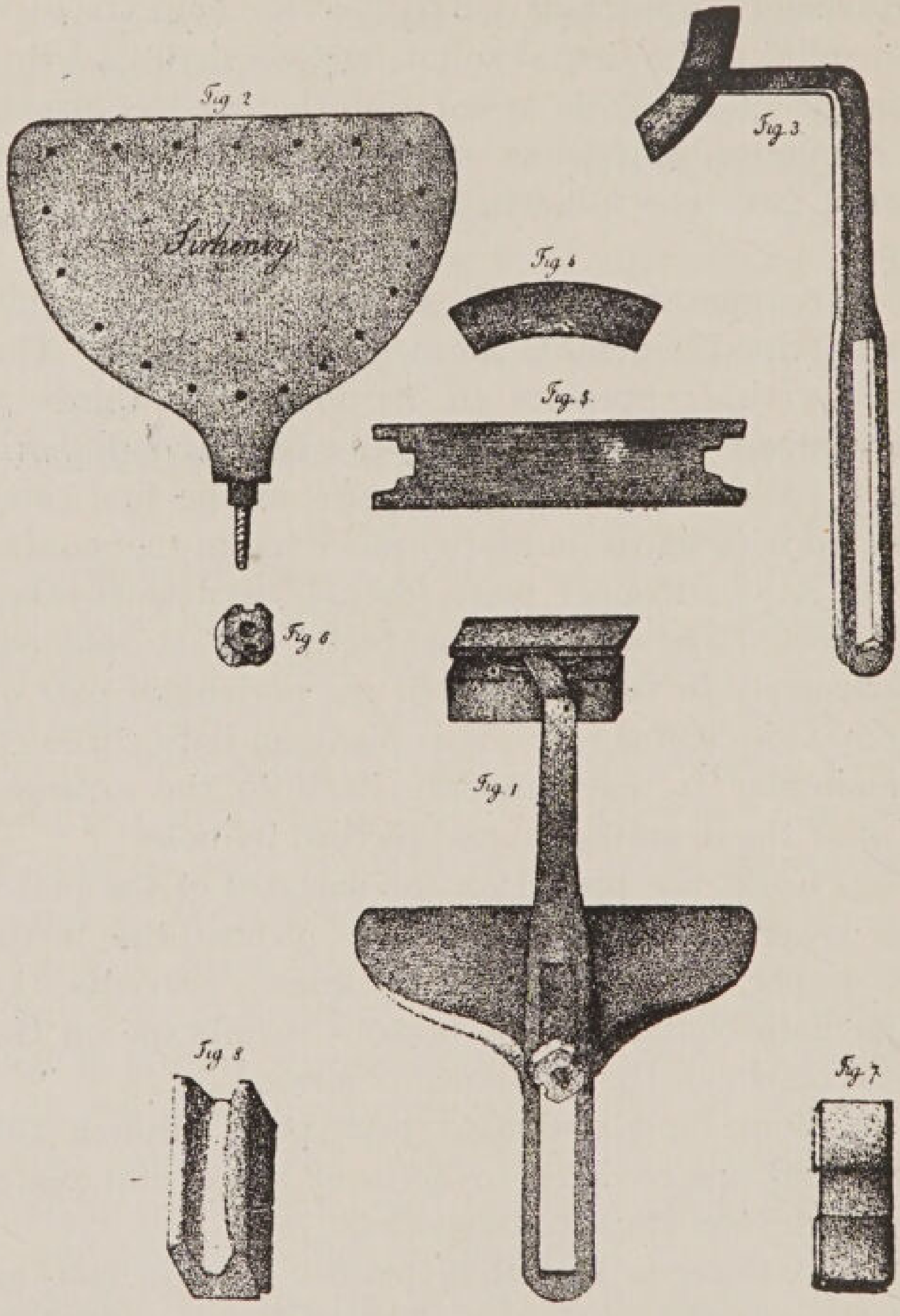


FIG. 127.—Houzelot's Fracture Appliance for the Mandible

1, Appliance assembled; 2, maxillary plate; 3, maxillo-dental rod; 4, dental plate; 5, key or spanner; 6, nut; 7, upper cork; 8, lower cork.

concave on its upper rubber-covered surface, it receives in this concavity the lower margin of the maxilla, which it presses from below upwards. Received by a narrow quadrilateral stalk in the window which we have seen cut in the vertical portion of the maxillo-dental rod, it is movable in this window, to the edges of which it is fixed by means of a nut, and by pressure exercised in front and behind. The nut fits on to a screw-thread on the stalk of the plate.

"6. A nut, notched at two opposite points of its circumference, which receives the two projecting parts of the spanner or key which turns it.

"7. An appropriate spanner or key.

"*Application of the Apparatus.*—Having reduced the fracture as generally described in textbooks, the surgeon first of all places the dental plate on the teeth, which are received into the canal of its cork; it is so applied as to act on the teeth on either side of the fracture. The left index and middle fingers hold it in this position. He thus engages the stalk of the maxillary plate in the vertical window. His left thumb, lying on the lower surface of this plate, pushes it from below upwards against the lower edge of the bone, which it should compress; and when the pressure is strong enough (which he can easily gauge, since his own fingers are making the pressure), then the right hand puts on the screw the nut, which he turns with the key. By tightening he thus immobilizes the lower plate on the window in the maxillo-dental rod. We support the apparatus by a few turns of a bandage; one passes from chin to occiput, the others pass beneath the chin and end above the vertex. They must be only moderately tight."

Such is the apparatus of Houzelot, and its mode of application, of which we have reproduced the verbatim description. It has great defects; its dental splint is too short and can hardly ever be used except for fractures of the anterior part of the jaw. Its external splint does not wrap round the whole curve of the chin, and gives an insufficient support. But we must reflect that Houzelot's first observation dates back to 1826, and in his day his appliance constituted a considerable advance in the treatment of fractured mandibles. Lastly, *his principle*—an internal and an external splint—is used in a large number of appliances invented one after the other from his day to ours.

Appliance of Morel-Lavallée* (1862).—This is actually a transition between the appliance of Houzelot and those which are made after taking a dental impression. Morel-Lavellée's appliance was made in the following way: A roll of gutta-percha, softened in warm water and placed in a metal gutter, was applied to the teeth, which thus fitted into it exactly. To the dental splint thus obtained was added a spring made of a fairly thin steel sheet, of which the upper end, forming a plateau, lay against the gutta mould, into which it was implanted by small points. The other end of this spring, fixed

* Morel-Lavallée, "Gutta-percha Appliance for Fractured Jaws" (*Bulletin gén. de thér.*, Paris, 1862, iv., iii. pp. 200, 248, 252).

to a concave pad, applied this pad as an external splint beneath the chin, which gave it its *point d'appui*. Although an improvement on Houzelot's apparatus (having a better adaptation of its splints), the appliance of Morel-Lavallée has the fault of only

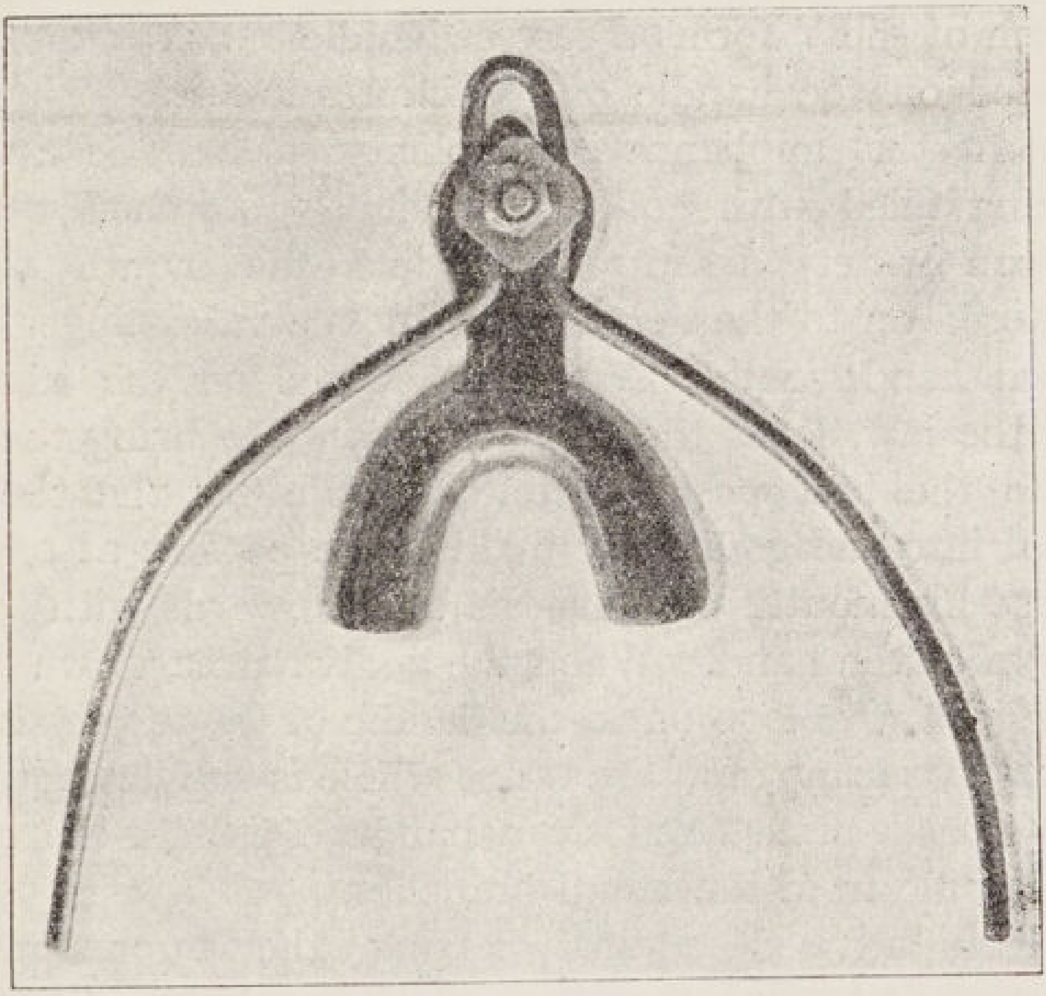


FIG. 128.—Simple Appliance for Fractured Mandible. (Nux.)

partly correcting the displacements of the fragments. For at the time of application of the softened rubber the correction is not always put beyond all doubt.

Nux's Appliance.*—This consists of two parts:

* Nux, " A Simply-made Appliance for Fracture of the Mandible " (*Odontologie*, Août, 1907, p. 132).

1. An impression tray with a flat base, covered with godiva or Stent's up to flush with its edge.

2. A splint of malleable iron wire, round, 3 mm. thick and about 30 cm. long. This wire is shaped in a vice in the form of a **Y**. The branches are gently arched to hug the contour of the jaw; and the stem of the **Y** forms a sort of handle which is superposed on the handle of the impression tray (Nux). To fit this appliance is simplicity itself: The tray, being filled with godiva (previously softened with warm water), is introduced into the mouth and pressed on to the dental arch by the index-finger of each hand; while the thumb, placed on the edges of the jaw, lever the fragments so as to bring them into the best possible contact. We get the teeth well into the godiva by making the patient at once close his mouth, pressing the chin upwards with the palm of the hand. When the godiva is hard, we fix the iron wire loop on to the handle of the impression tray by means of a nut. The whole is supplemented by a chin-plate fixed by a bandage passing up on each side from its lateral branches.

Nux advised against letting the impression-material overflow the tray, which would press back the gums and hinder the antiseptic washes which are necessary in cases of compound fracture. So the godiva should come to an end at the gingival margin, leaving the mucosa uncovered as far as possible. For that matter, it is easy to trim it with a hot spatula. Before placing the appliance, it is wise to file down the lower edges of the impression tray in the mid-line, to avoid the irritation which the gutter might cause to the frænum of the tongue and to the lower lip. Lastly we remove with a file a part of the upper and outer angle of the impression tray, and bore a hole in it opposite the premolars. By this expedient the upper molars can bite into the interior without hitting against the gutter, the premolars oppose more easily, and the articulation of the teeth is separated as little as possible.

It has a great disadvantage (for that matter, recognized by its author)—namely, that it does not enable us to place beyond all doubt the integrity of the interdental articulation. Thus, it is liable to the same objection as the appliance of Morel-Lavallée, with which it can be classed, since its manufacture does not call for the previous taking of a mould. We must in any case recognize that Nux's appliance is an ingenious means of making quickly a temporary or first-aid contrivance to immobilize the jaw. Meanwhile we shall be waiting to apply, in every case where this is possible, a treatment capable of assuring with certainty the preservation of the interdental bite.

"*It is essential,*" says Cl. Martin, "*not that the appliance moulds itself on fragments more or less reduced, but that the fragments mould themselves on to an appliance which is a hollow (or negative) replica of the shape of the dental arch as it was before fracture.*"*

II. Appliances which necessitate the Taking of an Impression, and made on a Corrected Mould.

The taking of a mould of the dental arches previous to making a retention apparatus marks a great

* Martin, *Rev. de chir.*, 1887, v., No. xi.

advance. This principle is common to all up-to-date appliances with single or double splints, however diverse their nature. Let us, then, study the principle before passing on to the appliances.

Taking an Impression.—This depends on the same laws as govern the taking of an ordinary impression. Nevertheless, the obstacles are greater, and are referable to the pain caused to the patient by the manœuvres of instrumentation, and to the greater or less difficulty which he experiences in widely opening his mouth. For narrowing of the jaw-opening almost always accompanies fractures of the lower jaw, at any rate during the few days immediately following the injury. Wax, godiva, or plaster, may be employed; if we elect the latter, we shall have to introduce it at the precise moment chosen, some seconds before taking the impression. This precaution is to prevent an admixture of saliva, which is always very copious in these cases, and can rob the impression of its finish. Godiva is preferable to plaster in this case, on account of the pain produced by the plaster when it has hardened; and we separate the material from the parts to be moulded. The impression (except in certain rare and very difficult cases where we have to proceed by partial moulds) is to be taken in one piece. Above all, it must be complete.* We need not take count of the displacement of the fragments, whatever this may be; for the displacement has no importance, once we have it reduced *on the model.*† During the pro-

* Cl. Martin, *Rev. de chir.*, 1887, vii., No. xi.

† P. Dubois, *Odontologie*, Juin, 1894, p. 325.

cedure of taking the impression, an assistant holds up the chin, so as to diminish the pain (consequent on the displacement of the fragments) by exercising the necessary pressure. The impression of the two jaws is indispensable for carrying out the two following operations:

Reduction of the Fracture on the Model, and Reconstitution of the Model.—Having cooled down the impressions and stripped off the models, we must first of all proceed to the reduction of the fracture on the model, which at this moment represents the jaw with its fragments displaced. With a saw we divide the model at the position of the fracture. The section is to be a good deal widened at its base—that is to say, at the part corresponding to the floor of the mouth. This is so as not to be hindered afterwards in the coaptation of the fragments. Then we fit the most important fragment to the upper jaw, to try and obtain the exact articulation of this fragment. The wear and tear of the teeth produced by the points of contact, that produced by a pipe-stem in a smoker, are guides which help us to find the articulation. In difficult cases we examine minutely the teeth impressions in the plaster to find there traces of wear, which, however faint, are precious guides.

When the articulation of the first fragment is adjusted, we fix together, with melted wax, the models in their proper relations. Then we begin a similar operation on the second fragment. This put in place and stuck to the first, it only remains to pour plaster into the solution of continuity between the two fragments. The plaster answers equally well for the reconstitution of the model and the intimate consolidation of its fragments. The model is next trimmed, the excess of plaster which has welled over on to the jaw, in the neighbourhood of the fracture, removed, and the surface levelled. We now have a reduced model—that is, the exact mould of the mouth before the fracture. The construction of an appliance for a fracture has the peculiarity that it can never be tried before placing it. It is therefore necessary to encompass oneself with minute precautions, so that it shall make contact with the parts on which it will rest, without damaging them, and also that it should fit as exactly as possible.

Preparation of the Model.—The best way to fulfil these conditions is to "prepare" the model on the fracture, as soon as the latter is reduced. This preparation consists in exaggerating the size of the tubercles of all the teeth as well as the projecting ridges of the mouth on which the appliance will rest. This is effected by liquid plaster or by means of small drops of melted wax. Only the proximal spaces ought to be respected, in such a way as to assure the retention of the appliance, while allowing it to be easily placed. This sort of preparation is indispensable to apparatus made with troughs, whether they be made of metal or rubber. It is on this model that we proceed to the combination and fashioning of the retention appliance.

In a case where there are no remaining teeth in the upper jaw, or if the number of these teeth is inadequate to reconstruct the articulation, the operation is simplified in this sense: that it suffices to reduce the fracture in such a way as to give to the jaw approximately the shape which it had formerly, without worrying as to its relations, since it had none. We shall pass in review the different apparatus used for the reduction and retention of fractures, made according to a mould.

I. Appliances with a Double Splint, for Teeth and Chin.

A. Description of Appliances.

Bullock's Appliance.—This is a splint in vulcanized rubber, moulded on to the teeth, which traverse it in part so as to articulate with the upper teeth. On the sides of the dental trough are fixed two metal rods, which leave the mouth near the commissures, curve downwards, and end in two simple rings which serve to fix them to a chin-plate by means of a lace (Nux).

Kingsley's Appliance.*—Little known in France, this has, however, been used by Cl. Martin and several others. Mahé has constituted himself an ardent partisan of this appliance, and has expatiated on its merits in his thesis devoted to the critical study of the treatment of fractures of the mandible.†

* Kingsley, "Treatise of Oral Deformities," 1882. See also Hamilton, "Practical Treatise on Fractures and Dislocations," translated by Poinsot, 1884, p. 135.

† G. Mahé, "Critical Essay on the Treatment of Fractured Mandibles," Thèse Paris, 1900. See also, by the same author, "Concerning Kingsley's Appliance for Treatment of Fractured Mandibles" (*Revue de chirurgie*, 1897); and "Note on a Case of Complicated Fracture of the Mandible, treated by Kingsley's Appliance" (*Rev. de chir.*, 1899).

Kingsley's arrangement comprises a buccal trough in vulcanized rubber, exactly fitting the teeth and constituting the internal splint. Two prolongations, formed of a steel wire, fixed to the front of the appliance at the level of the canine, act as retention rods. These prolongations are recurved backwards slightly in front of the commissures, and are directed horizontally as far as the angle of the jaw, parallel to the cheeks. The trough being constructed according to a mould of the dental arch which reproduces the

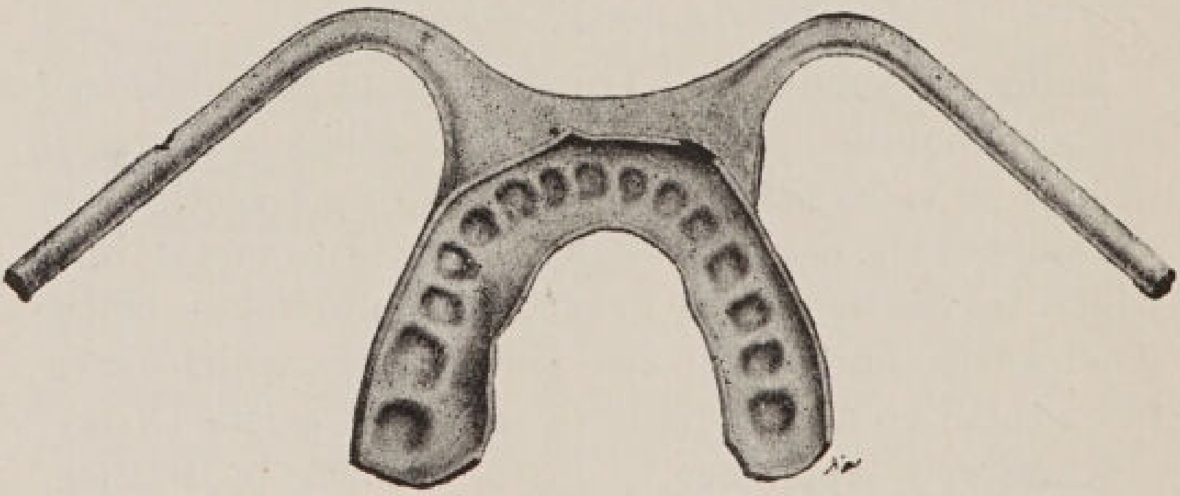


FIG. 129.—Kingsley's Appliance.

reduced fracture, when it is put in place the deviations of the fragments are found to be corrected. It only remains to maintain the appliance by taking support from the chin, with a submental dressing joining the two prolongations of the trough, which project on to the cheeks.

The dressing is done with a linen, or better elastic, bandage, attached to each end of the metal prolongations and supporting the chin. According to Kingsley, it is preferable to place beneath the bandage an actual splint consisting of a triangular plate, hollowed out behind for the neck, rounded in front for the chin, and extending each side a little beyond the jaws.

For fractures with but slight displacement, it may be useless to keep the external splint until the end of the consolidation; the internal splint suffices after a few weeks. In this case, Kingsley, as an improvement on his appliance, uses metal prolongations which are *removable*. To render them so, it is enough if, instead of submerging the ends of the steel wires in the mass of vulcanized rubber, we make these same ends rectangular on section. Thanks to this arrangement, they will fit into a metal sheath inserted on either side of the gutter, at the level of the commissures. Thus modified, the appliance can act as a double splint at the beginning, and a single splint at the end, of treatment. Until late years, this appliance (which has become classical in the United States) has been employed in this form.* On its appearance in 1882, Kingsley's appliance constituted an immense advance, and for many years it rendered excellent services. But it is not applicable to all cases of fracture, and has some disabilities which invalidate all appliances of the double splint type. We propose to discuss these later on, when we have examined the general points of this type.

Cl. Martin's Appliance.—It consists of a buccal piece and a chin-piece, joined by a fixation spring.

1. *Buccal Piece.*—This is formed by a double trough of sheet-steel, which has over rubber the

* Moriorty, *Boston Med. and Surg. Journ.*, 1897, p. 509.

advantage of being much more resistant. Sheet-steel allows us to use a very thin piece (3 mm.). This thickness of the metal is so weak that, to facilitate the introduction and removal of the appliance, Martin uses two troughs exactly fitting each other. Only the more superficial bears the fixation spring. This double trough, carefully plated to prevent rusting, should not descend lower than the neck of the teeth. It is pierced by holes on its upper surface

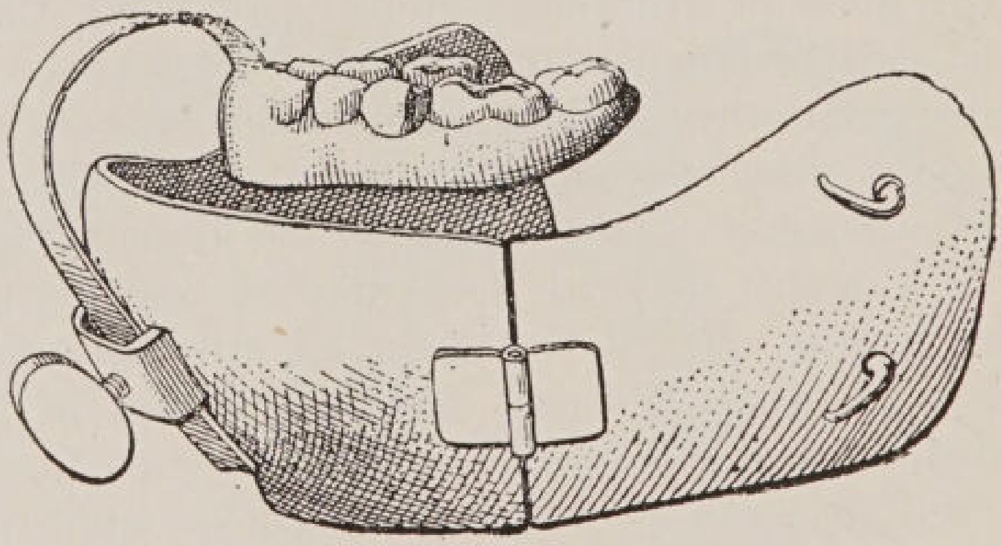


FIG. 130.—Appliance of Cl. Martin.

at points corresponding to the dental cusps. These holes diminish the thickness opposite the occluding surfaces of the teeth, and prevent undue elevation of this surface; besides, they allow a strong current of water to percolate between trough and teeth, to carry off pus and food débris which has passed in. The trough takes in the whole dental arch, and Martin insists on this point. "A principle must be conceded," he says, "in the treatment of fractured jaws—namely, that, whatever be the fracture, the buccal part of the appliance should take its *point d'appui* from the whole dental arch."*

2. *Means of Fixation of the Buccal Trough.*—This is certainly the most interesting feature of Martin's contrivance.† We know that, in jaw fractures involving the lateral part of the body of the bone, there occurs a displacement, which is constant, of the fragments, in opposite directions, by the muscles inserted into their neighbourhood. The anterior

FIG. 131.—Chin Trough of Martin.

fragment is carried inwards, backwards, and downwards; the posterior fragment is carried especially upwards. To reduce the fracture and keep it reduced, it follows that the anterior fragment should be lifted up, the posterior lowered.

This last-mentioned movement of lowering is all the more difficult to obtain because the track of the

* Cl. Martin, "The Treatment of Fractured Mandibles by a New Appliance," Paris, 1887 (Alcan, édit.), p. 10.

† Cl. Martin, *ibid.*, p. 42.

fracture is situated far back, and most of the double splint appliances act well on the anterior fragment, but feebly on the posterior; for the *point d'appui* of the external splint, in the neighbourhood of the chin, is placed too far forward relative to the posterior fragment. It follows from this that the most posterior part of the trough fits less tightly on the teeth than the anterior part, *although the converse is more necessary* [Translator's italics]. This is the reproach which can be levelled at the appliances of

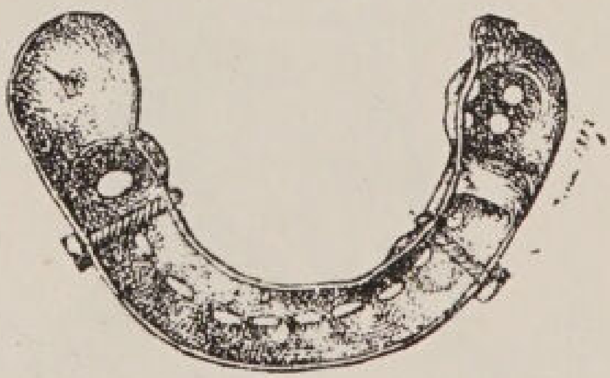


FIG. 132.—Penetrating Struts.

Houzelot and its descendants; the same may be said, although to a less extent, of Kingsley's.

In certain cases of fracture lying far back these splints give poor results, for they succeed only partly in achieving the depression of the posterior fragment. It may reasonably be laid down that the whole secret of the difficulty in treating fractured jaws lies in this dictum: *Lower the posterior fragment, and keep it lowered.* All other displacements are easy to correct. To attain this lowering of the posterior fragment, Cl. Martin avails himself of a single spring, median, of steel, and fixed to the middle of the trough. In the state of rest, the free end of this spring juts out between the branches of the trough. When it is stretched and fixed by its free end under the chin, he places the trough on the dental arch, which it covers. But its action tends to make itself felt especially on the part of the trough which is farthest back in the mouth, precisely in the region where it is expedient to get a forceful pressure to obtain the depression of the posterior fragment. Besides this, the counter-pressure of the spring on the chin tends to elevate the depressed anterior fragment. The illustration (Fig. 130) made by Martin shows clearly the action of this spring so ingeniously arranged.

3. *Submental Splint.*—Also of metal, this consists of three pieces which embrace the convexity of the chin and the lower border of the mandible. A median piece, very narrow, fits on to the region of the symphysis. It bears near its posterior edge a groove in which the free extremity of the median spring, fixed by a pressure-screw, engages. Laterally, this central piece articulates by hinges with two prolongations which extend some distance backwards, not far from the angle of the jaw, and which embrace in their concavity the greater part of the margin of the jaw. Near to their ends these lateral wings bear hooks; by attaching these to laces we transform this external splint into a true sling taking its support from the head. Martin thus divided his chin-piece into three articulated pieces to facilitate careful cleansing in the neighbourhood.

This apparatus is placed in position as follows:

The first trough is applied to the dental arcade, and when all the teeth are exactly fitting the fracture is found to be accurately reduced. The second trough, carrying the retention spring, is then placed above the first. The end of the spring is slid into the groove of the chin-piece, and fixed by a few turns of the screw. Covered with gauze pads for its whole extent, the chin-piece is put in place firmly, and its lateral wings are kept up by rubber bands attached to little hooks which are supplied at their ends. These elastic bands pass to the vertex of the head, and, thus fixed, the whole appliance is embodied with the jaw; the opening of the mouth is never hampered, thanks to the elasticity of the rubber bands. To change the gauze pads, it suffices to unhitch the hooks from the elastic bands; the lateral wings of the chin-piece fold back, whilst the median part always holds the end of the spring. It is also possible gently to separate the median piece without in the least upsetting the reduction of the fracture, when we wish to remove and change the submental pads soiled with pus, saliva, or food débris. This done, the wings are drawn up and fixed anew to the rubber bands.

It is also to make more certain that the fracture is kept in a reduced position in the various manœuvres necessitated for cleansing the apparatus that Martin advocates the use of double troughs fitted one on to the other.

Special Appliances of Cl. Martin.—In a certain number of special cases Martin has been led to modify his appliance. The cases in question were of fractures with displacements which were unusually stubborn to correct.

1. *Troughs with Pointed Penetrating Struts.*—When the margin of the mandible lacks teeth precisely in that part (the posterior fragment) which is so difficult to depress, the trough acts badly on the latter, and tends to slide. This inconvenience will be overcome by furnishing the trough with a sharp point which passes through the upper border of the

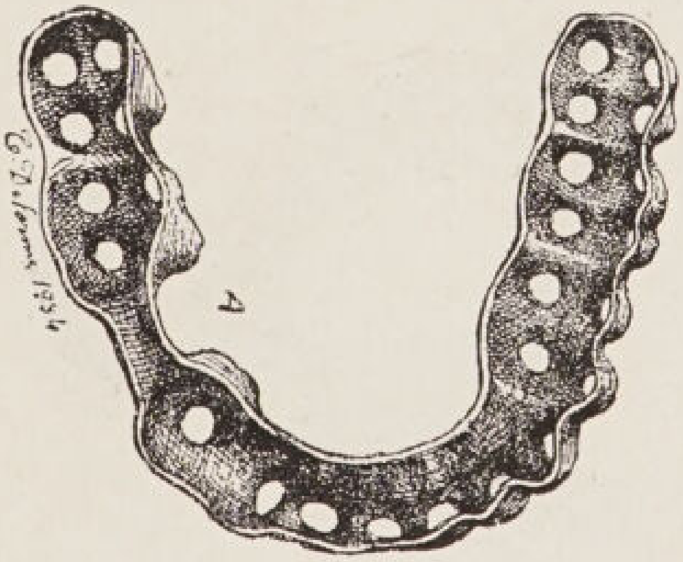


FIG. 133.—Metal Trough. (Martin.)

bone. The use of these perfectly tolerated struts, as by Martin, does not, according to his observations, cause any complication.

2. *Reimplantation of a Recently-lost Tooth.*—When a tooth comes out at a point remote from the seat of fracture, the accident is not of vast importance. It is not so when it occurs at the edge of the fracture track. In such a case the loss of the tooth occasionally determines an actual loss of substance, for the fragments tend to approach each other to fill

the chasm produced. *Therefore we should never extract a tooth, even if tottering, when it is in relation to the fracture track.* [This point has been much in debate in England. Personally, I have several times seen a tooth, which was actually rocking in the line of fracture, become firm, and thereafter be most useful for fixing an appliance.—Tr.] Maybe it will fall out later; but its presence during the first weeks of consolidation will at least have prevented a deformity due to approximation of the fragments.

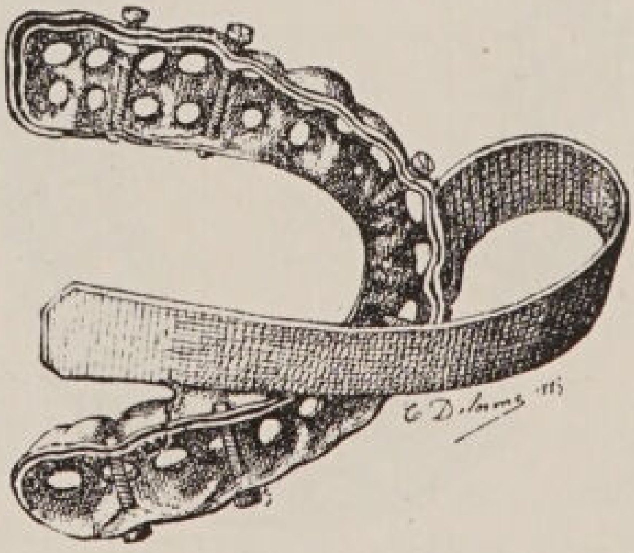


Fig. 134.—Trough. (Martin.)

If the trauma responsible for the fracture has entailed simultaneously the loss of a tooth immediately abutting on the fracture track, Cl. Martin advises that a cone of tin of the same shape, soldered to the trough, be inserted into the socket, and left there until the fracture is entirely consolidated.

3. *Interdental Screws* (Fig. 134).—In certain refractory cases Martin has used, so as better to immobilize the trough, screws fixed to this latter, and passing through the intervals between the teeth.

This exceptional resource should only be employed for a few days, since it damages the teeth.

4. *Appliance to correct Overlapping.*—In cases of fractures beginning to consolidate with overlapping of the fragments, Martin recommends the arrangement seen in Fig. 135. The gradual pressure of the screw stretches the adhesions, and replaces the fragments in good position.

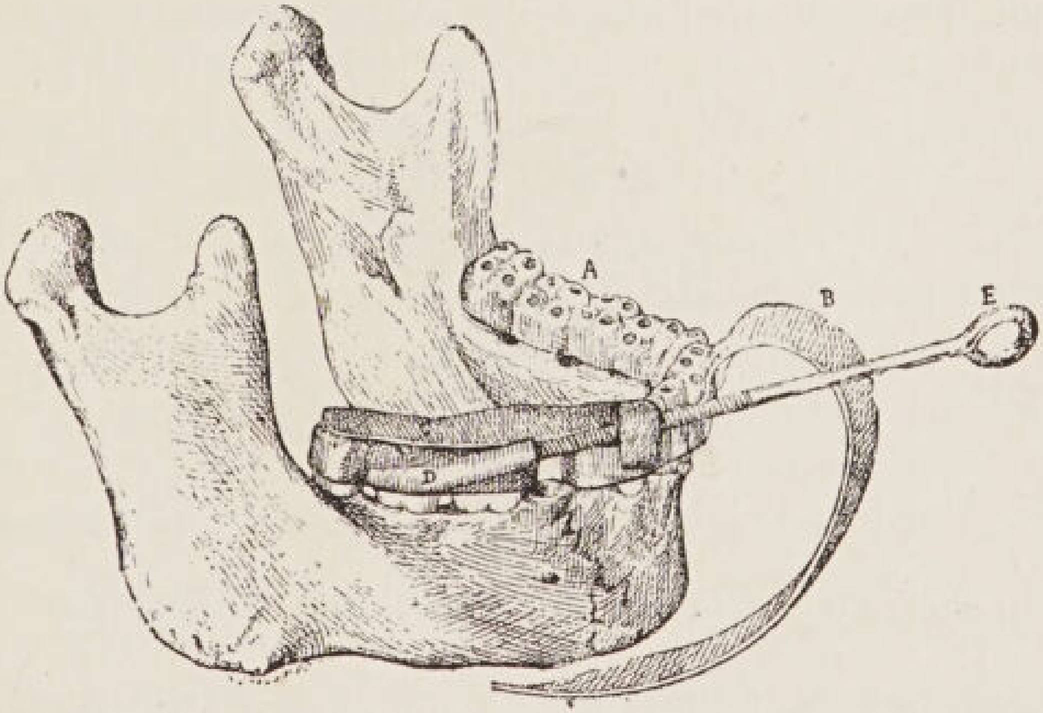


FIG. 135.—Martin's Trough, with a Screw to complete the Reduction.

5. *Separation of the Lower Margins of the Fragments.*—In simultaneous fractures of the condylar neck and the body, Martin has described a peculiar flattening of the face, due to the inward displacement of the middle fragment. In such a case, the buccal trough keeps the upper margin of this fragment well enough in place; but its lower edge, without any internal support, persists in being carried inwards

To correct this displacement (for that matter, a very rare one), Martin has successfully used his appliance, but replacing the chin-piece by a rubber ball (Fig. 136).

"This ball, thanks to its shape, depresses the soft parts below the chin, and preserves the form of the lower border of the bone if its arch tends to flatten out. The pressure of the ball may in the long-run ulcerate the skin where it presses. So that we should not leave it for longer than is necessary for the

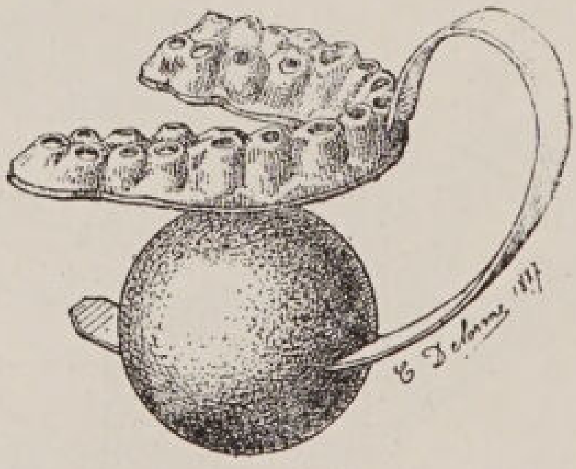


FIG. 136.—Martin's Appliance with Rubber Ball.

formation of adhesions. Then it is to be replaced by an ordinary appliance. We add the rubber ball to the end of the spring by perforating the ball through and through with a knife which has been moistened to make it cut rubber. It only remains to push the spring through the tunnel cut in the ball, which is in this way firmly fixed."

Construction of Martin's Appliance.—We have seen that the metal employed was sheet steel 0·3 mm. thick. Once the arch is moulded, and after its correction, we cast a second mould of it in zinc, with matrix of lead, which will serve for stamping the sheet-steel; of this we make the dental trough. The method employed does not differ from that in current use for ordinary dental prosthesis. It is as well to make the steel immune to changes by contact with buccal fluids, by plunging it into a bath of molten tin (after washing it in water to which a few drops of sulphuric acid have been added). Despite its simple appearance, Martin's appliance is difficult to make, for sheet-steel is really not convenient for stamping. As for the rest of the process, we must give the spring a suitable curve so that it shall not have an irregular action. This precise regulation of the spring presents certain difficulties. In order that the spring should act uniformly and effectively, the pressure made by it should be distributed uniformly over the whole surface embraced by the intrabuccal trough; and it should be counterbalanced by the *point d'appui* which the spring takes from the chin. The difficulty lies in accurately reckoning the curve which the spring should take; for if this curve be miscalculated, the pressure will be felt unduly either by the posterior or the anterior part of the appliance, which will interfere with the retention of the fragments. The problem is exactly to hit off the pressure to use, and has nothing to do with the construction of the appliance. Martin has shown the way to solve it. This consists of the application of a provisional chin-piece without mortise or hooks. Beneath this we slide a second plate which has mortise and hooks; and so the spring is easily fixed.

Modification of Martin's Appliance.—The difficulty in stamping the dental trough in sheet-steel led Martin to alter his appliance so as to make its construction easier. He suggests the use of a double, coarser trough, similar to an impression tray, but always in sheet-steel. The superficial trough carries the spring, and the underlying one is filled with a malleable substance such as gutta-percha. In taking the impression of the arch (restored to its form) by this method, we get a buccal trough just as exact as the metal one, and answering the same purpose. Cl. Martin remarked that: "The use of gutta-percha is not a reversion to the appliance of Morel-Lavallée; for not only is this substance contained in a metal gutter which prevents a quick alteration of shape, but also the impression is given by a dental arch of which the shape is restored."* This gutta-percha trough has the drawback that it takes up more room in the mouth than the stamped trough, and *in time* its shape changes. We remedy this latter fault easily by making a new impression in the gutta, resoftened by heat. Martin has also proposed to use silver amalgam to take the impression, instead of gutta-percha. It seems that we might equally well employ godiva. In any case, "whatever be the material used," says Martin, "we must bear in mind that it should never, under pain of starting inflammation in the gums, touch them; this is an axiom from which we must never diverge."

* Martin, "The Treatment of Fractured Mandibles by a New Appliance," Paris, 1887 (Alcan, édit.), pp. 72, 76.

Martinier's Appliance.*—Struck by the difficulties in making Martin's apparatus in a case where the latter had not given him the expected results, one of us has made and applied with success an appliance, also with two splints, and constituted as follows:

1. *Mouth-Splint.*—This is a stamped double trough fitting on to the restored dental arch. It is made of dental alloy, a metal easy to work on, while offering at the same time great resistance. Two extrabuccal prolongations are soldered to the upper trough.

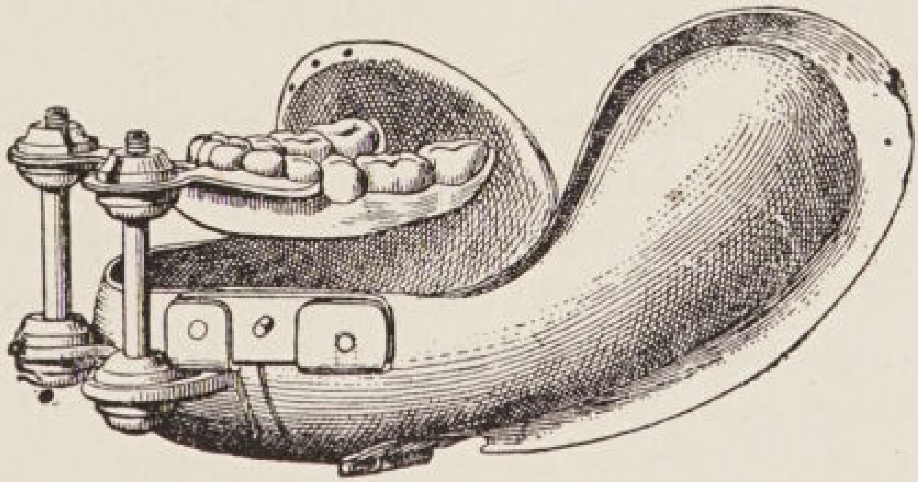


FIG. 137.—Martinier's Appliance.

These prolongations are pierced at their end by holes for the passage of screws.

2. *Chin-Splint.*—This is of aluminium. It can be divided into three parts—one central and two lateral —which are either like the submental plate of Martin, or are in two parts separated by a transverse line

* Martinier, "A Case of Fractured Mandible: Retention Appliance" (*Odontol.*, Mai, 1892). "Complicated Fracture of the Mandible" (*Odontol.*, Févr., 1893). "Considerations on Two Cases of Fractured Mandible" (*Odontol.*, Janv., 1895).—Paul Dubois, 1894, "Affections of the Teeth, Mouth, and Jaws," p. 552.

directed obliquely under the chin, and joined by two hinges placed at their ends. The junction of the two parts is made safe by a latch-fastening situated in front. The submental plate carries two parallel metal prolongations placed laterally at the labial commissures, which are tapped with a screw-thread and intended for the insertion of the screws which join this submental part to the buccal trough. The submental splint is attached to a skull-cap with rubber bands inserted towards the back of the plate by means of holes previously pierced for this purpose.

3. *Means of Retention.*—This is achieved by the screws joining the buccal trough on to the submental splint, and inserted into (*a*) the lateral extensions soldered on to the buccal trough opposite the canines, and (*b*) the metal extensions fixed to the submental plate, immediately below the former. The nuts fixed to the ends of these screws enable us to be certain of correcting the vertical displacements, according to how much one or both nuts are tightened. The position occupied by the extensions and by the screws (between the canine and first bicuspids) gives them the advantage of a powerful leverage on the posterior fragments, all the while keeping these, or the anterior fragments, rigidly in place.

Delair's Appliance.*—This has many analogies to

* Delair, "Simplified Appliance for Fractures of the Mandible" (*Odontologie*, 15 Févr., 1906, p. 97). See also Couturier, "Observations on a Fracture of the Mandible: Application of Delair's Appliance in the Army" (*Odontologie*, 15 Déc., 1907, p. 406).

that of Martinier. It consists of the following three pieces:

1. *Buccal Splint.*—For its construction, the author discards stamped metal and uses cast tin. The use of this metal partly constitutes the originality of the appliance. The construction of such a trough is in fact very easy and rapid; for it suffices to adjust and correct the dental arch, and then pour a mass of

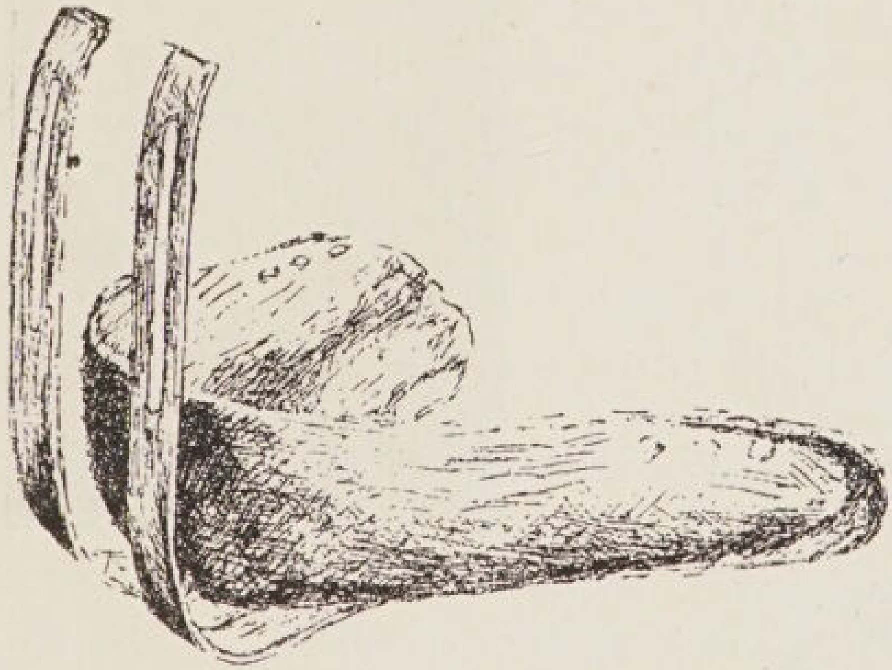


FIG. 138.—Simple Appliance of Delair for Fracture of the Lower Jaw.

lead into the mould of this arch. However, Delair advises, in order to obtain a more resistant substance, the employment of a mixture of three parts of plaster with one part of kaolin and fire-clay in equal proportions. This gutter presents in front two extensions, also of tin. To obtain the cast of this in a single piece, the author proceeds in the following way:

On the plaster impression he superposes two plates of pink wax, which he cuts off to within 6 mm. of the neck of the teeth. In front, between each canine and second bicuspid, he adds some small bars of wax 4 cm. long and 15 mm. wide; these are made of

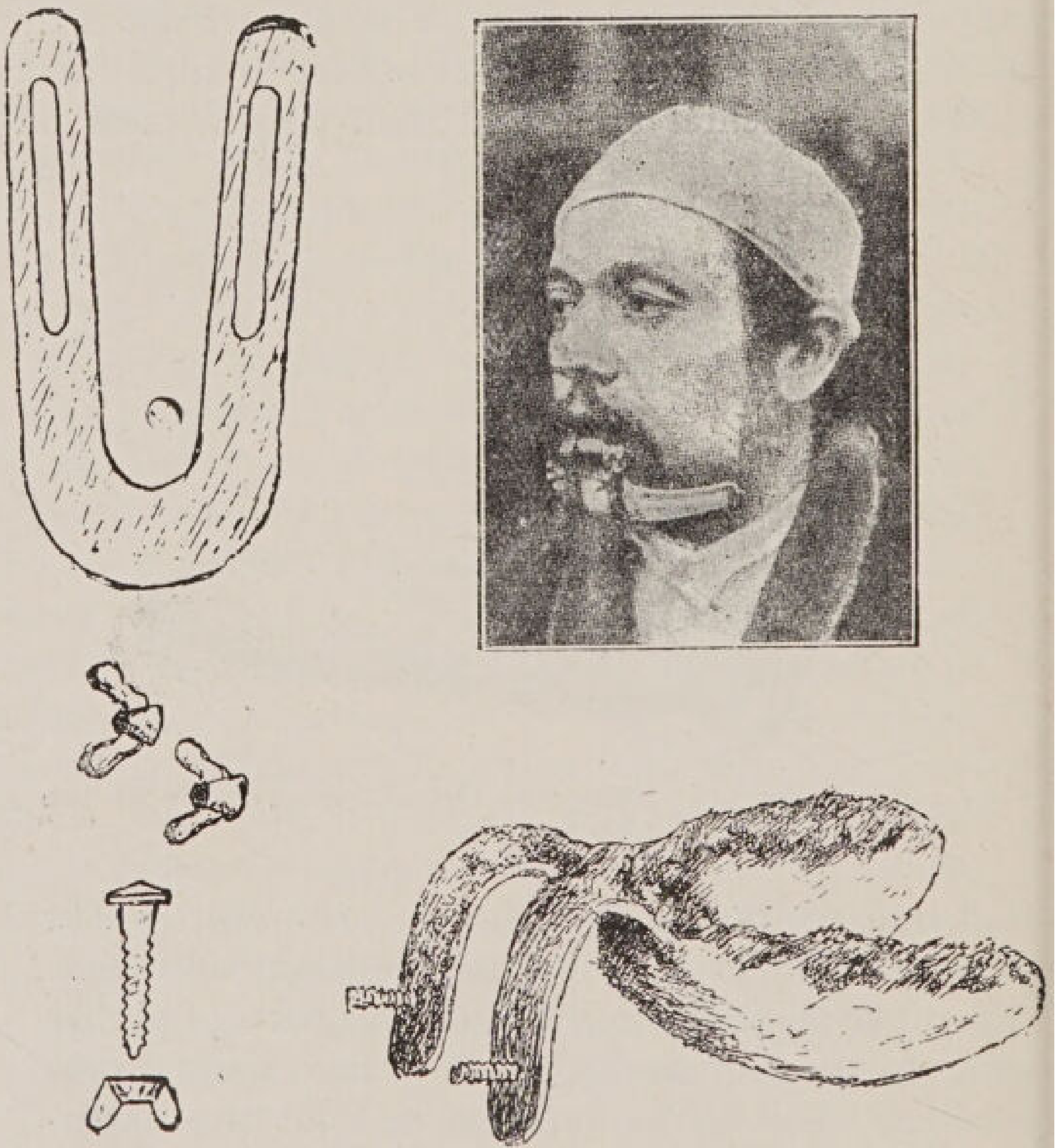


FIG. 139.—Delair's Simplified Appliance for Fractures.

three thicknesses, cut out of a plate of rose-coloured wax. The whole is invested in plaster as in an ordinary flask. The second part of the mould is taken with composite plaster, or even with casting-sand. The wax is removed and we proceed with the casting. To make this easier, the author advises that we place on the first flask " the upper half of another, which we turn upside down without the interposition of a cover, to get during the melting process what we call (in metal-workers' parlance) the 'runner' or heavy mass. This enables the tin to melt into the smallest crannies of the mould. We must carefully dry the mould before casting the tin at a dull red heat; fifteen minutes later we take it out of the mould, finish the piece with a file, and polish as required " (Delair).

2. *Chin-Splint.*—This is of aluminium, cut out of a plate 1 mm. thick, and shaped by a horn or box-wood mallet.

3. *Means of Retention.*—This is a U-shaped piece cut out of a plate of German silver 1·5 mm. thick, whose ends are slit along each limb of the U. This piece is riveted to the chin-piece in the mid-line, and the two branches are curved vertically upwards. A screw is placed at the end of each of the extensions of the tin gutter, these ends being bent downwards. These screws engage in the grooves cut in the vertical branches of the chin-piece, and receive winged nuts which allow us to fix the retention branches and to approximate the two splints at will. This very simple appliance can be made quickly, and Delair remarks that it can be turned out in two hours without any special outfit.

B. Critical Review of Double Splint Appliances made according to a Corrected Mould of the Dental Arch.

We have already said that the difficulty of treating fractures of the lower jaw lies in correcting the displacement of the fragments. Fractures in or near the middle line present but little displacement, and, when it exists, it is very easy to correct. In favourable cases any of the appliances give good results. But when there is a double fracture, as, for instance, at each mental foramen, the displacement of the median fragment is enormous, for this latter swings downwards and backwards. In the same way, when the fracture passes through the lateral part of the body of the bone, the posterior fragment is elevated, while the anterior is depressed and carried inwards and backwards. The correction of such displacements become very difficult, and in like cases any appliance whatever will only give poor results.

In the case of fracture into three fragments, notably when the middle fragment abuts on the mid-line, any of the appliances with double splints bearing a chin-piece which closely hugs the border of the jaw will easily lift the middle fragment. And the lateral fragment will be lowered as long as the fractures do not lie too far back. When the fracture passes very far back—for instance, just in front of the wisdom tooth—it becomes very difficult to lower the posterior fragment, because it is only by the end of the dental splint that we can act on it.

It appears, then, that Martin's is the best of the double splint appliances; its weak point is, particularly, its difficulty of construction, for it requires sheet-steel. This is not a real inconvenience except in so far as it concerns the sort of metal chosen by Martin. Sheet-steel is in truth difficult for stamping. But if we substitute an alloy of silver and platinum for the buccal trough, and aluminium for the chin piece, the obstacle disappears; when we make the chin-piece of stamped aluminium, we beat out or stamp hinges for the joints, and in this case the mortises are riveted. But there is above all the irregular action of the spring, due to the difficulty encountered in giving it the curve. In order for its action to be effective, we must succeed in giving it such a curve that the pressure it exercises may be distributed on a plane parallel to the surface. And we have mentioned the difficulties, which were for that matter recognized by Martin, who showed a means (already cited by us) of remedying them. We must add that this spring is generally made of a clock spring, and is not always sufficiently powerful. This, again, is a serious inconvenience.

Kingsley's appliance in vulcanized rubber seems to be free from this disadvantage. But its inconveniences are numerous. It is poorly tolerated by the patient, for the metal branches which pass along the cheeks interfere with a lateral decubitus. They prevent the man from bending his head sideways without pain. The removable metal branches do away with this inconvenience at the end of a few days. The metal branches have also other drawbacks. Their shape, curve, and situation, make the appliance difficult to construct. They have to be made of steel wire strong and rigid enough to bear, without weakening, the tension of rubber or bandage which joins them to the submental splint. It follows that their curve (at the level of the labial commissure), and the horizontal distance between them (they must be exactly parallel) along the cheeks, are not easy matters to bring about. We lack any precise indications, and the result of any defects may be pressure on neighbouring parts. In this case the modifications to which we must subject them entail manœuvres which are distressing to the patient.

The intrabuccal trough, which is made of rubber, is thick and bulky. The lateral pull which it undergoes, when we fix the appliance to the metal rods to join it on to the chin-piece, results in the thickening of the gutter, especially in its middle part. This adds to the bulk of the appliance still more, and may cause irritation, sometimes very badly borne by certain intolerant patients. The stability of the apparatus leaves much to be desired, and exacts a continuous watchfulness. The chin-piece, attached either by straps of webbing or by rubber bands to the metal rods, slips forwards. The elasticity of the material used for the straps obviously distributes the pressure uniformly; but its lack of rigidity is a defect, and we may accuse it of pressing laterally on the mandible, and of throwing the chin-piece forwards, owing to alterations in the obliquity of the straps. All who have applied Kingsley's appliance have been able to note this disadvantage, which has long since been pointed out by Martin. The figures will readily make comprehensible the criticisms levelled against this appliance.

Fig. 140 is the scheme of the Kingsley appliance viewed from in front. We notice that the edges of

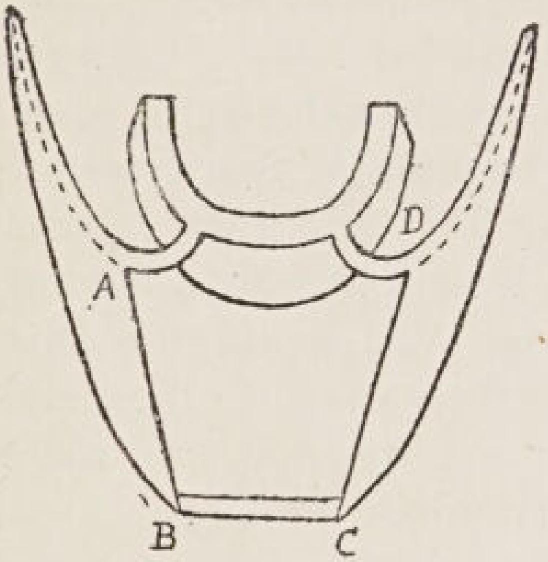


FIG. 140.

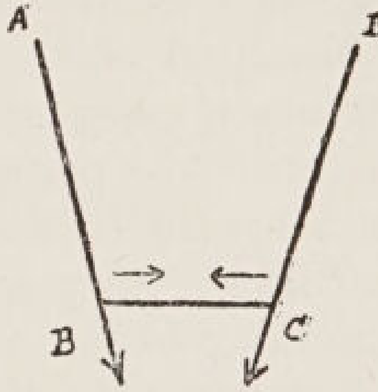


FIG. 141.

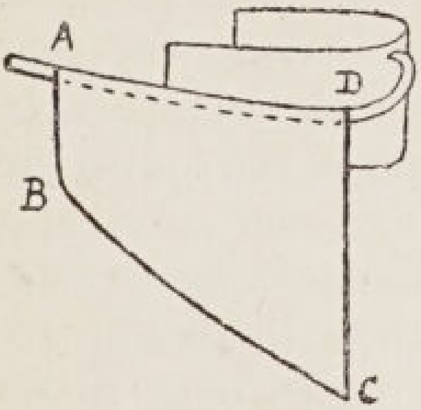


FIG. 142.

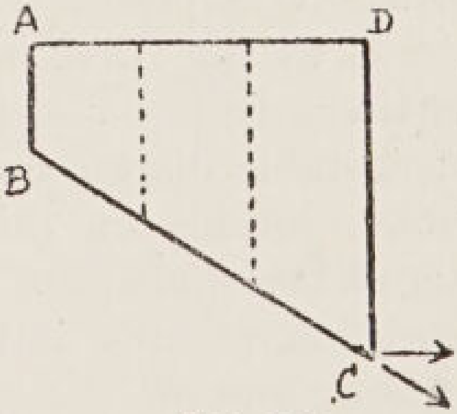


FIG. 143.

FIGS. 140 TO 143.—Scheme of Kingsley's Appliance. (Martinier.)

the stretched linen bandage bound a trapezoid space ABCD, the fixed points being A and D. The forces acting along AB and DC are thus not perpendicular to the plate. They may be resolved (Fig. 141) into vertical components, and also into horizontal components BC and CB. The effect of the latter is to approximate the points B and C—that is, to squeeze the jaw.

Fig. 142 is the scheme of the same appliance seen from the side. Here again the edges of the bandage form a trapezoid, ABCD, the points of fixed attachment being the whole length of AD. The force applied at D is practically at right angles to the plate. But when we pass from D towards A, the forces are transmitted obliquely along BC; and they have a horizontal component from behind forwards, tending to throw the plate forwards. We should add that the linen bandage is not absolutely fixed to the metal extensions—they can slide; and this being so, there is nothing to hold either fracture or dressing.

Martinier's Appliance.—In this the action of the spring on the posterior fragments may be insufficient. It was as the result of a failure of this sort that Martinier had (for a case of double fracture with considerable displacement) to replace the spring by screws working on the trough and the submental part of the appliance. This appliance finds its chief indication when it is laborious to maintain the reduction, and in which the fragments tend to be refractory to replacement. The mechanical conditions of the forces applied are quite different from the preceding appliances, and in theory their application appears to be better. Fig. 144 is a reproduction of this appliance. The screws are vertical; the metal prolongations through which they pass are horizontal. Thus, each screw forms with the extensions a rigid rectangle, and the forces applied to this fixed system are vertical and diametrically opposed (Fig. 144). Therefore they balance each other.

Disadvantages: The position of the prolongations at the labial commissures facilitates the flow of saliva, and necessitates the frequent changing of the submental dressing. The tightening of the nuts on the screws must be done with great care, so as to put on the two screws a scrupulously equal pressure.

Martinier's appliance is easy enough to make, and

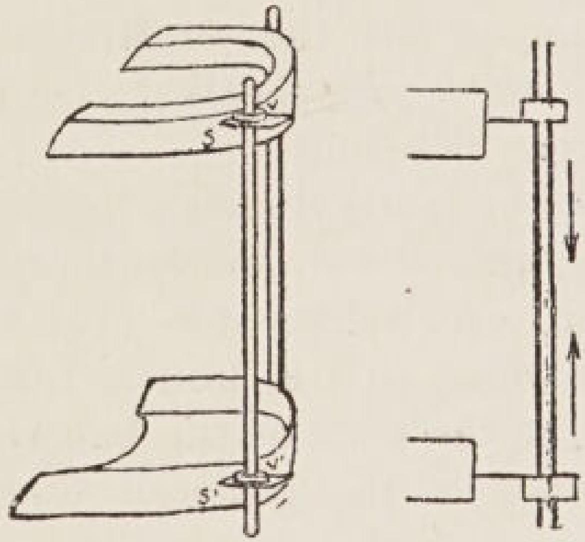


FIG. 144.—Martinier's Appliance and its Scheme.

the metal buccal trough is only slightly irksome, because it lifts up the interdental articulation as little as possible.

Delair's appliance is retained by a method which appears similar to the preceding (Martinier's). It has the advantage of extreme rapidity of construction. But as a set-off one can make the following criticisms:

1. The tin trough has the same disadvantages as those already quoted apropos of Kingsley's apparatus and thick troughs.

2. So as not unduly to raise the articulation, and to allow the patient to shut his mouth, we are compelled to diminish sensibly the thickness of the tin trough at its ends. If we are dealing with a case of fracture in which the posterior fragment is difficult to depress, the tin splint will have to be thinned as much as possible, and so will offer the minimum of resistance, exactly at the spot where it ought to provide most rigidity. Now tin, essentially malleable, offers no resistance when below a certain thickness. A trough stamped like that of Martinier would be more logical, and assure the best chances of acting on the posterior fragment.

3. The two vertical branches of the retention-piece, which join the two splints (buccal and chin) between them, are a little too near the mid-line. The pressure works well in front. But its action is less effective at the ends of the buccal trough, and the maintenance of the posterior fragment suffers from this.

II. Appliance consisting of a Double Dental Splint, Lower and Upper.

Gunning's Appliance.*—Gunning has described several different appliances, of which one, which takes its *point d'appui* from the upper jaw, has remained classical under his name. The appliance of Gunning, properly so called, consists of two gutters

* Gunning, "Treatment of Fracture of the Jaw" (*Indépendant Pratic. Bul.*, 1880, i. 171; ii. 296, 367, 430, 468, 526, 564. See also Garretson, "A System of Oral Surgery," 1873).

of vulcanized rubber (one fitting the upper, the other the lower dental arch), made of course to a corrected mould. These two splints or troughs are opposed, and united on four pillars, which thus make between them three windows 5 or 6 mm. high. When in place, the two arches fit into the two splints, and the lower jaw is further immobilized by a bandage or sling. In other words, the lower jaw is compelled to be immobile by taking the upper jaw as a splint, but with the interposition of two troughs. The

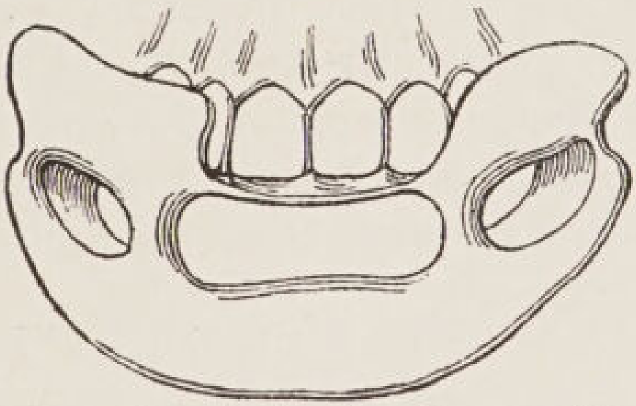


FIG. 145.—Gunning's Appliance. (Dubois.)

windows which separate the troughs allow liquid food to be introduced more easily.

In spite of its apparent simplicity, Gunning's apparatus is not easy to make, because it must be fitted with extreme precision, and, in fact, one requires to have constructed one of these appliances to make a fair estimate of them.

Placing it in position in the mouth also presents some difficulties. First one must fit the appliance on to the upper jaw, so as to make the lower arch penetrate into the corresponding trough and so reduce the displaced fragments. Finally a bandage, firmly put on, and preferably of elastic, keeps the fragments in the trough and resists their displacement.

The great fault of Gunning's appliance is its bulk and the necessity to immobilize the temporo-maxillary joint. It is, then, an irksome contrivance which will not always be tamely endured by all patients. Nevertheless it has one advantage—that it immobilizes the jaw while keeping the mouth open. And we shall see later that to open the mouth in cases of fracture encourages the depression of the posterior, and the elevation of the anterior, fragment, and therefore the correction of the displacement. Despite its inconveniences, Gunning's splint can give good results in certain cases of multiple fractures. Like that of Kingsley, it is in frequent use in the United States.

III. Appliances with a Simple Dental Splint.

These consist of a splint made to a corrected mould, and embracing as closely as possible the contours of the dental arch. Fauchard had already made similar splints with sheets of lead. The appliance of Nicolle of Neubourg, and that of Malgaigne, were formed by two sheets of iron applied, one on the inside, the other on the outside, of the dental arch, and joined one to the other by screws passing between the teeth. But these appliances were not made to a corrected mould. It is in Hammond's splint that we see the appearance of the true type of dental splint made after taking an impression.

Hammond's Appliance.*—It consists of a strong

* Christopher Heath, "Diseases and Injuries of the Jaws," translat. Darin, London and Paris, p. 40.

metal wire, bent by pincers to follow the contour of the arch at the level of the necks of the teeth, on the buccal and the vestibular aspects. This splint may be compared to a well-adjusted frame-work around the lower dental system, held in place by a certain number of ligatures passed through the interdental spaces (Fig. 146).

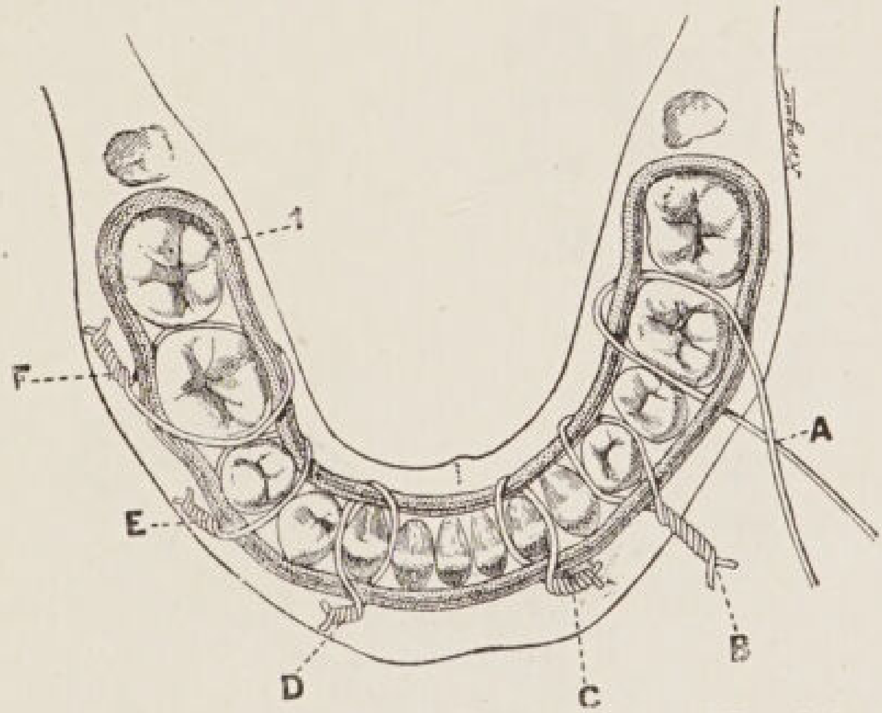


FIG. 146.—Hammond's Splint. (Heath.)
1, Framework; ABCDEF, fixation loops.

Dental Troughs or Gutters.—These are legion, and we cannot here enumerate all the writers who have made use of them. They conform to type as a rule, and may be sometimes in stamped or cast metal, sometimes in vulcanized rubber. According to the researches of Mahé, it appears that the first metal trough was applied by Tanes in London, and the first rubber trough by Sand in New York, in 1860.

The type of trough or gutter varies above all with the substance used and the means of retention. Those of vulcanized rubber have the defect of being thick and bulky, and thus irksome to the patient. Metal troughs, being much thinner, are better supported (see Fig. 147). Martinier recommends dental alloy, other writers German silver, Dubois and Billet aluminium, Cl. Martin sheet-steel.

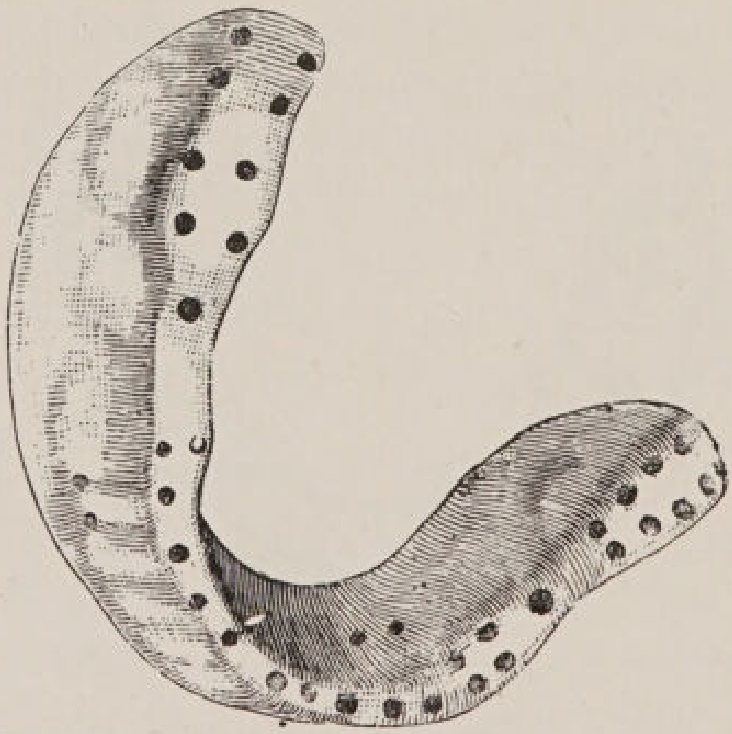


FIG. 147.—Metal Dental Splint. (Martinier.)

At the present time, with the facilities which have been given to dentists in casting metals under pressure, there is no point in discussing which is the metal of choice. Cast dental alloy, cast silver, or better cast aluminium, pure, allows us to make in a very short time a metal gutter of an enduring solidity and rigidity with a very small bulk. These troughs are pierced by holes, allowing a strong current of water to cleanse the underlying dental arch after the trough has been fitted. They are kept in place either by ligatures passed between the teeth and through the holes pierced in the metal, or by wedges, or even by screws (Martin). They should not descend lower than the necks of the teeth, and should extend the whole length of the arch.

Martin* has recommended in certain cases a splint which resembles both a trough and a Hammond

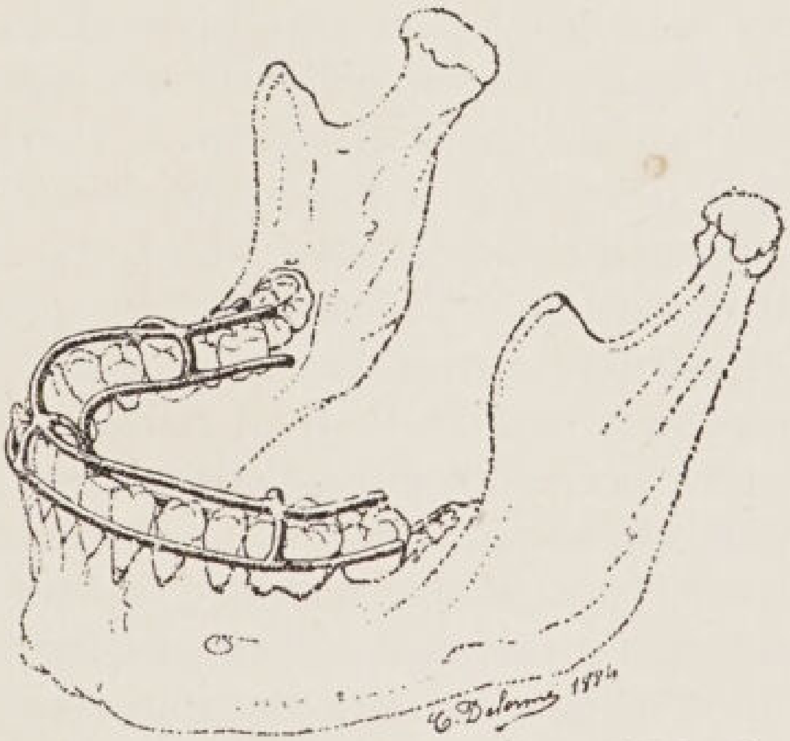


FIG. 148.—Three-Wire Splint of Martin.

splint. It consists of an arrangement of three silver wires joined together at three or four points. Two of these wires are arranged as in a Hammond splint; the third is placed on the cutting edge of the teeth. This appliance is fitted by interdental ligatures of silk or wire.

* Martin, "Treatment of Fractures of the Mandible," Paris, 1887, p. 76; Alcan, édit.

Lastly, of late years an excellent retention method —certainly superior to all others—has been in use. We refer to the sealing of a trough with cement; for our part, we have used this for a long time.

Criticisms of Appliances consisting of a Single Splint.

The appliances reduced to a simple dental splint are certainly the most attractive. When they are well made, exactly fitted and well placed, they give remarkable results; the invalids can eat, talk, make use of their jaws without any pain or worry. The appliance, if reduced to a minimum, is not visible, and its application is followed by an immediate functional restoration. There is one *sine qua non* of success—the absolute fixation of the splint. Hammond's appliance has the fault of reducing the up-and-down displacements imperfectly; it is, in fact, formed by an open cage, and in that direction exercises but a feeble action. Martin's appliance with three wires fulfils this task. Troughs formed out of a stamped metal plate are certainly superior to the splints formed by coupled wires, for they adapt themselves better to the dental arch and act on its whole surface.

But ligatures are only a mediocre method of retention, for they can never give to the appliance an absolute fixation. Thus, it happens that indications for the use of the simple trough have for a long time been narrowed down to feeble displacements easy of correction, fractures of the anterior part of the body of the jaw. When we wish to use it to maintain the reduction of double fractures with great displacement, or of fractures abutting on the wisdom tooth, where the posterior fragment is drawn up and difficult to keep depressed, the simple trough fails utterly, and we are compelled to have recourse to double splint appliances. Nevertheless it is not the trough which should be blamed, but its mode of retention, which will not assure a sufficient fixation.

Sealed on to the teeth with dental cement like an ordinary bridgework, the trough becomes a perfect mode of treatment for fractures of the body of the lower jaw. For ten years one of us has used this method of treatment, in fourteen cases of fractures, most of them under the care of his professor, M. Sébileau, and always with success.* For some years various authors have published remarkable results obtained in like fashion. In any case, we do not want to infer that this method has any special originality, but merely that this idea of sealing the dental splint with cement seems to us simple, and likely to appeal to the intelligence of a large number of practitioners, for the very reason that this mode of retention is in daily use for certain modern dental appliances.

It has been suggested to use, as a rigid splint, Angle's bands sealed on to the neighbouring teeth and joined by cylindrical screws fixed by nuts. An appliance so constructed will give satisfactory results in cases of fracture with slight displacement, but it is found to be absolutely inferior in refractory cases.

* Sébileau and Lemerle, "New Appliance for Fracture of the Mandible" (Soc. de Chirurgie, Mars, 1908).

This will be understood if one reflects on the small number of its points of support and on the weakness of splints built on these principles. To get good results in all cases of fracture in which a sealed trough can be used, it is necessary that the latter should comprise the entire dental arch, so as to be able to take a sufficient *point d'appui* and be embodied with the whole jaw. In the following two conditions the use of a sealed trough is impracticable:

1. A jaw which is edentulous, or equipped with teeth which totter in their sockets and cannot give the splint a solid purchase.

2. A fracture passing behind the third molar, or the absence of any tooth on the posterior fragment. [This second heading may be summarized by the definition, "A fracture posterior to the last *existing* tooth."—TR.]

Apart from these two conditions, the sealed trough constitutes, in our view, the treatment of choice for all fractures of the body of lower jaw. Its manufacture is the simplest thing possible. Formerly we used to stamp these gutters after the usual manner of metal-stamping—after cutting them out of a plate of silver or dental alloy. But now for several years we have been using Solbrig's plan of casting in wax, and we generally make the trough of silver or pure aluminium. Having placed the trough on the model, we articulate it with the upper jaw in such a way as to make the elevation of the dental articulation hardly noticeable. This result is obtained with a file by reducing all those points on the opposing surfaces of the gutter which hamper the articulation.

Well articulated and polished, the trough is now sealed with cement after taking the usual care in cleansing and drying the crowns of the teeth. For some minutes, until the cement has gripped well, the fragments are held with the hand; and it only remains to cleanse the patient's mouth of the débris of cement, an excess of which was used in sealing. As a fact, it is generally unnecessary, with sealed troughs, to apply a sling or a bandage to the patient, and this, again, is one of the great advantages of the method. As soon as the trough is fitted, the invalid ceases to suffer, and finds himself astonished at the feeling of well-being which he enjoys. Many a time we have seen patients take their food an hour after the gutter has been sealed on, and masticate solid food easily.

The absence of a chin-splint, moreover, constitutes another advantage, since it allows a man the easier to resume his occupations. The consolidation of a fracture of the lower jaw is long; as we shall see later, it may take from forty to sixty days. A patient who wears a sealed trough, which is invisible and so little tiresome that he forgets its existence, can take up his work again as soon as he has the appliance—that is, of course, if he has no other concomitant lesions. This was the case with many of our patients who came once a week simply for us to verify the condition of their sealed troughs. Nevertheless, in certain less favourable cases, it is essential to supplement the sealed trough, at any rate for the first few days, by the wearing of a sling or elastic bandage. This will occur when—

1. A wound of the soft parts requires a dressing.

2. There is a fracture in which one of the fragments undergoes a very unusual displacement—depression. This happens in double fractures, wherein the middle piece, especially if it is in front, requires, if it is to be well reduced, the aid of a chin-splint.

Lastly, there are fractures in which the bony displacement is impossible, or at best difficult, of correction, if this correction is to be maintained by a gutter. This eventuality may occur in two classes of case (of course we except the condition in which a foreign body, tooth, or bone splinter, placed in the track, prevents coaptation):

1. The fracture is recent, and muscular contraction is such as to resist reduction.

2. The fracture is already one of long standing, and adhesions have had time to form and oppose reduction. [This is a common finding after gunshot injuries. The adhesions may be divided under local anæsthesia, and Stent's packed in to prevent them re-forming. After the anæsthetic effect has worn off, the Stent's is remarkably well tolerated by the raw surface during healing.—Tr.] We shall see, apropos of the treatment of jaw fractures by Martin's wedge method, how it is possible to solve these difficulties.

CHAPTER IV

TREATMENT OF FRACTURES OF THE MANDIBLE BY THE METHOD OF CL. MARTIN*

Cl. Martin, *noting that the movement of opening the mouth initiated the natural lowering of the posterior fragments* [the italics are the Translator's] thought of utilizing this peculiarity in treating fractures of the mandible. He was not slow in noting that the chief obstacle to the reduction of the fragments was brought about by muscular contracture, and that mobilization and massage had a favourable influence on the latter. As the result of his observations, Martin gave up the double splint appliance which we described above, and reduced his instrumentation to three essential procedures: (1) Interdental wedges; (2) troughs; (3) rubber bands as a sling beneath the chin.

The treatment depended on the following genera principles:

1. Reduction of the fracture, obtained by means of interdental wedges; we force open the patient's mouth, and lower the mandible.

2. Massage and systematic movement of the fragments facilitate reduction by reducing muscular contracture.

3. To keep the fracture reduced, a buccal splint

* Cl. Martin, "The Simplification of Methods of Treatment of Fractures of the Mandible," Lyons, 1899; Storck, édit.—Cl. and Fr. Martin, "On a Simplified Method of treating Fractures of the Mandible," 21e Congrès français de chirurgie, Paris, 1908.

suffices. It consists of a trough made to a mould of the dental arch as it was before the accident.

Having laid down these principles Martin applied his method as follows:

1. **Reduction of the Fracture.**—"The reduction of the fracture is achieved," says Cl. Martin, "by making the patient take up the position of 'mouth open,' by mobilizing the fragments, and by massaging the region of fracture. When we make a man, whose lower jaw is broken, open his mouth, the fragments tend to be spontaneously reduced. This fact had already been noted by Malgaigne, Laborde, and Cluseaux, who, however, had never drawn the practical inference. It is, indeed, this physiological fact of which we avail ourselves to obtain reduction of the fracture. [It would seem better to refer to any phenomenon in connection with a broken jaw as pathological, rather than physiological.—Tr.] To maintain this reduction, it suffices to make permanent the position of 'mouth open,' by means of wooden or cork wedges placed between the two jaws.

"In the normal state, when the mouth is opened, the depressor muscles involve the whole mandible in the movement. But when there is a solution of continuity of the bone, the muscular equilibrium is upset, and antagonistic muscles can act in opposite directions. Picture, in fact, a single fracture tracking between the right bicuspids and canine. The left, longer fragment tends to fall by its own weight, and is pulled downwards and backwards by the depressor muscles, which in virtue of the solution of bony continuity have become retractors.

"If, then, we make the subject open his mouth, the right lower fragment is drawn downwards by the depressor muscles; and if we interpose between it and the maxilla an obstacle, such as a wedge, to resist its reascent, we shall see that the act of opening the mouth has brought the posterior fragment level with the anterior. It is only in a fracture between the central incisors that the displacement can be nil; for the bilateral muscles, acting on equal arms of a lever, are balanced. Even in this case, however, one may observe, produced directly by the trauma or due to the obliquity of the fracture, a displacement; this is as a rule easily reducible.

"Now imagine a double fracture, passing on each side between premolars and molars. Here we have two posterior and one median fragment. The latter, under the action of the depressor muscles (which behave like retractors, as above explained), is drawn downwards and backwards, and simultaneously rotates round a coronal axis, so that its alveolar margin swings forwards. The posterior fragments remaining in contact with the maxillæ, we get a characteristic yawning gap between the incisors of the two jaws. If now we make the wounded man open his mouth, and we place a wedge between the maxilla and the posterior fragments, we shall see the latter carried to meet the anterior fragment and take up its position level with the latter. To complete the reduction, we have only to correct the rotary swinging movement of the anterior fragment.

"Opening the mouth and wearing wedges does not invariably suffice to bring the fragments back to their normal position. But, to complete the reduction, we shall find a valuable ally in movement combined with massage. In fact, what tends to immobilize the fragments in a vicious position is not merely the obliquity of the fracture tracks, but also, and above all, muscular contracture. The pain of the wound provokes a permanent reflex stimulus of the muscles, and one revolves, as it were, in a vicious circle; the displacement of the fragments aggravates the contracture, which again keeps up the pain and resists reduction. It is, then, against contracture that we should fight. And the best weapons to overcome this are, beyond all dispute, movement and massage.

"To carry out movements, we seize each fragment with the fingers. The thumb placed beneath the chin, the index and middle fingers on the dental arches, we thus work these fragments in and out, up and down, to right and left—in a word, in all directions. If the skin of the chin has been much involved in the lesion, and a wound exists here, we can take hold of the fragments by the dental arches.

"The first séances of movement must be carried out with the greatest moderation; it is better, in the early days, to make them brief but fairly frequent. At first they will cause pain, more or less sharp; but it is not uncommon to find this disappear after the first few sittings. Further, these manœuvres very rapidly become tolerable, and at the end of some days are hardly at all painful. To this passive movement one can add active (performed by the patient himself), by a series of alternate efforts at opening and closing the mouth, the wedges staying in place. Such movements have the happiest results. It must be understood that they cannot be practised until painful phenomena are much ameliorated.

"Movements act effectively against the muscular contracture, which they quickly dispel. It has besides an important mechanical rôle, for it undoes faulty impactions, makes the fracture track more regular, eliminates loose splinters, and rounds off projecting points which oppose the approximation of the fragments. In a word, it facilitates good coaptation.

"Mobilization should be supplemented by massage of the region of the fracture and its neighbouring parts. This massage, exclusively external, is carried out on the whole chin region. It is wise to renew it as often as possible, and to give it such a direction that it always tends to bring the fragments to their normal position. The existence of extensive wounds about the chin is the only contra-indication."

We have deliberately reproduced verbatim this passage from Martin's memoir, because it is an exposition of the most original principles of the new method.

2. **Retention of the Fracture.**—Having obtained reduction, Martin maintains it by a dental trough and a rubber sling. Made according to a corrected mould, this trough is constructed in vulcanized rubber. Martin gives preference to this substance as being easier to work on. He limits its thickness to about 1·5 mm., and gets an accurate coaptation

by scratching on the model the necks of the teeth and the spaces between them. The piece is to be vulcanized on the model. The finished trough is as a rule easy to put in place. If one finds it resistant, it suffices to soften the rubber by steeping it in warm water, according to Martin's plan.*

When movement and massage have sufficiently reduced the muscular contracture to render easy the reduction of the fragments, we should arrange the gutter in place. Martin only applies his gutter when he is confronted by very mobile fragments. In this case he uses plated steel screws, inserted at the levels of the interdental spaces. A rubber bandage forming a submental sling always follows the adaptation of the trough. This bandage, not more than 5 or 6 cm. in width, pulls the chin backwards and upwards, and insures the elevation of the depressed anterior fragment. When in use the bandage requires to be watched, especially when there are several movable fragments; for any lateral pressure would cause an inward deviation. To avoid any such effect of lateral pressure, Martin advises that a small plate, whose margins separate the band from the side of the jaw, be placed beneath the chin. Finally, the elastic band should not even provoke pain; so it should be only moderately tightened.

Such is the scheme of simplified treatment advocated by Martin of late years. "We should add," he writes, "that wedges, trough, and rubber band, are to be worn constantly, day and night. At the

* Despite his great experience, we mention this process of Cl. Martin with all reserve.

beginning, to wear the wedges is quite unpleasant; so one may give during the day a little rest to the patient, by removing them now and then in the course of the day. But in general, after the second or third day, they are well enough borne."

CHAPTER V

MARTIN'S MODES OF TREATMENT ACCORDING TO DIFFERENT TYPES OF FRACTURE

THE application of interdental wedges varies with the type of the fracture we are concerned in treating. So it behoves us to investigate their use in each sort of case which can occur:

1. **Single Median Fracture.**—The fracture tracks through, or in the immediate neighbourhood of, the middle line. The muscles of the two sides are balanced; there is little or no displacement. The employment of interdental wedges is useless.

2. **Single Fracture behind the Canine.**—The posterior fragment is displaced upwards. To lower it one must open the mouth, and place a wedge between the posterior fragment and the upper arch (Fig. 149).

3. **Bilateral Symmetrical Fracture, the Two Tracks passing between the Molars of Each Side.**—The two posterior fragments are elevated; the anterior is depressed, and rotated from behind forwards. We must place an interdental wedge over each posterior fragment (Fig. 150).

4. **Double Unilateral Fracture; Both Tracks on the Same Side.**—The posterior fragment is elevated; the middle fragment, following the direction of the fracture, travels up with the posterior or down with

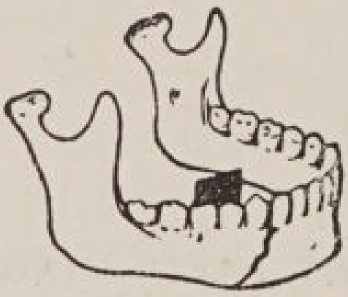


FIG. 149.

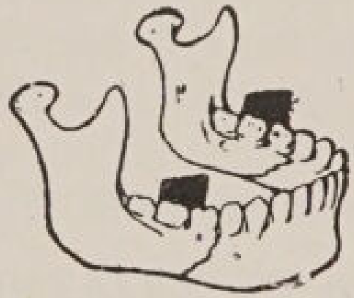


FIG. 150.

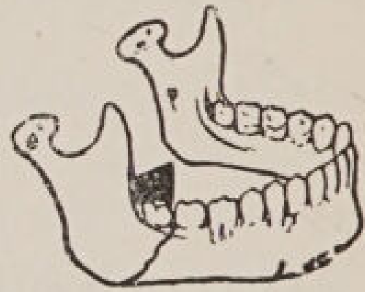


FIG. 151.

the anterior fragment. An interdental wedge is placed over the posterior fragment, and a second, if necessary, over the middle fragment (Fig. 151). [This figure shows neither the anterior fracture track nor the anterior wedge.—TR.]

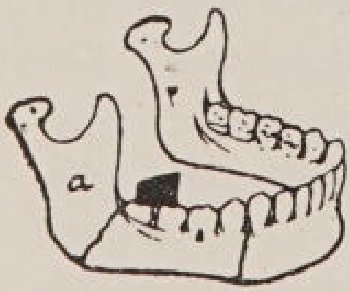


FIG. 152.

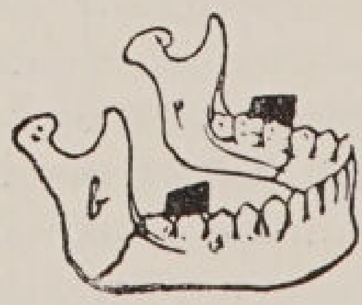


FIG. 153.

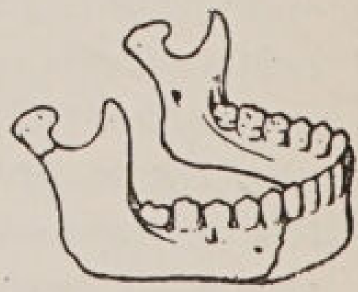


FIG. 154.

5. **Double Fracture, Unilateral or Bilateral, the Most Posterior Fracture passing behind the Wisdom Tooth.**—If the two fractures lie on the same side, the middle fragment is pulled up by the masseter; and reduction is difficult, since the ascending ramus of the maxilla affords no purchase. We place a

wedge over the middle fragment (Fig. 152). If the second fracture lies on the opposite side, we place another wedge in front of this fracture (Fig. 153).

6. **Unilateral Double Fracture, One Track passing behind the Canine, the Other near the Condyle.**—

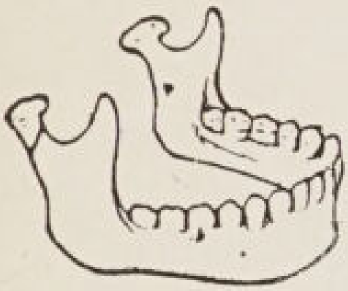


FIG. 155.

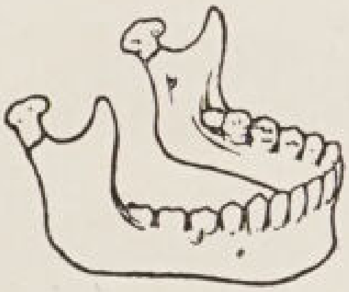


FIG. 156.

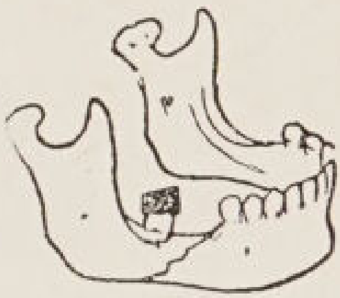


FIG. 157.

Lower the fragment as a whole by placing a wedge opposite the wisdom tooth (Fig. 153). [Wedge not shown in figure.—TR.]

7. **Fracture of One Condyle.**—If the interdental articulation is intact on the side of the fracture,

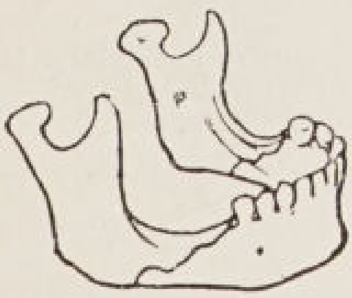


FIG. 158.

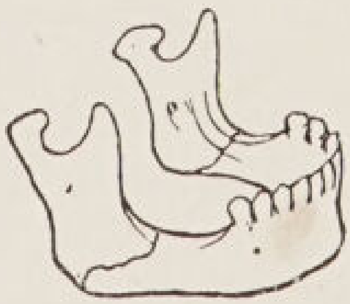


FIG. 159.

there will not be any displacement. If one of the jaws is edentulous, on the contrary, there will be a backward retraction of the jaw on the fractured side. To deal with this retraction, one may employ the appliances used for the correction of vicious scars after the resection of a part of the lower jaw.

Cl. Martin has made use of an apparatus made up as follows:

(*a*) A metal trough covering the lower dental arch on the side of the fracture. At the front of this gutter is soldered a rod, ending in a ring and projecting out of the mouth about 3 cm.

FIG. 160.

(*b*) A head-band encircling the head at the level of the temples; it carries on the side of the fracture a vertical metal rod coming down to the mouth. A rubber thread stretched between the end of this rod and the buccal trough enables us to apply acontinuous outward traction on the deviated jaw (Fig. 160).

One of us has obtained good results with the following arrangement:*

(*a*) A metal trough sealed on to the dental arch on the fractured side.

(*b*) A metal trough sealed on to the upper dental arch on the opposite side.

Two small hooks soldered on to the outer surfaces of the troughs enable one to stretch an elastic band between them; its traction carries the deviated mandible outwards.

8. **Fracture of Both Condyles** (Fig. 156).—Often such fractures do not unite, and end in the formation of pseudarthroses. This does not constitute a serious disability if the interdental articulation is good and resists backward displacement of the mandible. Conversely, if the jaws lack some of their teeth, this accident may occur. In such a case the indication is to remedy it by re-establishing the height of the arches by dental prosthetic fittings suitably articulated.

9. **Unilateral Fracture in the Middle of a Region destitute of Teeth.**—We should fill up the gap of the dental arch by a piece of vulcanized rubber, placed in the trough and opposing the displacement of the fragments. A wedge is placed on top of the gutter over the posterior fragment (Fig. 157).

10. **Unilateral or Bilateral Fracture of a Mandible lacking all its Molars, the Track passing through the Region formerly occupied by these Teeth** (Fig. 158).—

* G. Lemerle, "Appliance to reduce Cicatricial Retraction after Partial Resection of the Lower Jaw" (*Laboratoire*, Déc., 1907).

We should apply a trough, of which the posterior ends are thick enough to fill the chasm left by the missing teeth, and to re-establish the continuity of the articulation. We then place wedges between the jaws on top of the troughs, over the posterior fragment. In the presence of a unilateral fracture of a mandible devoid of all teeth, except the four incisors, one of us has employed the following method. The case in question was a patient of M. Sébileau. The fracture lay in front of the region occupied formerly by the wisdom tooth; the displacement of the posterior fragment was considerable. To obtain and retain its depression, we simply fitted a rubber appliance to the patient. It resembled a denture; but its posterior, very thick part overlay the articulation in such a way that the patient was compelled to keep the mouth open. Thus the posterior fragment became reduced with ease, and the patient made an uneventful recovery. In fact, it seems to us that in such a case it is advantageous to avoid the use of an interdental splint, by merely thickening the back part of the trough on the mandible.

11. **Bilateral Fracture of the Molar Region of an Edentulous Jaw, with Fracture Tracks which pass far back to the Junction of the Ascending Ramus and Body of the Mandible** (Fig. 159).—This type of fracture, of which the pathology has been brought to light by Cl. Martin, deserves to attract special attention. For such a fracture one should apply to the patient a rubber trough articulating to a nicety with the upper jaw, and the raising of the articulating surface of the teeth must be carefully avoided.

It is absolutely contra-indicated to use wedges between the jaws; for the position "mouth shut" must be substituted for the position "mouth open." And this is the reason: The posterior fragments—on which, moreover, we cannot get any purchase—are kept in a normal position when the mouth is closed. This does not apply to the anterior fragment, which consists of the body of the lower jaw, of which only the anterior part carries teeth. The anterior fibres of the masseter are inserted into the posterior part of the anterior fragment. These fibres pull up this posterior part of this fragment; the anterior part swings down, thus producing the gaping mouth. The displacement is such that the anterior fragment is raised, in relation to the mandibular angle (posterior fragment), because the former carries no molar teeth which, by their articulation with their antagonists above, could resist this ascending and rotary movement. The pathological data lead us to the following conclusions: In certain very special cases of fractured mandible, to open the mouth is *un*favourable to reduction. In these cases the mouth should, therefore, be kept closed, and the dental arches in exact occlusion. We shall get this result with the help of a trough which restores the edentulous mandible to its normal height, and the addition of an elastic sling to hold the upper and lower jaws in apposition. The use of wedges should therefore be entirely suppressed.

CHAPTER VI

GENERAL CONCLUSIONS ON THE TREATMENT OF FRACTURES OF THE LOWER JAW

AFTER this lengthy review of the numerous methods recommended for the treatment of fractured mandibles, it is convenient to put ourselves the following question: Confronted by a case of fractured mandible, what is to-day the course to pursue? The answer to this question will form the conclusion of our study. At the risk of repetition, let us, then, rapidly review the treatments at our disposal:

1. **Bandages and slings,** employed alone, are insufficient to maintain reduction, and can only be temporary means of immobilization. In conjunction with the wearing of a dental splint, they constitute a help which is useful, but not always indispensable.

2. **Bone suture and ligature of fragments** are septic operations which place foreign bodies in the neighbourhood of an open fracture. They can achieve the continuity of the bone, but cannot assure the preservation of the interdental articulation. Indeed, they take no count of this, and so do not produce a good functional cure.

3. **Double splint appliances not made to a mould of the reconstituted dental arch** are equally incapable of assuring a functional cure.

4. **Double splint appliances made to a corrected mould** can assure this cure; and until late years they constituted the treatment of choice for fractures of the mandible.

5. **Single splint appliances made to a mould** are less irksome to patients than those with a double splint. Their value is only as great if they are very firmly fixed on to the dental arch. The best of these processes is to seal metal troughs on to the teeth with cement.

6. **Martin's wedge method** is an immense step in the treatment of fractured mandibles. He has shown the advantages of massage and movement to check muscular contracture, the principal obstacle to reduction.

Studying the pathology of the most diverse cases of fracture, he has shown what marvellous use could be made of intermaxillary wedges to depress certain fragments, using at the same time a dental splint.

We consider that to-day the best treatment is that which associates Cl. Martin's methods of reduction with sealed troughs to immobilize when reduction has been completed.

Given a case of fracture of the mandible (for example, a single track passing between the second and third molars), we should proceed as follows:

1. We must assure antisepsis of the buccal region, which communicates with the focus of a compound fracture. To this end we have copious and frequent irrigations of the mouth carried out, with an irrigator and a glass cannula. " For this either boiled water, or, better, a solution of chloral 1 in 200, β naphthol 4 per cent., or iodine, may be used. Ombrédanne says that excellent results are daily being obtained with a solution of tinct. iodi, 150 or 200 drops to

the litre of cold (preferably filtered or boiled) water."*

Often the partial occlusion of the jaws which follows a fracture will make it difficult to carry out irrigations. In this case (if there is no space in the front or at the sides, produced by the absence of one or more teeth), we should avail ourselves of the buccal vestible, and of the cavity existing between the last molar and the ascending ramus of the mandible, to introduce the cannula.

2. We must reduce the fracture, not always an easy matter when there are great displacements. In this case we shall use Cl. Martin's method. By massage and movement we make the muscular contracture give way, and intermaxillary wedges judiciously placed will assist in the reduction. These wedges can be made very easily and practically with corks of a convenient size, and preferably bevelled at one end. It is a wise precaution to attach a thread which, passing out of the mouth, not only makes them easy to withdraw, but prevents an accidental slip into the pharynx. Wedges may equally well be made of soft rubber. In any case they should never be of vulcanite, nor, in general terms, of any incompressible material. Intermaxillary wedges are forced between the arches at that point necessitated by the displacement of fragments; and their sole means of retention lies in the contracture which it is their task to overcome.

* Ombrédanne, "New Treatise on Surgery," by Le Dentu and Delbet; section xvi., "Diseases of the Jaws," p. 16.

3. When the muscular contracture, the chief factor in the displacement of the fragments, is weakened, we take a mould of the arches. That of the lower arch is to be brought to a normal occlusion, and on it we then construct a trough, preferably of metal cast in wax.

4. When the fragments have become easily reducible, the dental trough is to be sealed firmly with cement; and, thanks to its absolute fixation, the reduction of the fracture is thus maintained, without as a rule any necessity of resorting to the help of a rubber sling. We shall thus have applied a treatment which is very simple, reducing to a minimum the distress imposed on the patient, and insuring perfect results. We think that this is the best mode of treatment in all cases of fractured mandible to which it is applicable, as it is to the majority. We have above pointed out the modifications which must be made in the trough for fractures of partly or completely edentulous mandibles; in such cases the trough should be in vulcanized rubber, and of course not sealed.

In the unique class of case (No. 11 of Cl. Martin, above) where we have to inflict "mouth-shut" position on the patient, he should wear a rubber sling. Finally let us refer to the cases of deviation of fragments which necessitate the wearing of an elastic traction appliance. We have described these appliances; it should be added that they can render the greatest services in certain fractures treated after some delay, also where the displacement of the fragments is kept up by fibrous adhesions. Elastic traction makes them yield rapidly, and allows us to obtain a good reduction.

1. **Duration of Treatment.**—It is wise to leave the trough in place long enough, about a fortnight *after* the consolidation seems to be certain. The time demanded for consolidation is quite variable. Cl. Martin gives the following figures:

From 20 to 30 days	.. ..	8 cases.
,, 30 ,, 40 ,,	.. ..	6 ,,
,, 40 ,, 50 ,,	.. ..	5 ,,
,, 50 ,, 60 ,,	.. ..	4 ,,

Our personal experience has taught us that the average duration is from thirty to forty days. Sometimes consolidation hangs fire on account of the onset of osteitis near the focus of an infected fracture. Then we get one or more abscesses, which apparently always point on the vestibular surface of the jaw; we have never seen them come to the surface on its buccal aspect. [In gunshot injuries, with massive damage to the soft parts followed by their extensive cicatricial adhesion to the fractured bone, the abscess usually passes right across the vestibule, which is often practically obliterated by scar tissue, and points outside on the face or neck. The result is sinus formation, which, if it communicates also with the mouth, constitutes a salivary fistula.—TR.] One or more sequestra are cast off; when a probe reveals the presence and mobility of these beneath the mucosa, we ought to remove them. The incision of abscesses, the removal of sequestra, and the lavage of the focus, should be carried out, of course, without interfering with the sealed gutter, which should only be removed after consolidation. In sixteen cases of fracture we have seen abscess formation and sequestration only three times. Such sequelæ usually happen about three weeks after the trough has been sealed on.

2. **Considerations on Certain Secondary Complications of Fractures of the Mandible.**—Gunshot injuries may end in extensive loss of substance of the jaw. In other, exceptional cases, the infection of the site of fracture may involve a massive necrosis of the ends of the fragments, and result in the formation of large sequestra involving both bony tables for their whole length and height. Such sequestra may be several centimetres long. [This must indeed be exceptional. Amidst the large number of massive gunshot wounds of the jaw which I have dealt with since June, 1916, I have never seen such a condition. Moreover, if both tables are thus involved the diploë could hardly escape; and osteomyelitis would rob the patient of his whole jaw, and probably of his life.—TR.] The natural outcome is a true shortening of the mandibular arc. In such a case we find ourselves in the following dilemma: Shall we aim at bony consolidation by insuring coaptation of the fragments after eliminating sequestra—that is, make sure of the continuity of the jaw by sacrificing the interdental articulation? Or, rather, preserve the articulation by renouncing attempts to consolidate the fracture? We range ourselves with the votaries of the latter plan, and frankly share, on this point, the views of Mahé. In fact, we cannot claim as a cure the consolidation achieved

with such a degree of shortening that the interdental bite is destroyed. The continuity of the jaw is re-established, but the patient cannot chew. To this a pseudarthrosis would be vastly preferable. Immediate prosthesis can be of the greatest use in such cases. After a loss of tissue involving a shortening of the mandibular arch, the fragments can be straightened, and the invalid treated as if he had undergone a partial resection of the lower jaw.

A block of vulcanized rubber fixed in the wound prevents cicatricial retraction (immediate prosthesis). When the wound is completely epithelialized, this rubber block is lifted out, and yields its place to an ordinary removable dental appliance (late prosthesis). The base of this restores the continuity of the jaw, and fills the cavity left by the lost piece of bone. From this time onwards, the patient possesses an intact interdental articulation. Surely such a functional cure is preferable to an anatomical cure; for, in the latter case, to consolidate is to make certain of losing all function. Unfortunately, the resources of prosthesis are still unknown to most surgeons. In our day immediate prosthesis is not regarded by everyone as the indispensable complement of any jaw resection. In the case of the loss of substance by fracture, it has, at any rate as far as we know, never been used. In fact, confusion reigns between immediate and internal prosthesis, and certain surgeons who recommend suture speak of the inevitable (soon or late) elimination of appliances of immediate prosthesis, and of their failure. They do not know that an immediate prosthesis is an external one, essentially provisional, which makes no allowance for the tolerance of the tissues, and that its precise destiny is to be removed at the end of several weeks. Then the late prosthesis is placed, and its rôle is limited to preventing cicatricial retraction.

SECTION II

TREATMENT OF FRACTURES OF THE UPPER JAW

CHAPTER I

GENERALITIES

FRACTURES of the maxilla fall into two groups: partial and extensive. Partial fractures comprise those of the alveolar margin, body, and maxillary sinus. Among these, fractures of the alveolar margin are the only ones which interest us because their treatment claims the ministrations of the dentist. Extensive fractures are produced (as at the base of the skull) along lines of diminished resistance, and are determined by the beams and struts which take strains (to borrow the terminology of engineering), which, again, depend upon the architecture of the maxillæ and of the facial scaffolding. Extensive fractures comprise intermaxillary disruption, horizontal fractures, and cranio-facial severance, all of which interest us, since to deal with them we must draw on the resources of the prosthesist.

Intermaxillary disruption is as a rule produced by a concussion on the chin from below upwards. It is more than likely that the lower dental arch, being contained by the upper, by its impact on the latter causes disruption; this would be facilitated by any defects of articulation which allow the lower teeth to slide towards the buccal aspect of the upper. In such fractures one can demonstrate an outward displacement of the two upper jaws, and the disappearance of the interdental bite. The separation of the jaws may amount to 1 cm.

Horizontal fractures may occur in two different types:

1. *The track detaches the whole alveolar margin en masse,* so that it is no longer held up except by the gums. The upper arch lies on the lower like a denture. This is a very rare fracture.

2. *The horizontal fracture of Guérin,* much more common, detaches *en masse* the lower part of the maxillæ, above the palatine vault. These fractures are as a rule the result of a violent horizontal blow below the nose.

Cranio-facial severance occurs when a double trauma, exercised in opposite directions on the chin and the cranial vault, causes an actual propulsion upwards and forwards. The same severance, but with a propulsion of the maxillæ in the opposite direction, can result from a violent blow on the root of the nose. Lastly, Walter has described an enormous fracture in four fragments, which is seen when with a cranio-facial severance there coexists an intermaxillary disruption and a fracture of Guérin.

CHAPTER II

TREATMENT OF PARTIAL ALVEOLAR FRACTURES

THESE involve especially the external table, and generally in the incisor region. As a rule they accompany a fracture of the mandible, especially when this latter only carries teeth in its anterior part. In fact, in this case, the shock which is borne by the mandible, and which causes the break, determines at the same time an alveolar fracture in the upper incisor region, being transmitted to this latter by the intermediary of the lower incisor mass. The front of the external table of the maxilla is crushed, and yields to the shock of the lower teeth, which form a wedge in that region. We have noticed that when the jaws carry all their teeth this partial fracture does not occur; in fact, in such a case the only fracture which is likely to result is an intermaxillary disruption, which has a similar mechanical causation to the former. But the latter fracture is vastly more rare, because the violence of the trauma transmitted to the upper jaw is much diluted by its being spread over all the points of the two intact dental arches. Partial fractures of the alveolar region heal admirably; and we must never yield to the temptation to elevate the bony fragments, although barely held up by the flaps of mucosa while the teeth totter in their sockets. A conservative régime is always indicated, and some time ago Malgaigne enunciated as a principle that all splinters, no matter how feebly adherent, should be religiously preserved. The best treatment for these fractures consists in applying a trough, which is sealed on to the teeth supported by the fragment, and on to neighbouring teeth. This trough should, of course, be made to a mould, taken after reducing the fracture. It should be added that the reduction of fractures of the maxilla is in general much easier than fractures of the mandible, for, in contrast with the latter, we have not to struggle against displacements started by muscular contraction. There are cases when the teeth offer no adequate support; in such a sealed trough is contra-indicated. We substitute a big rubber trough, covering the palatine vault, and also imprisoning the alveolar fragments to keep them reduced, when we cannot act on them through the intermediary of the teeth.

CHAPTER III

TREATMENT OF INTERMAXILLARY DISRUPTIONS

THIS consists in keeping in contact the maxillæ, which have been rent asunder in the mid-line. To do this easily, a trough surrounds the whole of the arch, and is continuous with a large palatine plate. It goes without saying that the appliance should be made to a corrected mould, so as to get consolidation without disturbing the integrity of the interdental articulation. When the disruption is considerable, Pont's appliance is suitable. This is a palatine plate

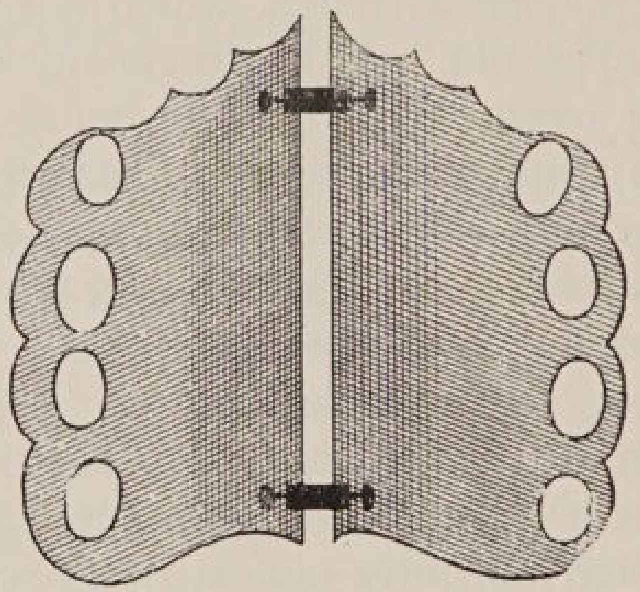


FIG. 161.—Pont's Appliance for Fracture of the Maxilla.

divided in the middle line, its two halves being approximated by elastic traction.

CHAPTER IV

TREATMENT OF THE HORIZONTAL FRACTURE OF GUÉRIN

SINCE the track lies horizontally above the palatine vault, the fragment formed by the vault plus the intact dental arch tends to become slightly depressed. Therefore it is wise to insure its good coaptation with the upper part of the two maxillæ by an elastic chin-band, or by a sling, which holds the dental arch in articulation with the mandible while lifting it up.

Cl. Martin's Appliance.—Cl. Martin has used the following neat method: On a palatine plate we place springs, as for a denture, giving them as a *point d'appui* either a lower denture or a gutter on the lower arch. When inserted, this appliance, by the pressure of its springs, keeps the palatine vault in

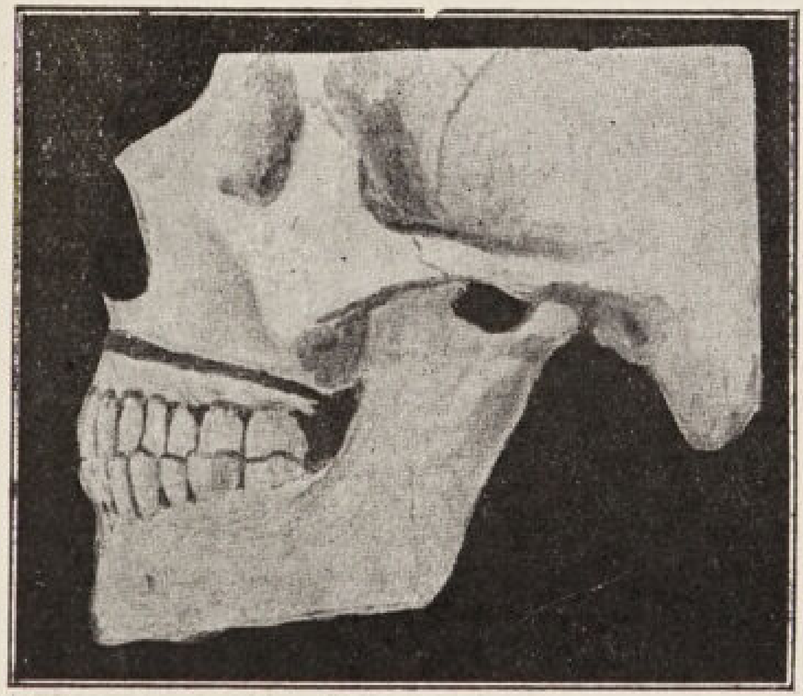


FIG. 162.—Guérin's Horizontal Fracture.

position, and enables the patient to eat and talk, sparing him the necessity of wearing a bandage or of keeping the mouth closed.

Beltrami's Appliance.*—This ingenious appliance has been invented and made for the complete fracture of the two upper jaws, known as " Guérin's fracture " (see Fig. 162).

The appliance, to fit which engenders no pain,

* Beltrami, " Emergency Appliance to retain a Complicated Fracture of the Upper Jaw," xive Cong. internat. de Méd., Madrid, 1903, p. 99, described by P. Martinier.

has enabled a patient to eat at once with ease, although before placing it any jaw movement was out of the question, owing to the mobility of the lower part of the maxilla, which, detached, floated like a foreign body in the mouth (Fig. 163). At the end of ten days consolidation was nearly complete, and the sufferer could eat solid food.

The treatment comprises the following different stages:

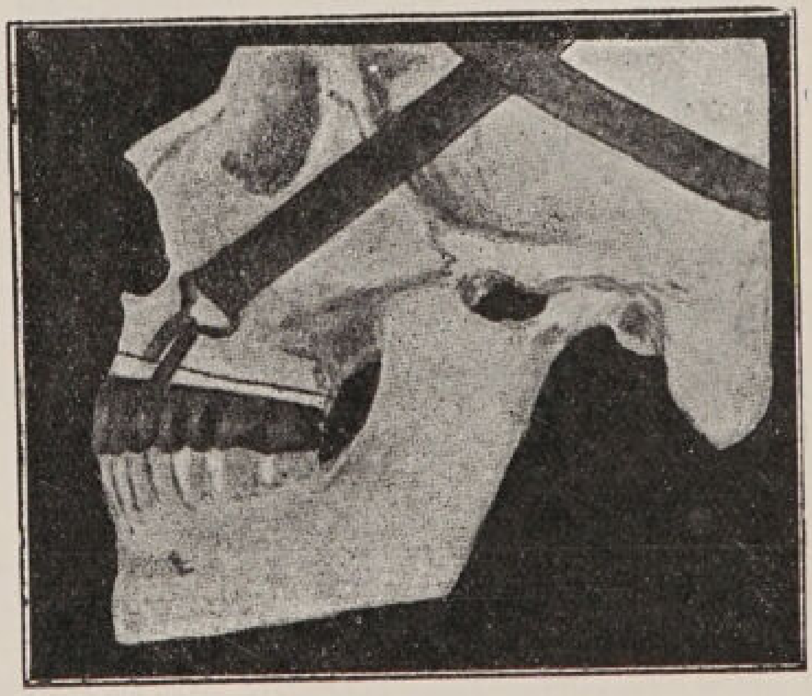


FIG. 163.—Beltrami's Appliance for Guérin's Fracture.

1. Taking the impression of the fractured upper jaw.
2. Stamping a plate in the ordinary way, this plate covering all the teeth.
3. Trial of the plate to see that it fits, and fixing two hooks to it by soldering. Making a skull-cap with tapes for attachment to the hooks, and pressing the fractured part upwards and backwards, holding it firmly.

The qualities which this appliance shows may be summed up:

(*a*) Ease in fitting; absence of pain.

(*b*) The appliance becomes fixed without any trouble or dragging; it is hardly visible.

(*c*) Mastication and speech are quickly achieved.

Prestat's Appliance.*—To fix a palatine vault which has been separated from the rest of the maxilla by trauma, Prestat uses two bands of silver, 15 cm. long and 2 cm. wide; he gives them the shape of an **S**-curve, so that each one has two gutters, one for the teeth and one for the lips. He places each band near to the labial commissure, on the canine and first premolar; then with pincers he compresses the gutter which is now on the teeth, so as to grasp the latter at the neck. Lastly he gives a suitable angle to the appliance, and fixes the whole to the patient's cap with tapes.

Richer's Appliance.—On a patient afflicted with multiple fractures of the facial bones, Richer, after taking a mould of upper and lower jaws, constructed a lower appliance covering the lower incisors, and an upper one to cap the incisors and premolars.

A small vertical gold bar between upper and lower caps at the level of the canines kept open a space through which the patient could be fed. On each side, lateral to this bar and opposite to the premolars, a German silver hook had been soldered. This pointed from behind forwards as far as the labial

* Bouvet, "Demonstration of an Appliance for Double Fractures of the Upper Jaw" (Communication to the International Dental Congress of 1900).

commissure; then, after its exit from the mouth, doubled on itself to curve backwards along the cheek, against which it lay. The caps being fixed by cement to the teeth, the maxillæ took up their normal positions as soon as a silicated bandage was attached as a vertical loop to the hook outside the cheek, the bandage then passing up to be attached to the head (Fig. 164). The appliances (upper and lower) were

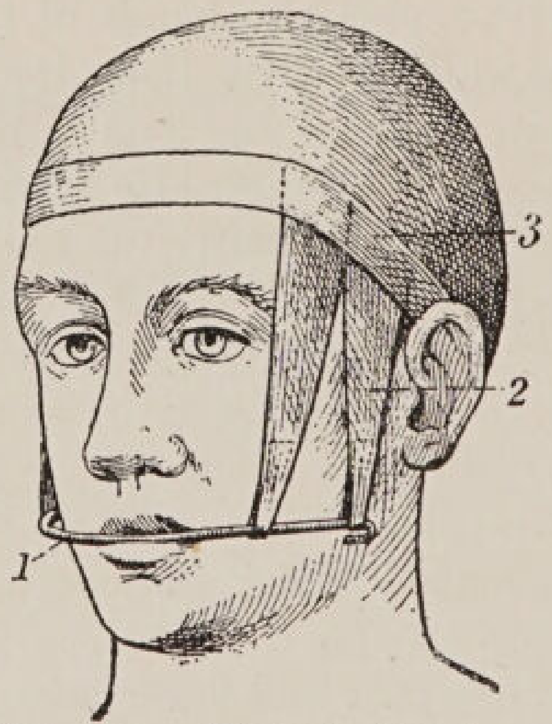


FIG. 164.—Richer's Appliance.

1, Extrabuccal hook; 2, vertical bands; 3, horizontal bands.

thus kept suspended without having to use the chin as a *point d'appui*.

Bouvet's Appliance.*—In devising this apparatus, the author says he was inspired by that invented by Martin, and modified by Martinier, for fractures of the mandible.

* Bouvet, "Appliance for Double Fractures of the Upper Jaw" (Communication to the International Dental Congress of 1900).

"This is the underlying principle: A metal plate, firmly enclosing the vault of the palate and the alveolar margin, is joined to a casque by a system of jointed rods, which enable one to arrange this plate and retain it in position, and, it follows, to keep the maxilla motionless. Having said this much, let

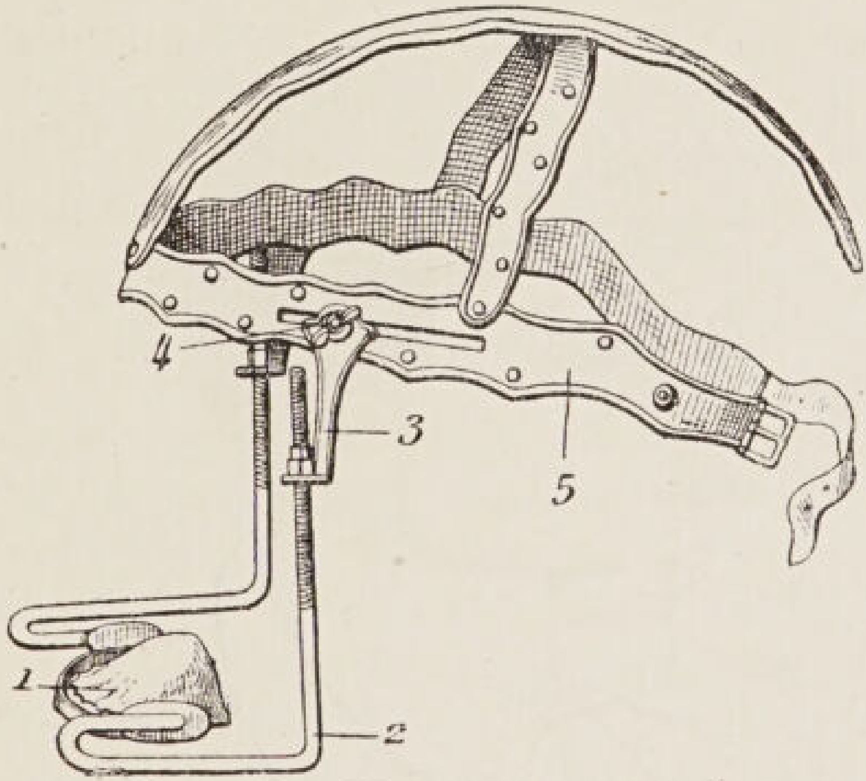


FIG. 165.—Bouvet's Appliance.
1, Palatine piece; 2, cylindrical rod; 3, flat rod; 4, screw of junction with casque; 5, casque.

us describe seriatim the pieces of the apparatus—namely, casque, plate, and system of jointed rods.

"The casque consists of three bands of bent steel, lined with leather. The horizontal occipito-frontal band can be tightened behind at will, by means of a strap and buckle at its two ends. The sagittal band has a free posterior end (as in a fencing mask), which grips the occiput. The third band is in a coronal plane, and unites the other two. The horizontal band has on its lateral parts, in front of the coronal band, a horizontal window 8 cm. long and 1 cm. wide. In this moves a small round sliding bar, continued outwards into a screw. The palatine plate (which is the fundamental piece) is of platinum; thus

FIG. 166.—Bouvet's Appliance in Position.

1, Palatine piece; 2, cylindrical rod; 3, flat rod; 4, screw for junction to casque; 5, casque.

we can give it great strength with only a slight thickness. It is made to a mould of the palate and dental arch. The gaps between teeth and the spaces where teeth are missing may be used to unite the palatine part to the parts covering the outer alveolar surfaces.

"The system of articulation comprises a solid flat triangular metal plate, pierced above by a hole for the screw to pass freely through. This plate is recurved below at a right angle, to make a little platform, perforated in its centre for the cylindrical rod. This rod is tapped with a screw-thread, and carries two nuts, the smaller of which is on top of the larger. After a vertical downward course of 10 cm., the cylindrical rod turns forwards at a right angle; after another 9 cm. it turns inwards in a semicircle; finally it becomes rectangular in section, and is soldered to the external surface of the palatine plate. The angular parts of the rod will have been tempered, which gives them a reliable amount of resistance to bending. The end of the rod is rectangular in section, for the firmer soldering to the palatine plate.

"Let us now see how the parts act. We put on the casque, and tighten the strap to hold it well in place. The palatine plate is put into position in the mouth, and the two cylindrical rods passed through the holes into the platform above. The small top screw is passed through the triangular flat plate, and the nut screwed on loosely. The round sliding bar, continuous with the small top screw, can slide in the window of the occipito-frontal band. The upper flat triangular plate can oscillate around the screw; and when its position is as desired, the nut is to be tightened. The cylindrical rods are now adjusted by means of their nuts, two on each rod. The advantage of this scheme is that it enables the surgeon to direct the maxilla (which is embodied in the palatine plate) at his will. He can raise or lower it, bring it forwards or backwards. When the whole is in position, it is impossible to get the slightest displacement."

CHAPTER V

TREATMENT OF CRANIO-FACIAL SEVERANCE

THE object of this should be to keep up and back the facial scaffolding which has been displaced downwards and forwards. To achieve this we can contrive apparatus taking its *point d'appui* either from the cranial vertex (appliances of Graefe and of Goffres), or from the mandible (appliance of Martin). We have already described Martin's appliance, apropos of horizontal fractures; it has the merit of causing no worry to the patient, and, although its springs act feebly, it is adequate. In the majority of cases, in fact, the displacements to be corrected are small and easy to reduce.

Graefe's Appliance consists of a steel forehead band, comfortably fitted, and kept in place by a strap and buckle behind the head. On each side a steel rod descends. This curves inwards and slightly upwards opposite the labial commissure, and ends in a hook which grasps the alveolar margin of the upper dental arch. The steel rods, sliding in a slot on the frontal band, can be fixed by pressure-screws. The appliance being in place, we obtain the elevation of the whole facial framework by sliding the rods up and down, fixing them by the screws so as to maintain the amount of traction deemed necessary.

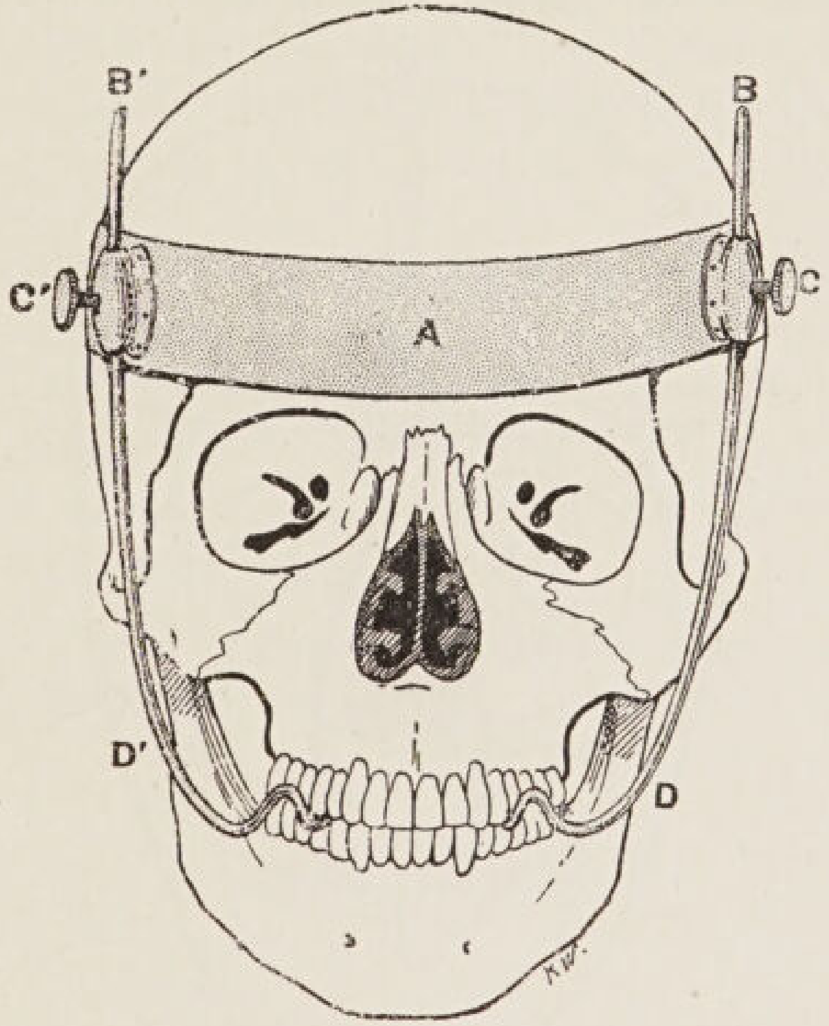


FIG. 167.—Graefe's Appliance.

A, Forehead band; BD, B′D′, metal rods ending below in hooks which lift the upper jaws; CC′, sliding bearings.

Goffres' Appliance depends on the same principle as Graefe's. It differs in the arrangement of the traction rods, which are closer to the middle line, and ascend each side of the nose to be fixed at the forehead level by pressure-screws. The advantage of Goffres' appliance is that it insures a more equal pull on the two rods, because they are close to the middle line.

In the case of Walter's fracture in four fragments, the apparatus used for cranio-facial severance is indicated—with this proviso, that, if we are dealing

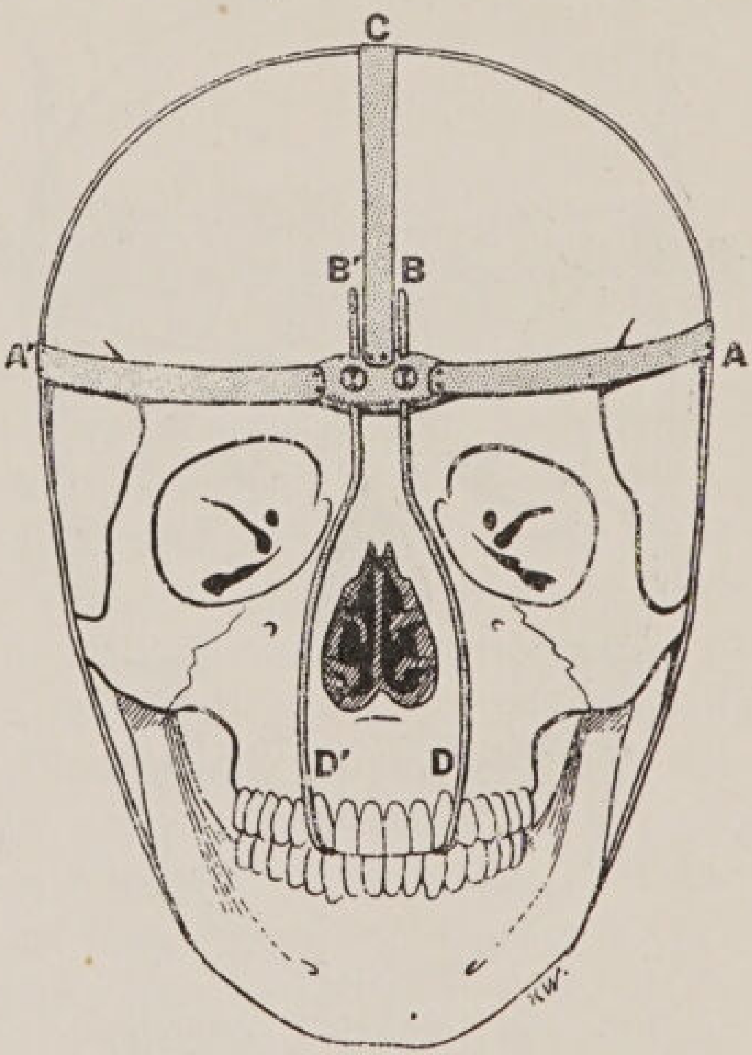


FIG. 168.—Goffres' Appliance.

AA′C, Tapes; BB′, metal rods ending in hooks, DD′, which lift the upper jaw.

with the appliance of Goffres or of Graefe, we must add a trough furnished with a large palatine plate, to reduce intermaxillary disruption. The palatine plate will oppose any tendency of the traction rods to make the fragments swing outwards, which would increase the intermaxillary disruption. There are surgeons who uncompromisingly reject all appliances, and recommend the systematic treatment of upper jaw fractures by suture of bone. We need not repeat the arguments which have led us to give up bony suture for fractures of the mandible. These arguments apply just as forcibly to fractures of the maxilla. Let us in conclusion quote the words of Cl. Martin:*

"In these fractures of both upper and lower jaws, it is always the upper which is cured more speedily. Such is the vitality of its bony tissue that, even when splintered into many fragments, it reshapes itself very easily; and there is no real difficulty in arranging retention appliances."

* Cl. Martin, "Treatment of Fractures of the Mandible" (Cong. de Chirurgie, Paris, 1908, p. 21).

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