

Injuries to head and neck / by H. Lawson Whale.

Contributors

Whale, George Harold Lawson, 1876-1943.

Publication/Creation

London : Baillière, Tindall and Cox, 1919.

Persistent URL

<https://wellcomecollection.org/works/reazjed8>

License and attribution

Conditions of use: it is possible this item is protected by copyright and/or related rights. You are free to use this item in any way that is permitted by the copyright and related rights legislation that applies to your use. For other uses you need to obtain permission from the rights-holder(s).



Wellcome Collection
183 Euston Road
London NW1 2BE UK
T +44 (0)20 7611 8722
E library@wellcomecollection.org
<https://wellcomecollection.org>

INJURIES TO THE
HEAD AND NECK

LAWSON WHALE

The Library of the
Wellcome Institute for
the History of Medicine

MEDICAL SOCIETY
OF
LONDON
DEPOSIT

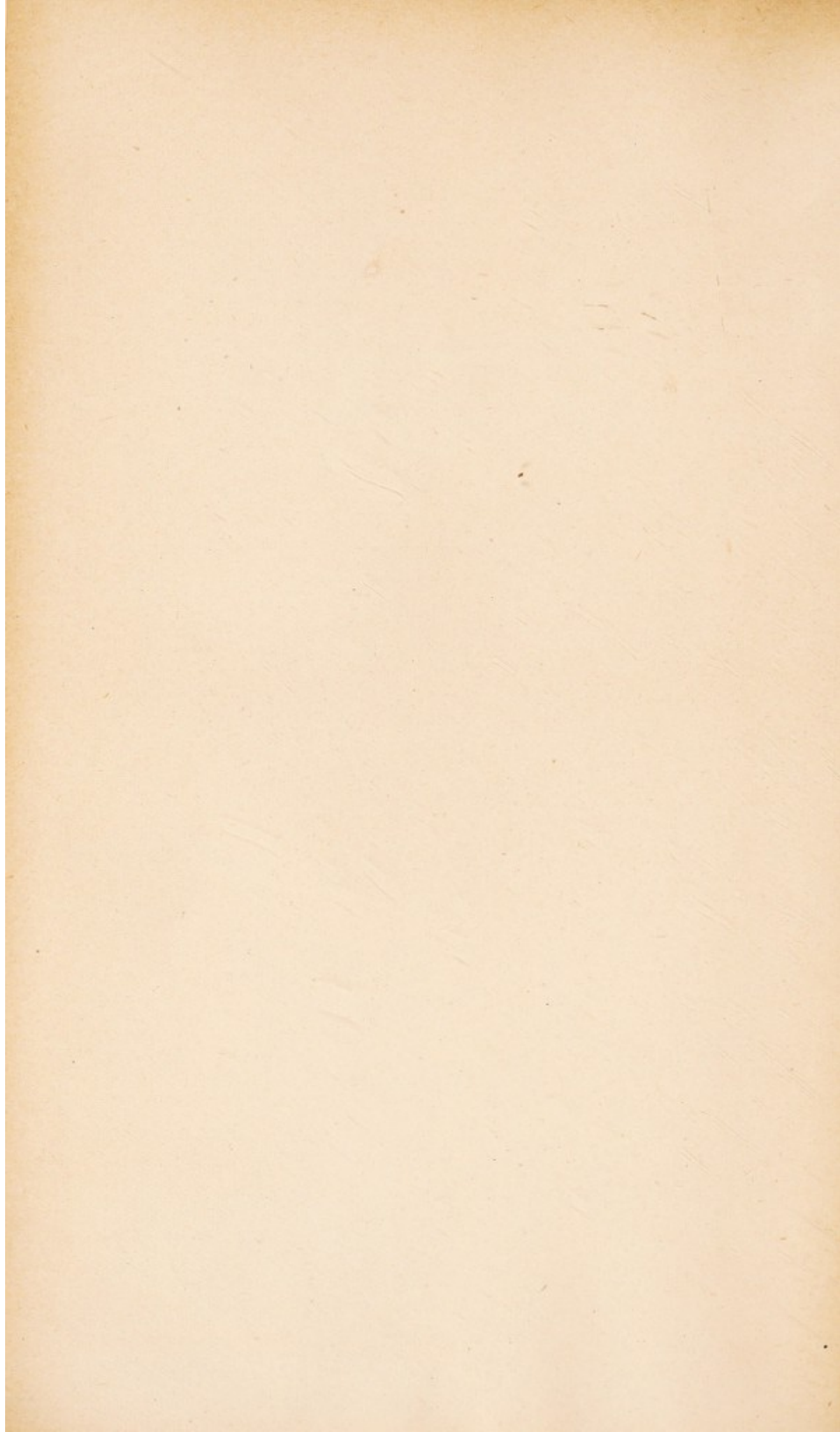
Accession Number

Press Mark



22102138316

Med
K30581





Digitized by the Internet Archive
in 2017 with funding from
Wellcome Library

<https://archive.org/details/b29812379>

Ernest Clarke Esqre, with
kind regards from the author.

INJURIES TO
THE HEAD AND NECK

INJURIES TO THE HEAD AND NECK

BY

H. LAWSON WHALE

M.D. CAMB., F.R.C.S. ENG.

CAPT. R.A.M.C. (T.F.), FORMERLY CAPT. I.M.S. (RETIRED); THE QUEEN'S HOSPITAL,
SIDCUP; NO. 83 GENERAL HOSPITAL; AND SURGICAL SPECIALIST TO

NO. 53 GENERAL HOSPITAL, B.E.F.

SURGEON FOR THE EAR, THROAT, AND NOSE TO THE LONDON TEMPERANCE HOSPITAL;
AND TO THE HAMPSTEAD GENERAL HOSPITAL.

WITH PREFACE BY

COLONEL FREDERICK F. BURGHARD

C.B., M.D., M.S., F.R.C.S.



LONDON

BAILLIÈRE, TINDALL AND COX

8, HENRIETTA STREET, COVENT GARDEN

1919

[All rights reserved]

PRINTED IN GREAT BRITAIN

14807095

WELLCOME INSTITUTE LIBRARY	
Coll.	welMOmec
Call	
No.	WE

A8

PREFACE

THIS war has effected many changes in surgical practice. Not only have older methods of treatment been profoundly altered and entirely new ones advanced, but a radical change has taken place in the outlook of the surgeon. On the one hand the general surgeon has been compelled to specialize his work to a considerable extent in order that he may bring to bear upon certain important groups of war injuries the advantages that only wide experience, constant practice, and persistent research can confer; while on the other hand those who before the war were already specialists in certain branches have come to realize that success in the treatment of war injuries of the regions comprised in their pre-war specialities demands a widening of their sphere of activity. War is no more a respecter of regions than it is of persons; strictly localized lesions are rare, and hence a specialist, whose powers are restricted to a very narrow compass, has but a limited usefulness in war. Thus it has come about that laryngologists, rhinologists, and otologists have, by a happy combination of the broad principles of general surgery with the special technique of their own field of work, produced a mass of brilliant work, the principles of which will remain firmly rooted and established long after the occasion that called it forth has become a mere memory. There is no better example of this than gunshot injuries of the face, nose, throat, and ear. Before the war the experience of living surgeons upon this subject was negligible: four years of specialist investigation and practice have produced most brilliant results, and we shall be left with a mass of knowledge that will be valuable for all time.

With this school of investigation Captain Lawson Whale has been associated from the earliest days of the war. Attached in the first instance to the largest Base hospital in Boulogne, he was brought into contact during the first battle of Ypres with many of those cataclysmic injuries of the face and neck which were the despair of those early days. Subsequently he was connected with the development of that great department of oral surgery at Boulogne under the charge of Major Valadier, C.M.G., where so much was done to systematize treatment and such excellent results were so early obtained. Finally, at the great school of maxillo-facial surgery in this country, the Queen's Hospital, Sidcup, he has been able to extend his experience and to follow up the end-results of treatment in a way that is not always possible on the other side of the Channel.

I think that anyone who reads accounts of the surgery of gunshot injuries of the face and jaws such as this volume deals with, and compares the position of knowledge of the subject to-day with that existing before the war, must feel his interest profoundly stirred. The general principles of surgery remain unaltered, it is true, but the methods in which they are applied, the patience, the persistence, and the minutely careful technique which are called for if these distressing cases are to be successfully dealt with, place the present-day surgery of injuries of the face and neck upon a plane far higher than many of us deemed possible prior to the war.

F. F. BURGHARD.

March 17, 1919.

INTRODUCTION

It has been said that if a man cannot refrain from writing and publishing a book he should, at least, be very careful in the choice of a title. To follow this wise counsel in the present case was not easy; but the title of this small volume was eventually selected on the following grounds:

The surgical responsibilities and field of operation of the specialist in diseases of the ear, nose, and throat had extended vastly during the years preceding the war. In former times his labours must have been monotonous, his limitations wearisome. He syringed out ears, cauterized turbinate bones, and removed varying amounts of tonsils (only rarely the entire mass); uncomplicated mastoid operations usually represented the limit of his enterprise. A widening horizon has changed all this.

The explorations of the rhinologist extend to the pituitary fossa; those of the laryngologist, by endoscopy, to the bronchi and œsophagus; while the aurist, being constantly confronted with otitic intracranial infections, is practised in dealing with the middle and posterior fossæ of the skull. And if, in addition to this, the oto-rhino-laryngologist happens to be in continuous collaboration, incidental to the war, with dental and prosthetic specialists in dealing with all the complications of massive jaw injuries, it seems accurate to describe the province of his recent activities as the "head and neck."

This volume is in no sense a textbook; nor does it (with the small exception of "Mustard-Gas Laryngitis") include any tabulated series of cases, nor any statistical information. It is merely a systematized attempt to make useful generalizations from a few cases of more than ordinary interest.

The ground covered includes instances of many of the results of trauma above the clavicle; and it is hoped that an account of these selected types of injuries, with suggestions

as to their treatment, may be helpful as a small book of reference.

There are two most important departments of head surgery which are not dealt with, since they belong essentially to other specialized branches—the brain and the eye. These are only mentioned where an injury to one or other overlaps the regions of which the text treats. A short section on the lachrymal sac is included; but for any trespass so committed apology is made in the text to ophthalmologists.

Interest in facial surgery is certain to outlive the war which aroused it. And in the chapters on facial and nasal reconstruction an attempt has been made to assist medical men in industrial districts, and other communities where machinery accidents occur, by suggesting to them not only what to do at once, but also what to leave undone until later.

For the use of the photographs from which many of the illustrations were reproduced I am indebted to the courtesy of Major Valadier; these are Nos. 4, 12, 13, 14, 15, 18, 21, 22, 23, 35 to 38, 42 to 54, 57, 58, 59, 61, 62, 63, 67 to 70, 74 to 79, 81 to 85, 89 to 105, 107, 108, and 114. Of these, thirteen appeared in an interim report in *the British Journal of Surgery*, vol. v., No. 17, 1917.

It is, unfortunately, impossible adequately to express appreciation to all those who at different times have helped me by giving access to records or collaboration in the cure of cases under my care. I should like especially to thank, in France, Lieut.-Colonel Sidgwick, Commandant, and Major Valadier, in charge of the Oral Department, 83rd General Hospital; at Sidcup, Lieut.-Colonel Colvin, Commandant, and Major Gillies, Lieut.-Colonel Newland, and Major Pickerill, heads of the British, Australian, and New Zealand sections. And, both in France and England, the several experts in skiagraphy, prosthesis, and dentistry who have on many occasions subscribed their indispensable share to the treatment of the patients.

H. LAWSON WHALE.

HARLEY STREET, W.,
March, 1919.

CONTENTS

CHAPTER	PAGE
I. HÆMORRHAGE - - - - -	I
II. EXTRACTION OF FOREIGN BODIES—INFECTIONS - -	17
III. THE PHARYNX AND ESOPHAGUS - - - -	41
IV. THE LARYNX - - - - -	55
V. THE EAR - - - - -	75
VI. THE NOSE AND ACCESSORY SINUSES - - - -	97
VII. THE ACCESSORY SINUSES CONSIDERED IN DETAIL—THE LACHRYMAL SAC - - - - -	109
VIII. RHINOPLASTY - - - - -	138
IX. RHINOPLASTY: DIFFICULTIES—SHAPING THE NOSE—AFTER- TREATMENT - - - - -	162
X. THE FACE: EARLY TREATMENT - - - -	194
XI. THE FACE: LATE TREATMENT - - - -	216
XII. THE JAWS: THE MANDIBLE - - - -	253
XIII. THE JAWS: THE MAXILLA - - - -	269
XIV. THE MANDIBLE: BONE GRAFTING - - - -	280
INDEX - - - - -	317

INJURIES TO THE HEAD AND NECK

CHAPTER I

HÆMORRHAGE

SECONDARY hæmorrhage in wounds of the neck may, of course, occur at any moment after a man is wounded; but the patient's admission to hospital is the earliest time that can concern the surgeon in charge.

Of 23 cases sufficiently grave for me to tie one of the carotid vessels, 10 occurred in the first three days, 20 (including the above-mentioned 10) before the end of the seventh day, and 3 between the latter and the eleventh day. The average period of incidence was four and a half days after the man was wounded. The most usual days were the first and third—4 cases occurred on the first, and 4 on the third day.

A comparison of these figures was made in France with those indicating the period for secondary hæmorrhage in wounds of other parts of the body; and it seems, as a result of this comparison, that in neck wounds the catastrophe may be expected earlier than elsewhere. The most probable reason for this is that in many cases the wound simultaneously injures the mandible, pharynx, or larynx, and so gives egress to infective saliva.

There are certain aggravating causes which, as would be expected, often determine the incidence of the bleeding. Such are coughing, swallowing, and in general movement, either of the head on the trunk, or of the body as a whole. It is no uncommon thing for a man with a deep wound in the neck to begin to bleed at the moment when he is lifted on to the stretcher to be taken to the X-ray room.

Reference was just now made to the part played by the infected contents of the mouth leaking into the wound; this, of course, must precipitate the sloughing of any arterial wall. In fact, in the prognosis as to recurrent hæmorrhages after tying either a bleeding-point or the arterial supply of the area involved, I think undoubtedly the chief factor is whether the oral cavity directly or indirectly communicates with the wound; or, if it does not, whether the line of incision made to tie an artery can be subsequently dressed so as to keep it rigidly free from infection from the pharynx. To keep the wound made by the surgeon uncontaminated by that made by the missile is difficult, sometimes impossible, when the latter is a large cavity.

Of 7 cases in which I have tied the common carotid, with or without the internal jugular vein, there were 3 in which I had previously ligated the external carotid artery. And in all these 3 cases the necessity for the subsequent operation arose, not because the first operation failed to control the blood-supply of the area (and obviously not on account of collateral circulation, which would necessitate tying vessels on the other side), but because the uncontrollable trickling of the highly infective buccal contents made the tissues like sodden blotting-paper, and ligatures inevitably sloughed off the softening arterial walls. For reasons such as this I have had to cut down and tie the common carotid under most unfavourable circumstances in dire emergency—on one occasion, for a patient in bed, with no preparations or anæsthetic of any sort.

In following one of these desperate cases to its logical conclusion a time arrives, as we should expect, when further tying of vessels is no longer feasible. The tissues break away directly they are touched; and as soon as one point is tied the gentlest swabbing starts another bleeding. The difficulties are increased by the fact that the infection and the rotting of the vessel walls has through the whole course of the case been spreading progressively down the neck, where the large vessels become ever deeper and less accessible, until at last the surgeon is reduced to plugging, perhaps

deep in the supraclavicular fossa. The outlook is naturally as bad as can be, but such cases do sometimes survive. Fig. 1 is a photograph of a patient who recovered after going through the following ordeal, which is more than all I have just described:



FIG. 1.—From pterygoid plexus, branches of the external carotid, and tributaries of the internal jugular vein; this patient bled repeatedly, and his life was despaired of. Progressive sloughing in the fascial planes of the neck necessitated tying, on different occasions, every available vessel, including the common carotid. He recovered completely. The photograph was taken when he was convalescent.

Corporal M., wounded May 29th, 1918, admitted to — Hospital, June 6th.

Nature of Lesion.—A rifle bullet had passed through the left mastoid to exit over the left infra-orbital foramen.

June 6th.—Hæmorrhage from left maxillary antrum. Left external carotid tied; incision entirely closed.

June 10th.—Hæmorrhage from carotid incision. Opened up; found full of pus, and all vessels friable. Left common carotid artery and internal jugular and common facial veins tied.

June 18th.—Two hæmorrhages from maxillary antrum. *Operation:* Wound laid widely open from entrance to exit, and plugged.

June 28th.—Hæmorrhage from region of pterygoid fossa. Plugged.

June 29th.—Hæmorrhage from the same region as the previous day. Some small veins tied.

July 6th and 7th.—Three hæmorrhages. Plugged over the middle of internal jugular vein; everything too friable to tie.

July 9th.—Bled when dressed.

After this, wound was dressed every second day with Bipp. It was partly closed on July 26th.

July 31st and August 1st.—Hæmorrhage, two ounces each time, from left external auditory meatus. Lightly plugged.

August 12th.—Convalescent.

September.—One month's leave.

December.—Well.

Commentary.—The wound was deep and septic, and the original carotid incision (June 6th) should not have been closed. The last two hæmorrhages were probably from the petrosal sinuses (*vide* course of bullet). Although the internal ear can hardly have escaped damage, there were never any labyrinthine signs. There was never any paresis, aphasia, or cerebral symptoms after tying the common carotid, although the external had been tied previously. In the four days' interval between the ligature of these two, the vertebral system had time to take over more of the work.

When plugging is the only resource, the wound bleeds afresh if frequently dressed, so that the surgeon has a choice of two evils: whether to have the wound dressed insufficiently often, thus inviting an extension of the sepsis and sloughing, or to determine, at all events, to keep the wound as free as possible by dressings of adequate frequency, and in so doing dislodge the frail thrombi again and again. In such circumstances a compromise may sometimes be reached by using some such preparation as Bipp, spread thinly on the gauze used for a plug. Pressure is maintained, and the gauze kept firmly in place by a few sutures passed widely through the skin, preferably threaded through vulcanite buttons or rubber tubing before tying; the strands (of silk or silkworm gut) lie across the gauze, stretched like the rungs

of a wide-meshed ladder. Such a dressing may be left for two or even three days; and as soon as granulations have covered in the necrotic bleeding-points various other and more frequent dressings are employed.

The same considerations which may render frequent dressings impracticable will make the use of an effervescing solution, such as hydrogen peroxide, hazardous in early stages; in a purely mechanical way the bubbles by their movement unsettle the delicate clots, which are already occluding the vessels all too loosely and sluggishly. The picture above sketched of a friable condition of the vessel wall spreading steadily from above downwards from the external carotid or its branches to the common carotid, often involving the internal jugular vein in its course, should always be before the mind of the surgeon, and constitutes an irrefutable reason for never completely sewing up the line of incision through which the first ligature has been made. If the wound is sewn up, it will very likely require subsequent reopening on account of infection, and a collection of pus will be found.

In this reopening of the incision care must be taken that the carotid sheath is really exposed. If the sheath has in the interval become covered with granulations it is not always easy to identify, even by pulsation. And the granulations may not actually be on the sheath, but may bridge across it, covering in a deeper collection of pus beneath. This deceptive appearance of deep granulation tissue shutting off a still deeper bag of pus has occurred several times in my experience. And if unwary of it, the operator will drain the abscess which lies just beneath the deep fascia, and cherish the conviction that he has saved the patient's life, until a fatal hæmorrhage through a concealed pool of pus makes it clear, all too late, that he has done no good whatever.

In dirty cases the wound should be left widely open, and dressed at least twice daily. As we pass in review from such cases to others which are moderately clean, we shall be able to insert one or two sutures at the top of the wound,

which is very lightly packed from its lower angle. And even when we have to deal with what we think a sterile incision in the neck, a light wick of ribbon-gauze should be passed up from the lowest point. From all I have seen of such cases, I have concluded that it is never justifiable to sew up completely.

As prophylaxis against secondary hæmorrhage of wounds in the neck it is necessary in all cases of doubt to open up the wound widely, not only for drainage, but in case wounded vessels are encountered, which if left alone would surely bleed later. The following case illustrates this point:

Private G. H., admitted to No. — General Hospital, France, November 1st, 1917. On admission he had all the signs of pneumonia. His wound was due to a rifle bullet, which entered on the left, opposite the upper border of the thyroid cartilage, and made its exit on the right at the cricoid level.

November 3rd.—Sudden internal hæmorrhage into the trachea, drowning him in a few minutes.

Autopsy.—The bullet had grooved the epiglottic cushion, and fractured the great cornu of the hyoid and the superior cornu of the thyroid cartilage on the left. At its exit it had passed beneath the concavity of the upward arch made by the right superior thyroid artery at its origin; the bullet had thinned the arterial wall here, and the vessel had burst into the larynx.

Commentary.—The patient, from the moment of his admission, was so ill with pneumonia that a general anæsthetic would probably have been fatal. But if under local anæsthesia the wound had been opened and investigated, the damaged artery would certainly have been noted and divided between ligatures, and possibly his life saved.

Let us consider the line of procedure in dealing with a hæmorrhage from a wound of any part of the face, throat, or neck.

The depth of the wound is of greater importance than its area, and in extreme cases the obvious course will suggest itself at once. On the one hand, a mere oozing from a superficial injury will be controlled by light pressure. On the other hand, a furious gush of blood, whether arterial or

venous, from a deep wound near to the carotid sheath will demand ligature of one of the main trunks without delay.

But it is cases which lie between these two extremes which are debatable, and call for more ample discussion.

As a general rule, the wound should be extended by an incision long enough to give a good exposure, and the bleeding-point tied; the deeper the source of bleeding the longer will be the incision.

When the wound is a deep narrow track, the incision will simply open this and convert it into a shallow gutter, irrespective of the anatomical structures cut through. But in all other cases the surgeon may, to a greater or less extent, choose the position and direction of his incision. And he should so choose that he may do the least cosmetic and functional damage; and, above all, that in the event of sudden further hæmorrhage during the operation, he can rapidly control the vessel likely to be responsible. As examples of this I may mention the following:

In the hairy scalp the incision scars will not show afterwards, and in any case no exact surface markings for arteries can be given, so that the line of incision is not important.

The difficulty of securing scalp vessels in artery forceps and then tying them is illustrated by the several varieties of clamps devised to control these after incision. And often the vessels must be crushed by underrunning with a needle, or a continuous stitch passed along the cut edge so as to embrace it about every $\frac{3}{4}$ inch.

Control of scalp vessels becomes easier as we approach the parent trunks, and so it is found that below and in front of the hair line incisions made in the transverse forehead creases make it possible to tie the larger branches of the temporal, supra-orbital, and frontal without disfiguring the forehead.

Bleeding vessels in the side of the nose and the cheek may be reached by an incision along any part of a curved line which extends, with its convexity downwards, from a point midway between the nasion and the inner canthus to the angle of the jaw. This incision does a minimum of injury to the facial nerve, and its central and more obvious part

lies in the natural infra-orbital crease, and so leaves but little scarring; and through it the angular, infra-orbital, and facial vessels may be reached. If it be found that the blood is coming deeply and profusely from the antrum, this should be temporarily plugged while the external carotid is tied.

For the facial artery, the classical short horizontal incision over the mandible will not be often employed, because the wound has often injured the jaw, floor of the mouth, and tongue as well, and the external carotid must be tied.

Wounds of the inferior dental artery by itself never give rise to bleeding which cannot be controlled by plugging.

If it is reasonably certain that the facial and lingual vessels are jointly and entirely responsible, these may be simultaneously reached by a crescentic incision, concave upwards, from the symphysis region down to the hyoid, and then backwards for 2 inches. The subsequent scar is not disfiguring, and spares the inframandibular branch of the facial nerve. A flap of skin, platysma, and deep fascia is raised, the facial is found just before it reaches the jaw, and the lingual just above the great corner of the hyoid.* If the bleeding be limited to the tongue, deep stitches passed through this organ provide the best practical control.

In the front of the neck, between the thyroid cartilage and sternum, it is often possible to employ transverse "collar" incisions; but if it is necessary to dissect deeper than the infrahyoid muscles these should be split parallel to their length. If a tracheotomy wound exists, it is wise to keep as far away from it as possible.

The above remarks apply to the opening of a deep bleeding track, or the making of a fresh incision to control the vessel responsible for bleeding from such a track, when this vessel is a branch of the external carotid. But more usually the superior thyroid, facial, lingual, and ascending pharyngeal are all implicated to varying extents, and it is best to tie the external carotid at once. With increasing experience

* If a wound involves the submaxillary salivary gland or Wharton's duct, the latter should be tied and both the superficial and deep parts of the former removed when the lingual artery and vein are being ligatured.

in bleeding from these branches, and disappointment after tying them, the surgeon will more frequently attack the parent external carotid at the outset. This is done through the usual incision along the anterior sterno-mastoid border. I have several times tied the facial or lingual at their origin through this incision, and left a loose ligature around the external carotid; and tied or removed this ligature later.

If attempts to tie either the bleeding-points in the wound or one of the branches of the external carotid have failed to control the hæmorrhage, fresh sterile towels and instruments should be produced, and the surgeon, having washed up, makes a formal dissection to tie the external carotid itself.

The dissection for tying this vessel is well known and described in any textbook, and here I will merely make a few observations.

In wounds of the neck, first observed several days after their infliction, the dissection is rarely a formal set operation with all the structures occupying their normal relations. These relations are conspicuous by their absence in gunshot wounds of submaxillary and carotid triangles when the mandible has been fractured: the infrahyoid muscles pull everything out of place. It becomes, therefore, all the more important to take advantage of any structures which remain uninjured and in their proper positions, and which may serve as guides. Above, the hypoglossal nerve, or below, the omohyoid, are likely to be identified; and in a badly smashed neck with a large deep hæmatoma the surgeon should be grateful for even these landmarks. Between them the common facial vein, as it crosses to the internal jugular, is probably the least disturbed structure encountered in tying the external carotid. It will often expedite matters to tie in two places and divide this vein, which commonly hampers the surgeon where speed is advisable.

If in an emergency there is not time to dissect the sheath off the artery, the operator must be absolutely satisfied that his ligature does not include the vagus.

In the neighbourhood of a septic wound it is preferable to

tie in one place rather than divide between ligatures; the latter plan only provides an extra raw surface and two unsheathed arterial ends for sloughing.

A subsidiary question is the best position of the ligature with regard to the origin of the superior thyroid. Its anastomoses in the front of the neck are so free that it is safer to tie this vessel, as well as the external carotid, in all wounds which affect the area of supply of the superior thyroid, as well as the area of the lingual and facial. In cases where the superior thyroid arises from the external carotid at its actual bifurcation, or from the common carotid, the safest procedure is to tie the superior thyroid and the external carotid below the lingual.

The *common carotid* may be tied primarily as a measure of choice; or secondarily, when, owing to sepsis, a ligature has sloughed through the external carotid, and the operation wound has to be prolonged downwards until an indubitably healthy vessel-wall is reached.

Primary ligature will be undertaken when the wound above is so unhealthy and the tissues are so friable that it is impossible to make ligatures hold fast on bleeding-points, on branches of the external carotid, or on the external carotid itself. Additional ligature of some of these will be necessary as soon as the rush of blood is stopped from below by the control of the common carotid, otherwise the collateral circulation is certain to cause failure.

Now, if ligatures would hold, to tie the bleeding-points or the external carotid or its branches would itself control the bleeding; so that the additional closure of the circulation from the common carotid has merely the effect of cutting off the head of blood-pressure, lest the smaller vessels tied above be unable to resist this. That is to say, primary ligature of the common trunk is only performed when the tissues are so soft and perhaps gangrenous that the prognosis is, in any case, very gloomy. The artery can usually be tied within its sheath.

Secondary suture of this artery is necessitated when sepsis has led to recurrent bleeding. It usually has to be done with

extreme urgency, and the bleeding vessels above must also be tied as soon as the artery is well controlled, if they have not been secured just before. Frequently the internal jugular vein has also to be ligatured.

It is very difficult to deal with these two large trunks satisfactorily in cases where bleeding follows, at an interval of a week or more, ligation of the external or common carotid above, and where the carotid sheath for most of its length has become covered by a thick layer of granulations. Under these circumstances, if these granulations extend far down the neck, there is neither time nor space to dissect out the vessels below, and an aneurysm needle is carefully passed—so widely as to be sure of not puncturing the internal jugular vein—around artery and vein together; in such a case it is very difficult to be sure the vagus has not been included in the ligature.

I have never seen an instance of paresis, or of any clouding of cerebation beyond what was accountable for by the loss of blood, from ligation of the common carotid. But I have seen thrombosis from external pressure on the internal carotid at its origin, and the case was sufficiently unusual to be here reported:

Private S. was admitted to No. — General Hospital, France, on July 13th, 1916. There was an entrance wound over the middle of the right maxillary antrum, but no exit wound, and no signs of any lesion in the mouth. Instantly, on admission, whilst being put to bed, he had a copious hæmorrhage from the post-nasal space into his mouth. A probe indicated that the direction of the wound was from the right cheek to the left mastoid; but since his condition was too desperate to allow us to take him to the X-ray room, we could not tell how far the missile had penetrated. So it was difficult to know from which side the blood came. Compression of the right common carotid checked the flow, and accordingly the external carotid on this side was tied at once, and with the desired result. But in a few hours his right side was hemiplegic, and he died eighteen hours after admission.

Autopsy.—The right external carotid and its branches were occluded by the ligature. A round shrapnel ball lay

in the **Y** of the bifurcation of the left common carotid. This vessel and the left external carotid were patent (Fig. 2). But from its origin the left internal carotid was thrombosed; the firm clot extended into the left half of the circle of Willis, and into the left middle cerebral to the top of the Sylvian fissure. Over the left Rolandic area was a thin subpial layer of red cortical staining.

Commentary.—From its position the bullet must have cut off all blood from the internal carotid. Had the bullet been a little lower in the neck, and occluded only the common

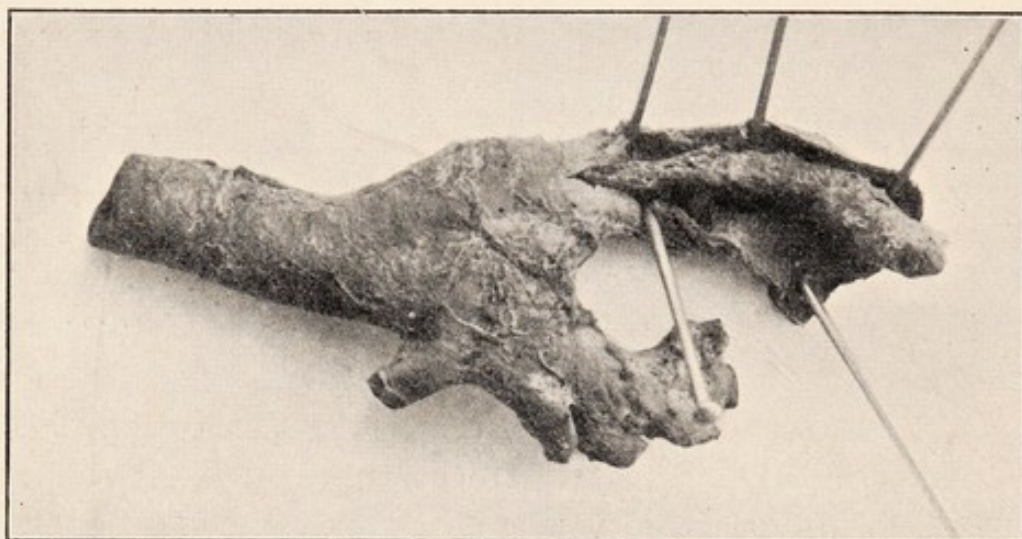


FIG. 2.—A round shrapnel ball had come to rest against the carotid bifurcation, so as to cut off not only the normal supply from the common carotid, but also any reversed flow down the external carotid. Thrombosis, hemiplegia, death. The clot is well seen. If the bullet had been a little lower in the neck, the patient would probably have recovered, for reasons given in the text.

carotid, the reversed flow from the external would presumably have maintained the circulation in the internal, as occurs after ligation of the common carotid.

That ligation of the common carotid in a young man with healthy arteries need not be expected to cause any cerebral incapacity is generally admitted. As regards the venous return, it would be agreed that to tie both internal jugular veins within a short time of each other would be to risk calamity. Yet I was once obliged to do this, and did so with impunity in the following case:

Private S., admitted to — General Hospital, France, February 13th, 1918, with a gunshot wound of the floor of the mouth and tongue, a comminuted compound fracture of the mandible, and extensive patches of broncho-pneumonia.

February 17th.—Hæmorrhage. Deep sutures passed through tongue to control bleeding; these were allowed to slough out, which they did between February 21st and 24th.

February 24th.—Repeated hæmorrhages from the right side of the mouth and tongue between 11 a.m. and 5 p.m. A general anæsthetic was considered unjustifiable. Under novocain the right lingual artery was tied at its origin at midday, and a ligature left loosely looped around the external carotid.

During the dissection the external jugular and common facial veins also were divided between ligatures to obtain better access. The patient was so restless owing to his pneumonic dyspnœa that at the close of the operation the ligature slipped off the proximal end of the common facial vein near to the internal jugular. The internal jugular was therefore tied.

At 7 p.m. sharp hæmorrhage from right side of tongue: provisional ligature tightened around right external carotid.

February 26th, 11 a.m.—Free hæmorrhage from left side of tongue and floor of mouth. The loss rapidly reached half a pint. There was no time for local anæsthesia. A light general anæsthetic was given for tying the left external carotid. The left external jugular was divided between ligatures for access.

The deep veins, tributaries of the internal jugular, were so unhealthy that they broke on touching, and ligatures would not hold. The left internal jugular, which was enlarged and engorged, was therefore tied, also the common facial.

Subsequent condition showed no change whatever as the result of shutting off so many blood-channels, except that the bleeding never recurred. There was never any change in colour or temperature of the face, nor any suggestion of cerebral œdema or interference with cerebration.

March 7th (nine days later) he died.

Autopsy.—Extensive broncho-pneumonia and abscess of lung. Brain normal.

Commentary.—During nine days, under close observation, the patient suffered no inconvenience as the result of closing off the following vessels, all of which were ligatured within a period of thirty-six hours:

On the right: the lingual and external carotid arteries; the common facial, external and internal jugular veins. On the left: the external carotid artery; the common facial, external and internal jugular veins.

It might have been expected that a collateral venous circulation sufficient to satisfy the demands of the brain would also restart the bleeding from the wounded area.

The chief interest lies in the venous return. The right internal jugular, which carries much more blood than the left, happened to be tied first. The blood at the torcular Herophili was therefore diverted to the left internal jugular, and also through collateral intracranial channels, which had some little time to accommodate to their extra load. It is interesting to speculate as to whether the patient would have withstood the ordeal so well if the left jugulars (internal and external) had been tied first, because then the right internal jugular, originally the larger, would have been carrying so much blood that subsequently to cut it off suddenly might well have been fatal.

With all four jugular veins shut off, the vertebral and spinal venous systems must have done the work.

The collateral circulation which can rise to the occasion so rapidly and completely is occasionally a slight handicap. Arterial bleeding may occur from a small facial wound twenty-four hours after ligature of the external carotid on that side.

In the posterior triangle, incisions to tie bleeding vessels should be made, for preference, sloping downwards, outwards, and slightly backwards, as for exposing the cords of the brachial plexus. After rapidly clamping in several places and cutting the venous plexus made by the suprascapular and transversalis colli veins near their junction with the external jugular, the corresponding arteries are found and tied. Through the same incision the third part of the subclavian artery may be found. But if a wound necessitates the control of this vessel, it is best to incise along the upper surface of the clavicle, dividing the inner part of the sterno-mastoid muscle, and then with a broad spatula to push back rapidly all structures from behind the bone, and resect its inner half.

Intravenous infusions of saline with pituitrin are a useful

adjunct in dealing with emergency hæmorrhages. The infusion should be given while the operation is proceeding, if it has not been given before. This saves time, not only in checking the effects of dangerous anæmia, but also in passing the cannula into the vein—a simple procedure, which may be much more difficult half an hour later, when the veins have been emptied by the patient's loss of blood on the operation-table.

In the more deliberate treatment of hæmorrhagic anæmia, transfusion is, of course, a more physiological procedure than infusion. A plan has been suggested, and to a certain degree applied, of systematic examination of the blood of everyone available in the Base of the "Zone of the Armies," and then assigning each man to one of four "groups." The serum of each group has definite hæmolytic relations to its own and each of the other three groups. If one of the men so classified be required as a donor of blood, the selection of a man from the correct group tends to eliminate one possible source of disappointment—that is, hæmolysis.

Of the several methods of transfusion, that of direct transfer from radial artery of donor to radial vein of recipient through cannulæ and rubber tube prepared with sterile paraffin is most attractive, in that the technique involves a minimum departure from physiological conditions. But the method has the grave disadvantage that the amount of blood transfused is a matter of guesswork, the only data being the duration of flow and the condition of the donor and recipient.

Of the several methods of giving a measured amount—from 500 to 1,500 c.c.—of fresh or preserved citrated blood, I have found the use of syringes quite satisfactory. It employs three surgeons, and at least six paraffined syringes. One operator uses his left hand to steady the needle in one of the veins in the antecubital fossa of the recipient, the needle pointing towards the latter's shoulder; his right hand receives the filled syringes and injects the blood. The second operator occupies a similar position as regards the donor, except that the needle points towards the donor's

wrist, and the blood is withdrawn into the empty syringes. The third operator stands between the other two, with a small table in front of him; the table is covered with sterilized towels, and bears a constant supply of warm saline solution, two bowls, and the syringes. He takes the empty syringe from the first operator, and hands him a full one; he also takes the full syringe from the second operator, handing him an empty one. He keeps a watchful eye on the syringe barrels, from which he clears off occasional clots by washing out with saline. Carried out in this way, the transfusion is practically continuous. During the four or five seconds' delay between changing syringes, each of the first two operators closes the hub of his needle with a finger of the left hand.

CHAPTER II

EXTRACTION OF FOREIGN BODIES—INFECTIONS

Localization and Extractions of Foreign Bodies.

IF a bullet or piece of shrapnel is felt through the intact skin with the finger, or at the bottom of a track with a probe, and it is certain that it lies superficially or in a mass of muscle at a spot entirely remote from any important bloodvessels, nerves, or organs, it may be removed without confirmatory evidence.

But such certainty cannot often exist in the case of the neck unless the foreign body is quite obviously subcutaneous. And, as a rule, skiagraphy will be required. This is the more true when the track has healed up, either entirely or in its deeper parts, so that a probe cannot help much unless pressure, which is unjustifiable, be used. As a general rule, the soft tissues of the face, nose, and pinna, and the erector spinæ and trapezius muscles are the only parts of the head and neck where a foreign body if more than skin deep may be sought for without previous skiagraphy. Even in the scalp this rule applies. For the missile may overlies a depressed or comminuted fracture of the skull, or a gap in one of the great venous sinuses, and damage may be done by disturbing bony fragments if any operation be undertaken without obtaining sufficient information.

The exceptions to this general rule are urgent emergencies. For example, it may be necessary to open up the tissues at once for hæmorrhage, or for rapidly spreading sepsis or gas gangrene. In such cases the foreign body will naturally be searched for at the same time; but if not found, attempts should be postponed, rather than extend the incision into healthy tissues any more widely than has already been

necessary to deal with the sepsis or hæmorrhage. Another example is dyspnœa due to the pressure of the bullet or shrapnel on the trachea low in the neck below the thyroid isthmus; a tracheotomy tube in this case may be badly tolerated, and whether tracheotomy be employed or not, it is necessary to remove the missile without delay.

Such dyspnœa may occur for the first time when the patient's head is turned about this way or that to take the skiagram. Under such circumstances a probe may be passed along the track, if one exists, on to the foreign body, guided by the image on the fluorescent screen. The wounded man is then at once moved gently to the operating-theatre; someone walking at the side of his stretcher all the while steadies the patient's head with one hand and the probe with the other, and the probe is then cut down on. For most occasions this plan is more desirable than that of actually operating with the aid of a screen.

Besides the ordinary surgical probe, the telephone probe may be of very great help in the removal of deep foreign bodies. Despite the most perfect technique for radiographic localization—whether stereoscopic or the cross-thread method, or by photographs taken in both coronal and sagittal planes—there are regions of the head and neck in which it happens that, even with a wound-track to give additional guidance, the bullet is not found without a great deal of manipulation, such as probing, swabbing, and perhaps bleeding, often on a patient who is not fit to stand a lengthy anæsthesia. Such regions are the upper and posterior parts of the ethmoidal gallery, the sphenoidal cells, the palatine and speno-maxillary fossæ.

Fig. 3 shows the skiagram of a large piece of shrapnel in the sphenoidal sinus and pituitary fossa of a patient; it had fractured the anterior clinoid process. In this case, which was referred to me by Colonel Lister, C.M.G., the track was still open. The entrance wound beneath the left eye appeared, as is so often the case, much too small to give entrance to so large a mass. The wound was enlarged by incision in the infra-orbital crease, and access obtained by

removing the outer and inner antral walls. Even then no metal could be seen at the bottom of the track. And with the ordinary probe the most that was possible was to differentiate, at scattered points, between metal and dead bone.



FIG. 3.—A large piece of shrapnel embedded in the pituitary fossa and sphenoidal sinus; removed through a curved infra-orbital incision with the aid of the telephone probe.

But with the telephone probe the outline of the shrapnel could be made out, so that it was possible gently to cut away the overhanging rough edges of basi-sphenoid and sphenoidal cell, and extract. The operation was nearly bloodless, and occupied twenty minutes.

Such cases as this, in which the track is still patent, save the surgeon a large part of his responsibility; for whether it be anatomically the route of choice or not, he can at least do no harm by cautiously following the track; and if unsuccessful, he can always proceed to make a formal dissection through a chosen incision.

When the track is healed, the problem is more difficult. Fig. 4 shows such a case. The rifle bullet was pointing



FIG. 4.—Bullet partly embedded in the centre of anterior surface of the fourth cervical vertebra. The track had entirely healed, so that a formal dissection was necessary. Uneventful recovery.

obliquely upwards, exactly in the middle line, its point embedded in the anterior surface of the fourth cervical vertebra. The track had entirely healed, and the entrance wound was represented by an almost invisible scar low in the neck. I removed this bullet by dissecting in front of the right carotid sheath, and behind the wall of the hypopharynx.

In such cases, the dangers are only partly overcome by the successful removal. The after-treatment constitutes a most

difficult problem; to this I shall refer in connection with mediastinal abscesses.

Before making an incision to extract a foreign body whose track has entirely healed the dissection should be so planned as to have under control any large bloodvessels likely to be

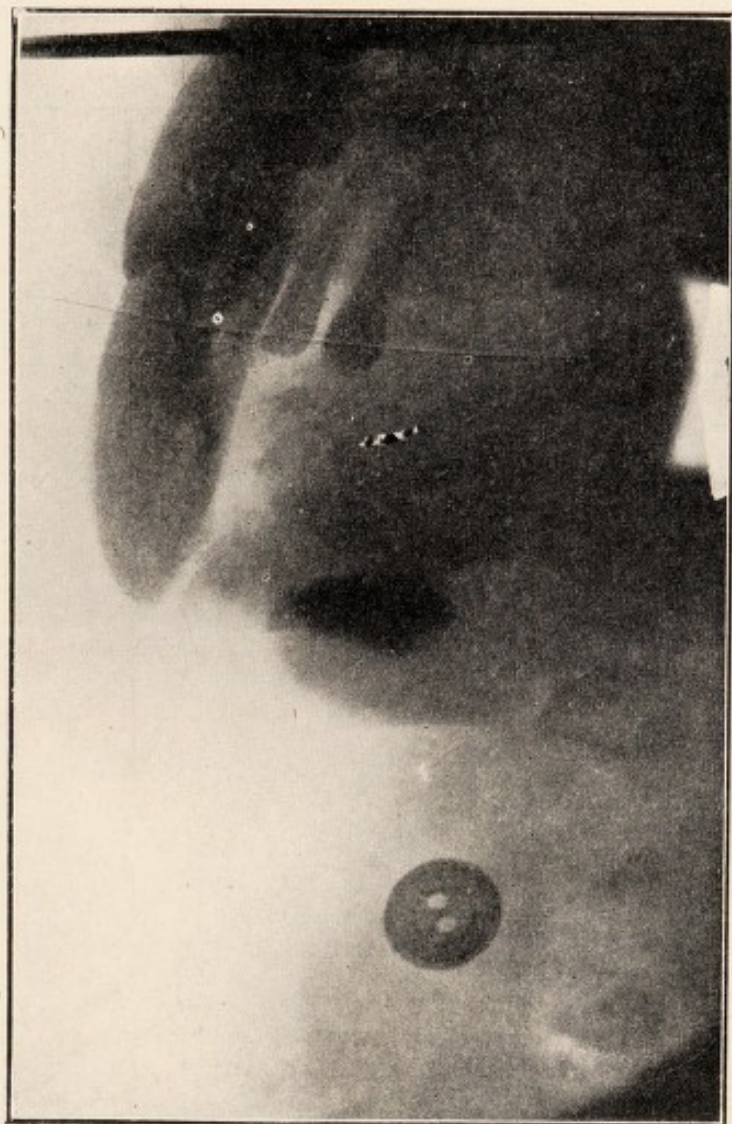


FIG. 5.—A piece of shrapnel in the root of the tongue, photographed eleven months after the wound. It caused no trouble, and the patient was in fine health. But in case in middle age it might be an adjuvant cause of carcinoma, it was removed.

encountered. The interval elapsing between X-ray photography and operation should be as short as possible, to reduce the likelihood of the foreign body having moved in the interim. In the case of the tongue and floor of the mouth, shrapnel and bullets are most elusive, because the parts are

never at rest for long. Fig. 5 shows a piece of shrapnel which was difficult to palpate or localize, but was removed by the external route from between the genio-hyoglossi muscles nearly eleven months after the man was wounded.

The following case illustrates the fact that a missile may suddenly alter its position even when lying more or less surrounded by bone:

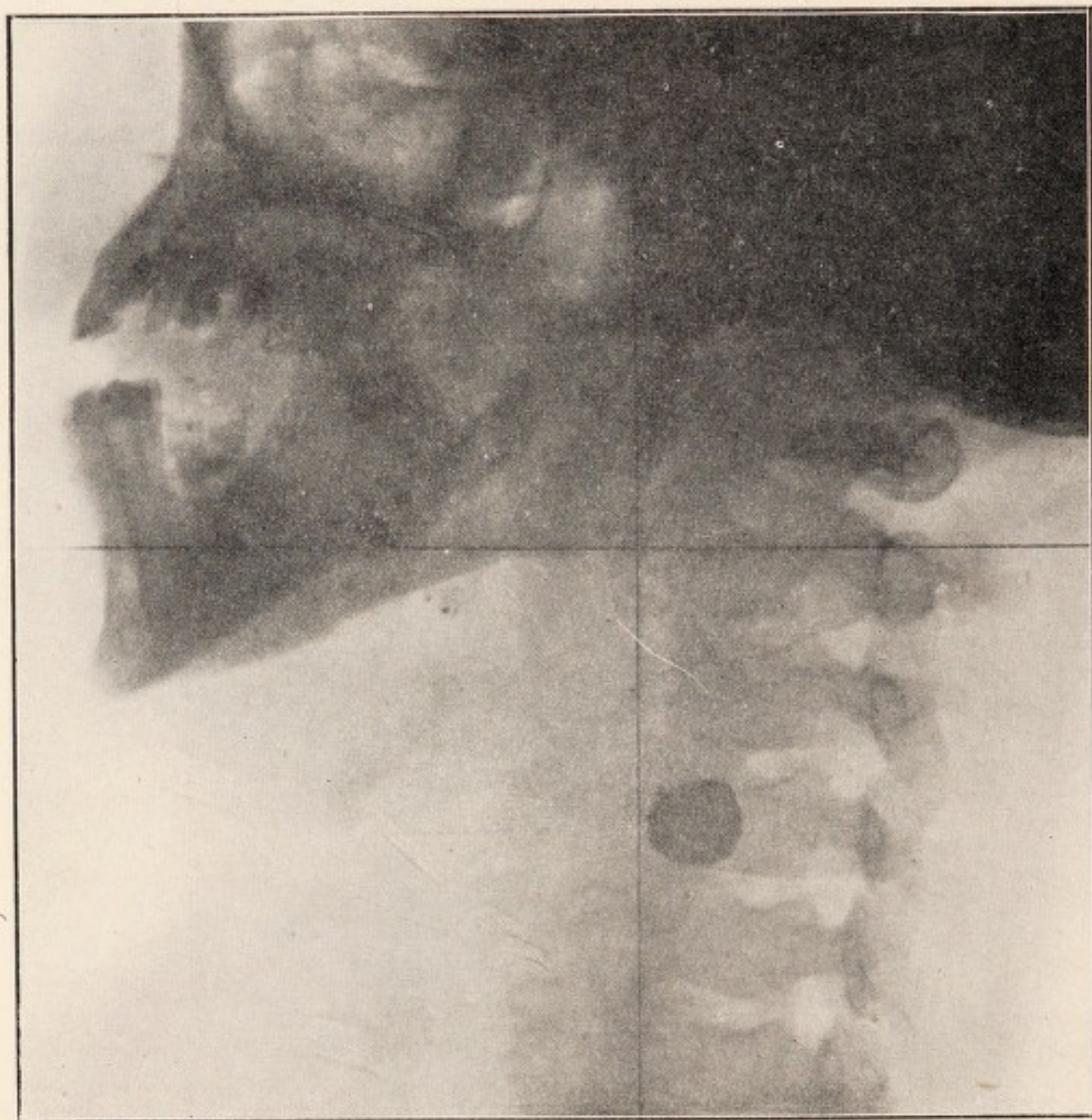


FIG. 6.—Shrapnel ball pressing on the left vagus, resulting in death as soon as chloroform and ether were administered.

Private F., wounded April 19th, 1917, admitted to No. — General Hospital, France, on April 21st. There was an entrance wound 1 inch long at the left inner canthus, and no exit wound. The skiagram showed a bullet high up in the ethmoid. It could be felt by a probe, but was invisible intranasally after cocainization.

April 22nd.—Operation. A post-nasal plug was inserted. An incision was made prolonging the track into the infra-orbital crease. No bullet was found. The post-nasal plug was examined, and found in good position. The post-nasal space was now palpated bimanually, through the wound and above the palate, with no success.

X-ray screening a few hours later showed the bullet in the colon, from which it was passed *per rectum*.

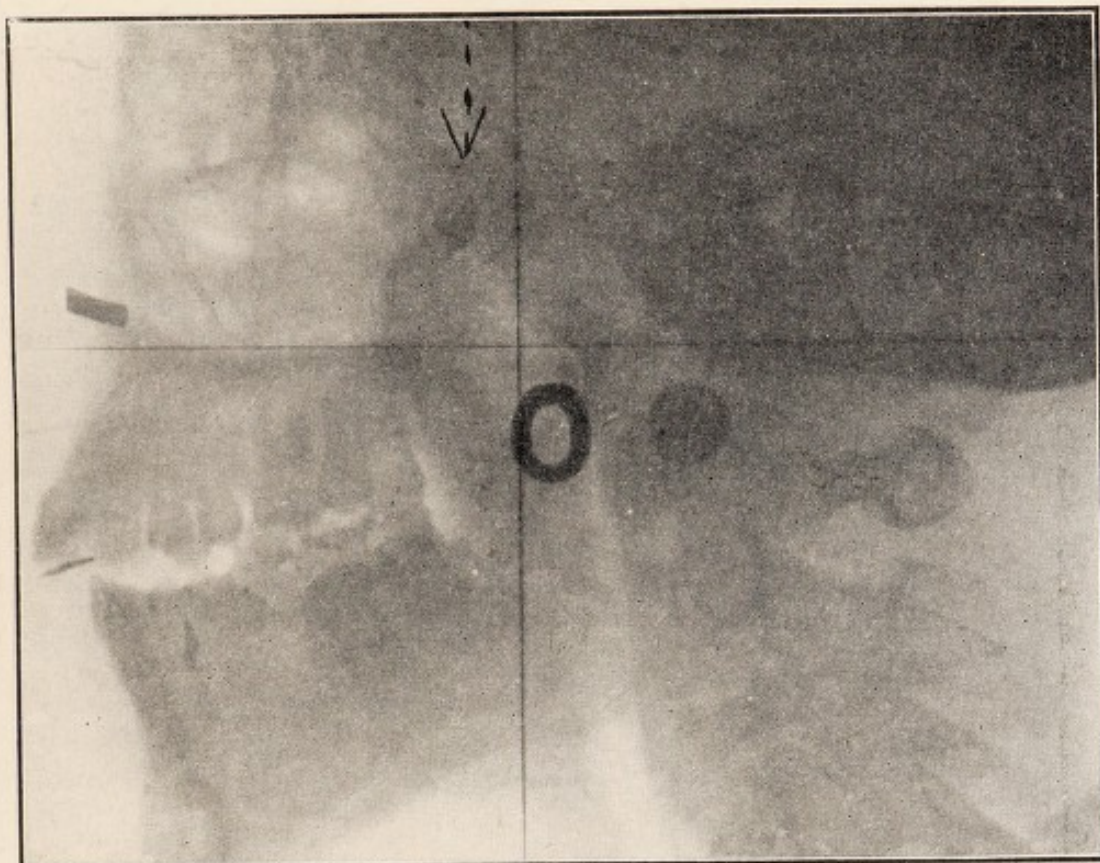


FIG. 7.—The arrow points to a piece of shrapnel which caused no trouble, and was advisedly left *in situ* in the sphenomaxillary fossa.

Commentary.—The bullet may have passed into the œsophagus when the post-nasal plug was removed; but it seems more likely that it had been swallowed previous to the operation.

Lastly, the problem is not settled by a decision that a foreign body has or has not moved from one part of the soft tissues to another. It may ulcerate into or out of the œsophagus or trachea. And if it pass beyond the thoracic inlet, it may be uncertain whether it be in the air-passages, lung, or mediastinum.

In one case a piece of shrapnel entered opposite the left side of the larynx, and the skiagram showed it to be apparently in front of the trachea, below the episternal notch. There was only slight dyspnœa. The surgeon in charge performed a low tracheotomy. Three days later, before proceeding to extract the shrapnel, another skiagram was taken, which showed no shadow at all. Further examina-



FIG. 8.—Shrapnel in the maxillary antrum; removed through the outer antral wall, beneath the cheek.

tion by the fluorescent screen and photographs discovered the shrapnel in the upper right side of the thorax. It moved with respiration round about a point opposite the sternal end of the fifth rib.

Further information as to its position was obtained by periodical clinical examination of the lungs, by the extent of its movements with the respiratory excursions, and by stereoscopic skiagraphic measurements. But the evidence was

conflicting as to the site, whether in the right main bronchus or the mediastinum.

A week after his admission I was asked to use the bronchoscope. All I could see or feel was a rough red torn patch of mucosa in the right bronchus an inch below the tracheal bifurcation. Eventually the patient died of septic pneumonia.

The autopsy showed that the shrapnel had penetrated the



FIG. 9.—Lateral view of Fig. 8.

subglottic larynx, and passed down inside the trachea; here it had rested when the first skiagram was taken. Later, it had passed into the right bronchus, and ulcerated through into the lungs immediately adjacent, forming a cavity for itself, bounded partly by ulcerated bronchial cartilage and partly by lung tissue.

As regards the moment of selection for removing the missile from the neck, there is no doubt that when it is certain the extraction is necessary the sooner it is done the better.

And this applies to the majority. Among dangers inherent to leaving foreign bodies in this region, we should always remember laryngeal œdema; ulceration into the œsophagus, trachea, or great vessels; arterio-venous or other forms of aneurysms; damage to the vagus or recurrent laryngeal nerves; sepsis spreading in the fascial planes. The following case is illustrative:

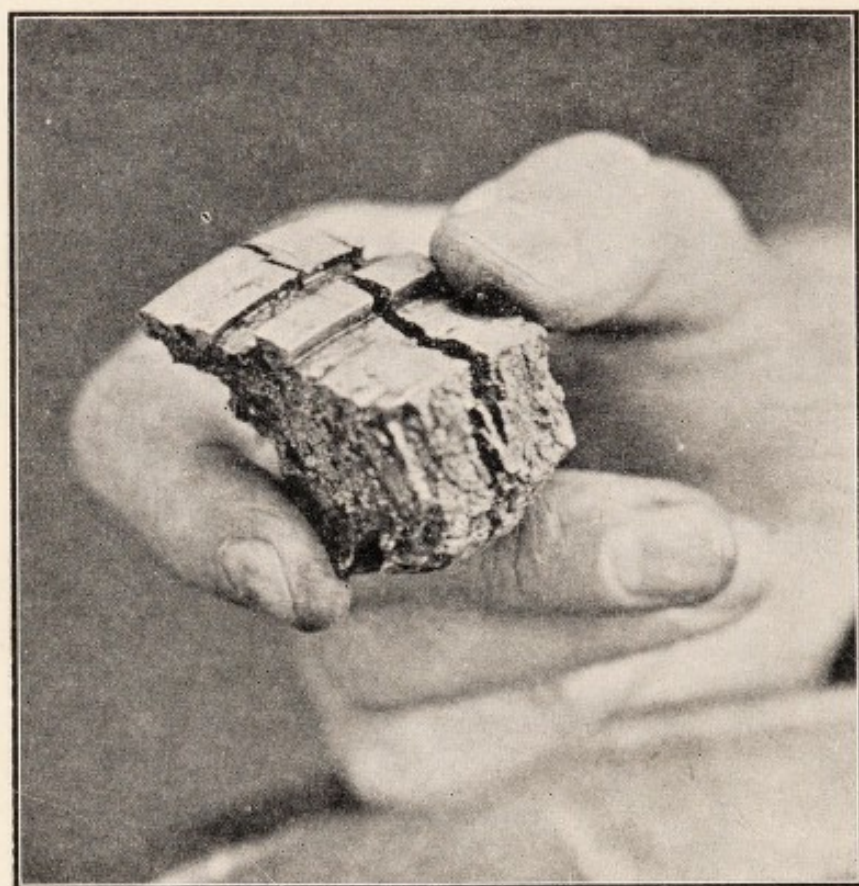


FIG. 10.—Shrapnel, weighing $5\frac{1}{2}$ ounces, removed from maxillary antrum after eight hours' residence there. It had destroyed the naso-antral wall; also the posterior antral wall, rendering it an easy matter subsequently to look direct into the sphenomaxillary fossa. By forcing its way in these two directions the shrapnel had remained completely concealed from view.

Sergeant B., admitted to No. — General Hospital, France, on November 1st, 1917.

The entrance wound was directly beneath the columella, and the hard palate was fractured. There was no exit wound. The skiagram (Fig. 6) showed a round shrapnel bullet on the left lateral side of the vertebra, C 4. There was slight dyspnoea. Temperature, 99.4° . Pulse and respiration constantly varying, but averaged 100 and 20 respectively.

November 3rd.—Operation, chloroform and ether. Incision along left anterior sterno-mastoid border. Pus was formed at once. The carotid sheath was now drawn forwards. The breathing became shallower. There was no pus deep to the carotid sheath. Before the bullet could be found operations were suspended for artificial respiration. Tracheotomy was now performed, and oxygen given. Despite all efforts the patient never breathed again.

Autopsy.—There was a little pus in the mid-line in the post-pharyngeal region, but none behind the carotid sheath. The bullet was lying behind the left carotid bifurcation, pressing on the vagus.

Commentary.—I attributed death to the effect of chloroform on a patient whose vagus nerve was already injured.

If the patient's condition does not justify general anæsthesia, local anæsthetics should be employed. Novocain of a strength of not more than 2 per cent. has the greatest advantages, especially as regards tolerance and absence of toxicity.

There remains a small minority of cases in which it is wisest to leave the foreign body, especially if smooth. In the early days of the war, when round shrapnel balls were more frequently found than lately, I have several times deliberately left in the speno-maxillary fossa a ball which had produced no symptoms during a sojourn of several weeks, because the risks entailed in its removal were out of all proportion to the probable risks of leaving it severely alone. Fig. 7 is a case in point.

Infections, General and Local, and their Treatment.

Septicæmia.—In considering systemic blood infections as the result of wounds in the war, the outstanding addition to our previous knowledge concerns gas-producing organisms. This subject is entirely in the province of the bacteriologist, and will, therefore, not be further referred to. Sir Almroth Wright, and those who work with him or along his lines of investigation, have revealed much to us, not only in the treatment of systemic infections, but more particularly in the local treatment of wounds.

As regards the neck in particular, this region is so crowded with important structures that the evil effects of wounds there, especially if a septic foreign body be allowed to stay deep in the tissues, are likely to be manifest as local results on any of these important structures before a general septicæmic effect has time to show itself. This is, however, not invariable, as will be seen from the following case:

Private K., admitted to No. — General Hospital, October, 1916, wounded by a round shrapnel bullet. This had entered over the right mandible, which, with the right great cornu of the hyoid, was shattered. The bullet had then passed down in the deep tissues to lodge and remain in the mid-line behind the junction of manubrium and gladiolus. Owing to the jaw being comminuted the larynx could not be examined. There was never any dyspnœa or dysphagia.

I did not see the patient until the eighth day, when he was moribund from septicæmia. But I performed the autopsy.

Post-mortem.—The bullet had perforated the ventricle of the larynx. The tissues in the path of the missile were torn and bruised, but there was no macroscopic collection of pus anywhere.

Commentary.—It is remarkable that a body the size of a round shrapnel bullet should have stayed in this position for a week without causing any dyspnœa. The foreign body caused no local trouble at all, and clinically the case was obviously a general septicæmia. Possibly his life would have been saved by the removal of the bullet, although this would have been a serious and drastic procedure.

The opening up and draining of wounds of the neck is guided by ordinary surgical principles. But it must always be remembered, as a rather special feature of this region, that the neck comprises a series of longitudinal compartments whose boundaries are fascial planes; and that the contents are a number of vessels, nerves, and viscera which course in and parallel to these planes, and are attached to their walls. These contents are, therefore, relatively inelastic, and their safe margin of displacement from the normal position is limited.

As corollaries to these facts we may deduce the following special rules:

It is important in the neck as far as possible to dissect longitudinally, not transversely, so as to avoid opening up other fascial compartments. Dissection should, moreover, be by clean cuts rather than by blunt dissection along fascial planes. For these planes open up in a longitudinal direction very easily. If, for instance, the fingers be placed deeply in the wound and moved up and down with the intention of opening it from the hyoid to the cricoid region, the compartments will be separated much farther than appears or was intended; and, actually, infection may have been given ingress right down to the thoracic inlet. Again, it is not safe to leave a tube for long in the neck unless pads of muscle or granulation tissue separate it from important structures. If, for instance, a $\frac{1}{2}$ inch tube rest for long against a carotid artery it will probably ulcerate into the vessel. Such facts as these were, of course, well known in civil pre-war practice; but their importance is now emphasized by the more frequent necessity of draining deep wounds of the neck. Indeed, the question of lengthy drainage by tube involves a paradox. If we remove it or replace it by a much smaller tube too soon drainage is inadequate, and the patient dies of general or local sepsis. If, on the other hand, we leave a large tube *in situ* we may invite a fatal secondary hæmorrhage.

As regards medications for dressings, everyone has his own views, and I merely wish to say what I have found useful. And this bare statement will be given quite unsupported by any bacteriological evidence, such as the count of organisms in a microscopic field at regular intervals.

Hydrogen peroxide cleans up the wound beautifully, but has its risks; the bubbles, by mere mechanical action, may carry infection up and down in the planes of the neck. Consequently, it is a safe rule to rely on other things—saline, flavine, eusol, or some other chlorinated solution—until about the fifth to seventh day. By this time protective granulations are well on the way, and hydrogen peroxide, applied immediately before whatever other solution is in use, is of great value.

Bipp is another valuable dressing which has limitations in the neck. It should never be used for any wound which communicates, directly or indirectly, with the oral cavity or œsophagus. I have seen several cases, and heard of others, in which, after using Bipp in a compound fracture of the jaw or perforating wound of the hypopharynx, grave symptoms supervened, strongly suggestive of poisoning by iodoform or bismuth.

Sanitas, half a dram or one dram to the pint of water, works admirably in cleaning up the earlier foetid stages of neck wounds. If a little enters the alimentary canal there are apparently no ill-effects. Unfortunately, sanitas was not obtainable in France after the first months of the war.

Soap, as used by the French, gives very good results. As would be expected from its chemical composition, if a little be swallowed no evils result beyond the unpleasant taste.

Gauze is wrung out of a lather of soap and placed in the wound; for the first few days a weak solution—2 per cent.—and later 20 per cent., may be used, and changed daily. Its action is probably physical rather than chemical; when, after twenty-four hours, the dressing is removed, softened sloughs will come away with the gauze. Such sloughs might equally be removed by hydrogen peroxide; but, as above stated, the latter has other disadvantages. Salt-packing is often very useful.

The slow subcutaneous administration of oxygen in the neighbourhood of foul wounds has advocates amongst the French. The apparatus used is a model of ingenuity and finish; but this, and the moral effect on the patient, are probably the chief advantages which may be dogmatically claimed for the method. For this is purely empirical, and there is no scientific criterion by which results may be checked. My personal experience of this therapy by local subcutaneous infusion of oxygen leaves me quite sure that I have never seen any harm result, but quite uncertain whether it has had any good effects.

Mediastinitis ; Vagitis.—While in France I came to regard the spread of infection along the fascial planes to the thorax

as the most dread of all possible complications of wounds of the neck. Against hæmorrhages, against septic inhalation, infections of the lung, and even against septicæmia, a certain amount of treatment and even prophylaxis is possible. But mediastinal involvement renders the prognosis more gloomy than anything else. And not only is the prognosis bad, but the diagnosis of this sequela may be, as I pointed out in the *Lancet*,* difficult, and its onset quite insidious.

If we consider neck wounds from the point of view of the possible tragedies in the face of which we may fail to save the patient's life, the following clinical classification is evolved:

1. Massive gunshot wounds of the neck, resulting in a gangrenous cavity, which involves a great part of one or both anterior triangles. In these cases our immediate anxiety will not be concerned with a deep spreading cellulitis. The most obvious sequelæ are secondary hæmorrhage, septicæmia, or, if the air-passages are involved, septic pneumonia.

2. In a second class of case the wound is not massive—indeed, it may be quite small—but it is very deep, and obviously communicates with the deepest fascial compartment, the retropharyngeal space. In this case a retropharyngeal cellulitis, with or without a macroscopic abscess, is almost certain. And we at once proceed to combat it by surgical drainage, which, at the retropharyngeal level—that is, not lower than the cricoid cartilage—is a comparatively easy matter.

3. The third class is much more distressing and difficult to deal with, for two reasons: the wound and its apparent consequences have been insignificant, so that the surgeon is less likely to be prepared for grave happenings; also, the seat of damage and danger is low down in the neck, and, therefore, formidable to deal with when it is diagnosed.

Let us suppose a patient is admitted to a hospital several days after a wound high up in the neck, even as high as the mandible. The wound has been produced by a smooth bullet or a small, not jagged, piece of shrapnel, which has not

* *Lancet*, September 29th, 1917.

left in its wake a suppurating track. There is no exit wound, and the small wound of entrance has nearly or entirely healed. There are no signs, local or general, of inflammation; but when he is first fed he complains of pain on swallowing; or, when his head is first moved, as for taking a skiagram, he becomes dyspnœic. Stereoscopic skiagraphy shows a foreign body, which, though small, is very deeply situated. During the next few hours the pulse and respiration increase, not uniformly, but in fits and starts. The signs of pressure on trachea or gullet become more insistent, and it is decided to operate for the removal of the bullet or shrapnel as soon as possible. But, as he is obviously in bad general condition for an anæsthetic, it is preferred to wait until the next day. Next day, however, the pulse and temperature become still more rapid—always in spasms, never consistently. If the pupils be looked at there may be some irregularity. The temperature now rises and swings erratically.

Whether it is decided to wait yet a little longer for a more favourable moment or to intervene at once now probably matters little. The removal of the metal, adequate surgical drainage, cardiac stimulants and oxygen, are all unavailing. And in one or two days, with no other signs than I have outlined—without ever losing his colour or appearing ill—the patient dies.

Pending the result of the autopsy, the medical officer in charge would excusably explain such a clinical history by assigning the cause of death to either (a) septicæmia, (b) shock, or (c) heart failure. And if, in a rush of work overseas, there were no time for an autopsy, the rather vague alleged cause of death would never be analyzed or amplified. In any case, let us see if it will bear examination.

(a) *Septicæmia*.—Often the patient has died before there has been time to cultivate his blood for organisms, in which case the diagnosis is merely supposititious; or, if organisms have been found, and were the cause of a fatal systemic infection, this infection must have been very acute to cause death in about forty-eight hours.

Now, acute septicæmia is not characterized by a pulse and respiration rate which suddenly, and at an interval of an hour or less, changes from very slow to very fast, and *vice versa*; nor by a healthy normal colour and general appearance.

(b) *Shock*.—If so, to what was shock due? If to the injury, it may be asked why the patient was so well when first seen; we should be obliged vaguely to define the shock as “delayed.” If to the operation, it may be stated at once that this was neither extensive nor lengthy enough to cause shock. Moreover, no form of shock, delayed or otherwise, is consistent with the pulse and respiration changes; nor with the temperature, which, instead of being consistently low, steadily became irregularly high after about the first day.

(c) *Heart Failure*.—That this has occurred is clinically obvious; but the statement of the fact is not a scientific explanation of the cause of death. As I have just shown, there was nothing to warrant the opinion that either a blood infection or shock should cause the heart to fail. We must, then, look for another cause.

To this question post-mortem findings supply the answer. Whether there be found a macroscopic abscess in the pre-vertebral region or not, there will be definite signs of infection around the vagus. Since the pulse and respiration vacillated from slow to rapid, they allow no certain deduction as to whether this lesion was physiologically of an irritative or a paralytic nature. There was certainly a vagitis; and, since any concomitant pupil changes are more often a dilatation than a contraction, and this would indicate irritation of the sympathetic, it is probable that the vagus lesion also is of the irritative type.

The following cases illustrate this condition of vagitis:

CASE I.—Private A., admitted to No. — General Hospital, August, 1916, with a small clean incised wound, 1 inch in length, over the thyroid cartilage. Except for this the whole neck was normal, and remained so until death. Temperature was intermittent up to 101° F. The pulse and

respiration were irregular, the former averaging 100, the latter 18. Dyspnoea was present, but not extreme. Lungs and heart normal. Skiagrams were taken.

Second Day.—The pulse and respiration rose and fell so fitfully as to be difficult to chart. No note was made of the pupils at any time. Operation. (Second day.) A piece of shrapnel casing, 1 inch $\times$ $\frac{1}{4}$ inch, was easily removed from just above the left lobe of the thyroid gland, deep to the infrahyoid muscles, just below the cricoid level, at the point where the recurrent laryngeal nerve passes beneath the inferior pharyngeal constrictor.

A light wick of ribbon-gauze was inserted into the operation wound. Thereafter dyspnoea entirely ceased, but the pulse and respiration continued as before.

Third Day.—Pulse became thin and respirations shallow, ushering in death.

Autopsy.—The operation wound down to the oesophagus was found to be quite clean. In the prevertebral space there was a layer of purulent lymph, from the thyroid cartilage to vertebra D 2, involving both vagi.

CASE 2.—Private B., admitted August, 1916. A shrapnel bullet had entered behind the angle of the left jaw and lodged between the right outer antral wall and cheek, from where it was removed under local anæsthesia. The temperature was intermittent up to 102° F.

Pulse varied from 100 to 140, and respirations from 20 to 60. These changes in rate of pulse and breathing occurred with startling suddenness.

The entrance wound was directed inwards to the prevertebral region. This was dressed with a light wick of ribbon-gauze soaked in saline: it was considered that the patient's condition precluded exploration under a general anæsthetic.

From the second day onwards his left pupil was widely dilated to 12 mm., with no reaction to light. Lungs and heart were normal. He died on the fourth day.

Autopsy.—On the left side there was a thin layer of purulent lymph in the prevertebral region from the pharynx to vertebra D 3; the purulent exudation involved the left vagus and sympathetic. There was no macroscopic collection of pus.

CASE 3.—Private P., admitted April, 1917, with a clean-healing skin wound, $\frac{1}{2}$ inch long, in the mid-line over the thyro-hyoid space. There were no other signs of injury, and none of inflammation. Temperature was normal.

It was when his head was being turned to one side by the

radiographer in taking a skiagram that he first complained of dyspnœa.

The skiagram (Fig. 11) showed a foreign body as large as the little finger-nail, just to the left of the mid-line, opposite vertebra C 7, and 2 inches from a point on the skin surface 1 inch above the sternal end of the left clavicle.

Operation.—A probe would not pass along the track from the skin wound for more than 3 inches; it was, therefore, obvious that the foreign body (? shrapnel) could not be removed by opening up the track.

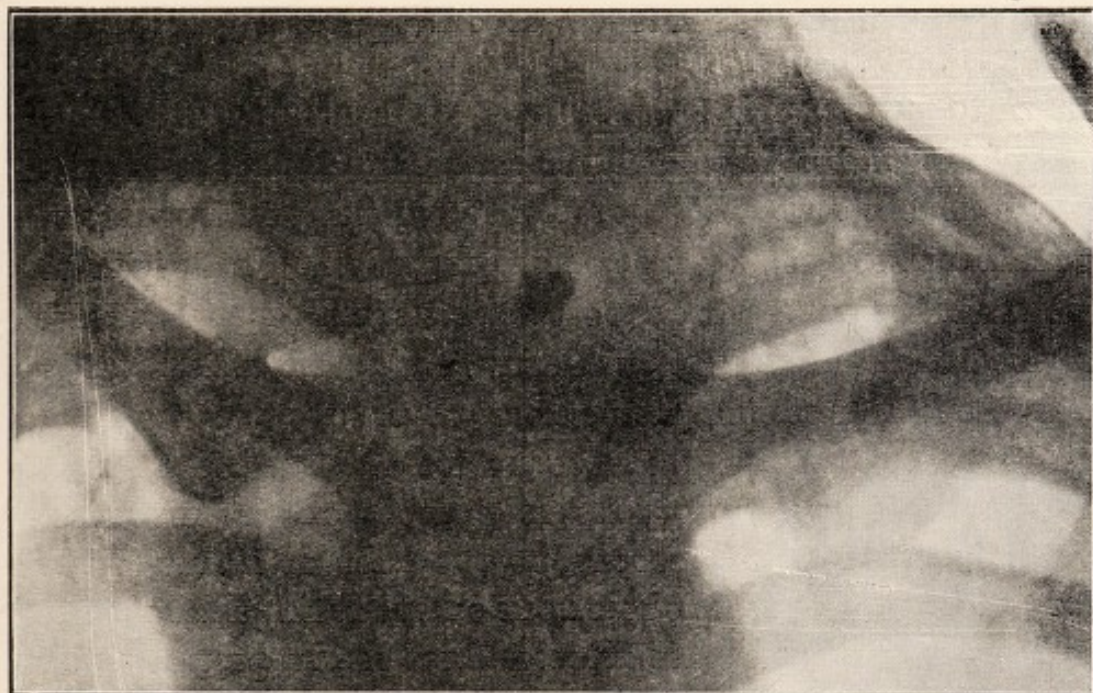


FIG. 11.—The entrance wound, over the thyro-hyoid space, was almost imperceptible, and the long track could not be followed. By a dissection low down in the anterior triangle the shrapnel was easily removed from the anterior surface of vertebra C 7. Thereby symptoms were completely relieved; but the patient developed a mediastinal abscess, and died on the fourth day after the operation.

A formal dissection was now made along the anterior edge of the left sterno-mastoid tendon. It was then clear that a probe passed along the original track took a course deep to the sterno-thyroid muscles, and there ceased abruptly.

The sterno-hyoids and sterno-thyroids were divided, and reflected sufficiently to pass a finger down to the vertebræ. Here a small piece of shrapnel was found, lying in a pool of turbid grey fluid, which welled up as fast as swabbed away. Subsequent staining with osmic acid and microscopical examination showed the fluid to be chyle. The thoracic duct was searched for, but not found. In case the œsophagus

should have been wounded as well as the thoracic duct an œsophageal tube was passed. The operation wound was drained by a tube, and the patient put to bed, head low, semi-prone on the left side. The operation occupied twenty minutes, was practically bloodless, and completely relieved the dyspnœa.

On the following day the patient gradually developed an irregular temperature and spasmodic rapidity of pulse and respiration. On the third day these attacks merged into a tachycardia, and rapidity of breathing (40), and the pupils became fixed (3 mm.). Heart and lung sounds were normal, but diminished.

There was no hiccough or other diaphragmatic derangement to suggest injury of the phrenic nerve.

His pulse became running. The wound remained clean, and his colour good. He showed no loss of flesh as the result of deprivation of chyle, possibly because the time was too short. He died on the fourth day.

Autopsy.—The wound, from skin surface to prevertebral fascia, was found to be absolutely clean.

On stripping the œsophagus from the spine a layer of purulent lymph was found from the level of the carotid bifurcation to vertebra D 2. This collection involved both vagi. For 6 inches of its length the left vagus was irregularly infiltrated, and thickened to $\frac{1}{4}$ inch. There was no trace of the thoracic duct higher than vertebra D 3. There was no wound of the œsophagus.

Another case illustrating vagitis is found in Case Private M., p. 61, in the section on the Larynx. The influence of a foreign body pressing on the vagus, apart from suppuration, is exemplified in Case Sergeant B., p. 27, in the section on Removal of Foreign Bodies.

The diagnosis of mediastinitis is suggested by the cases above recorded. The temperature does not help much; it is irregular, without rigors, and may reach 104° F. The most suggestive features are the spasmodic alternation of pulse and respiration rate. The variations are so sudden and extreme as to throw doubt on the accuracy of the charting. The respirations may change in a moment from 20 to 60, and in half an hour back again to 40. These variations in pulse and respiration, coupled with an alteration in the size or mobility of one or both pupils, form a symptom-

complex of vagitis with implication of the sympathetic. And from such a symptom-complex this diagnosis may be made in the presence of a deep wound, although small and healed or healing, anywhere in the neck; whether the pre-vertebral space had been obviously opened or not is immaterial.

There is another sign of mediastinal abscess: pain late in the act of swallowing. I have seen this once in civil practice, produced by a discrete abscess low down in the posterior mediastinum. This does not occur after wounds of the neck, because the patient dies before the suppuration has extended far enough.

Treatment.—This consists of good surgical drainage, and posture—that is, placing the patient in such a position that gravity assists in draining sepsis away from the thoracic inlet.

As regards surgical drainage, there is nothing to add to what is common knowledge to any surgeon of experience. As regards posture, there may perhaps be greater need for emphasis. In all these cases there is a more or less insistent orthopnoea, and it is difficult to persuade the patient to lie down at all. But the utmost perseverance should be used. The foot of the bed should be raised, the pillows removed, and the patient placed as far as possible semi-prone on the affected side.

Personally, it has for a long time past been my routine practice to place in this position any wounded man from the deeper parts of whose neck I have removed a foreign body.

There is one suggestion I would like to make: that, granted free drainage of the neck and posture are the essentials in treatment, these should be adopted at the earliest possible moment. And if dramatically sudden variations in rate of pulse and respiration, with pupil changes, be remembered as a syndrome, this syndrome should be watched for by the surgeon. For by recognizing it early he may be able to give the patient a better chance.

Lungs ; Pleura.—In operations on the upper air-passages in civil practice, with every opportunity for deliberate pre-operative care, septic pneumonia is the surgeon's bogey.

Despite the most careful correction of pyorrhœa, extraction of carious teeth-stumps, and other measures for the efficient toilette of the mouth for some days before operation, patients occasionally die in the most experienced hands from this dread complication.

Little wonder, then, that gross injuries to unprepared mouths should bring in their train a high percentage of inhalation infections of the lung. The treatment of these conditions falls, of course, mostly on the physician; but the surgeon has a responsible interest, in that lung complications prevent or postpone necessary surgical interference. On active military service, when a patient is admitted with a wound in the neck, pyrexia of some degree is either present or soon becomes manifest in a majority of cases.

The temperature may be due, firstly, to the wound or a retained foreign body; secondly, to the inhalation of septic infection into the lung; or, thirdly, to a combination of these two causes.

In the first case the surgeon may proceed undeterred; in the second, he hands over responsibility to the physician; it is the third class of case which is more common and always debatable. For here we are at once confronted by a dilemma. Shall we have the patient anæsthetized to open up the wound and remove the missile, incidentally running the risk of converting a mild bronchitis into a pneumonia, or of encouraging the spread of a very small patch of consolidation? Or shall we wait in the hope that the lung signs will soon abate, thereby risking all the evils which may result from delay in removing a foreign body or draining a deep wound?

This problem presented itself to me nearly, or quite, every day in France. Each case must, of course, be considered on its individual merits. The decision rests, not between the surgeon and physician alone, but concerns also the anæsthetist.

I have no intention of trespassing, in these observations, on the province of the anæsthetist. His science has made great strides during this war, and he alone is the expert. But we are imagining a consultation with him.

Granted that surgical intervention has been decided on, and is such that local anæsthesia is unsuitable. The salient features in the patient's condition are an acute bronchitis or a small patch of pneumonia, and a condition of lowered resistance; the latter is due partly to shock and exposure, and partly to increasing septic absorption from the wound.

The anæsthetist may consider that in his collapsed state the patient may die under chloroform. He would, as far

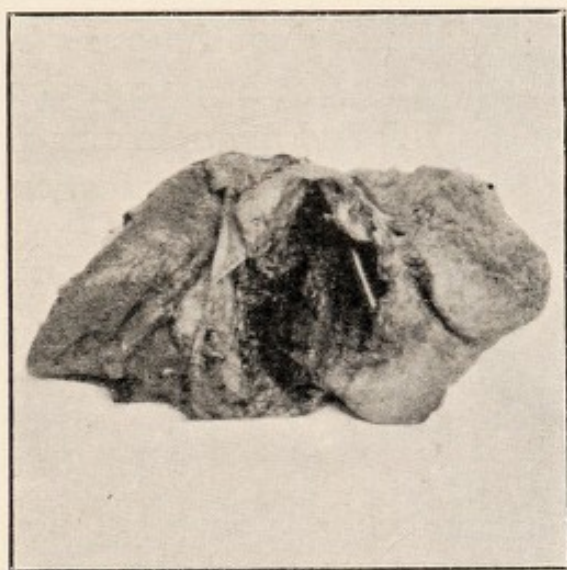


FIG. 12.—Gangrenous cavity in lung. Inhalation infection from a wound of jaw and mouth.

as the operation is concerned, prefer ether; but he does not like to give ether to a man who already has a bronchitis or pneumonia.

In these cases, which, as I have said, are extremely frequent, the anæsthetist usually decides on various mixtures of ether and chloroform. But it is worth recording that for a long time in France we found even this compromise too risky. At the period which I have in mind, and which covered many months, it was the rule rather than the exception for patients with jaw and face wounds to be "chesty" from the moment of admission; and a large proportion of these "chesty" cases showed physical signs of bronchitis or patchy broncho-pneumonia, either on admission or within forty-eight hours. Any existing physical

signs were aggravated by an admixture of ether with chloroform; and of those having no physical signs, many developed an ether bronchitis or pneumonia. So that, by common consent, we avoided ether entirely for patients wounded one or two days previously, and used pure chloroform, preferring the risk of an increase in the proportion of patients who collapse more or less under the anæsthetic to what seemed a much more certain risk of a lung infection. And we never regretted this decision.

I can give no figures in support of these remarks, which are made with all deference to the anæsthetists as being the final court of appeal. But my recollections on the subject are recent and vivid, and my opinion strong.

The extreme cases of virulent lung infections from wounds of the upper air-passages are practically hopeless and beyond treatment. Fig. 12 shows such a case, with a massive gangrene of the lower lobe. If a single large abscess is diagnosed by physical signs and puncture, one or more ribs should at once be resected. But more usually, as is shown by innumerable autopsies, there are multiple small abscesses. And the infection is obviously by inhalation, for these abscesses are peri-bronchial in situation. I have also seen bronchiectatic cavities as big as a walnut.

Pleurisy is fairly common after injuries of the neck, but may be just as common after other wounds, and may have no relation to the site of injury. I have seen one mild case of pleurisy at the right base anteriorly, seemingly as the immediate result of removing part of the eighth right costal cartilage for rhinoplasty.

The cases of pleurisy in my experience clear up quickly almost without exception. Only twice have I seen an empyema after neck-wounds. The condition was, of course, dealt with in the usual way.

CHAPTER III

THE PHARYNX AND ŒSOPHAGUS

The Pharynx.

THE points in the treatment of pharyngeal wounds which are evidently important in their early stages will be found under the sections on Hæmorrhage, the Removal of Foreign Bodies, Tracheotomy, and on Feeding in Cases of Fractured Mandible. The most troublesome after-results are buccal and salivary fistulæ, and various more or less grave disabilities resulting from a destruction of the lining mucosa of the mouth.

Buccal and Salivary Fistulæ.—To overcome these is not so formidable as would be supposed. If the fistula does not actually involve a salivary gland or its duct the closure of the opening in two layers, deep structures and skin, as described under Wounds of the Face, will usually succeed. Sometimes this proceeding fails the first time; but even so, it leaves a much narrower communication with the mouth than the original. And a second similar operation will then invariably succeed.

When the fistula actually connects with a gland or its duct the condition differs according to which salivary gland is involved.

The **sublingual gland** is frequently concerned: witness the large number of wounds which carry away the front of the mandible, as far as the bicusps on both sides, and sometimes the anterior third of the tongue as well. Yet I have never seen a case where a fistula in the sublingual region was not easily closed by the ordinary plastic operations on the soft tissues. The most reasonable explanation of this would be that the ducts of this gland are so numerous and so short

that a lesion sufficient to destroy all of them would also destroy the gland.

Fistulæ of the submaxillary gland are fairly frequent, but not difficult to cure. If such exist anywhere in the area of the gland or its duct the latter should be tied, and then the gland excised from both superficial and deep aspects of the mylo-hyoid.

A salivary fistula in the side of the neck may be due to communication with the submaxillary gland, even though the opening be situated too far back or too low down to accord with anatomical topography. This is only one of many instances of structures being displaced after gross fracture of the mandible or hyoid bone, or damage to neighbouring muscles. It is a point to be remembered, because, in such a case, if the fistula be traced the gland will probably be found.

As regards the **parotid gland and Stenson's duct**, intractable cases of fistulæ are much more rare than a reference to surgical textbooks would suggest. Abscesses from parotid wounds are also rare, which is, perhaps, the more remarkable when it is remembered that there are now many able-bodied men who carry with them bullets or shrapnel in the spheeno-maxillary fossa, or some other region difficult or dangerous of access, which bullets have traversed the parotid gland to reach their lodgment, and no attempt has been made to deal with any of the deep parts of the track.

When a wound certainly involves the parotid a short tube should be left from the gland into the mouth, and stitched to the mucosa for a few days, to encourage the formation of a factitious accessory duct; this, and external plastic closure in two layers, will usually succeed. I have never yet had to perform the complicated operations described for the cure of this condition.

On the whole, the prognosis as to surgical cure of buccal and salivary fistulæ is very good. This is fortunate, for their persistence interferes with or prevents bone-grafting of the mandible.

The destruction of the oral mucosa is a more serious matter, entailing physiological disability.

In the deeper parts of the mouth various lesions of the palate and fauces are met with. The number of miraculous escapes when, from the course taken, a bullet should inevitably have killed a man, is legion. And not the least remarkable are those in which a missile has passed out through the neck from some part of the back of the mouth, or *vice versa*.

In one case, a bullet entered behind the right mastoid and emerged from the left angle of the mouth. The right tonsil



FIG. 13.—A new upper lip was made by a curved incision (concavity downwards) into the cheek, beginning at the upper margin of the gap on either side. The two flaps were then rotated downwards and forwards to meet each other.

was hanging by a thin pedicle at its upper pole, but otherwise was cleanly enucleated. The man made an uneventful recovery, leaving us to wonder what happened to his internal carotid and jugular bulb.

In the later treatment of injuries in this region, the faucial pillars may be perforated or adherent, and may require excision.

Small clefts in the soft or hard palate may be dealt with

surgically; very large gaps in the hard palate are best closed with an obturator, which must be easily removable for cleaning. Adhesions of the velum to the posterior pharyngeal wall must be divided; this may be done under local anæsthesia. To prevent the otherwise inevitable reforming of these adhesions a vulcanite prosthesis, kept oiled, and taking its attachment from the teeth, must be temporarily worn between velum and pharyngeal wall. To close a large gap in the soft palate there are false vela made of several segments



FIG. 14.—The appliance (see p. 45) was intended to obliterate the two curved sulci in the cheeks.

working on lobster-tail or ball-and-socket joints. These are extremely ingenious as mechanical devices, and although I have personally never seen a good result from their employment, some French prosthesisists speak highly of them.

In the anterior buccal part of the mouth the remote results of destroying mucosa are adhesion of the cheek to the maxilla, narrowing of the upper or lower gingivo-labial sulcus, and tongue-tie.

It should be said at once that these sequelæ are not curable by prosthetic methods.

Fig. 13 shows a man whose premaxilla and upper lip had been entirely destroyed. Having completed the first stage of plastic restoration, I found he was left with a deep sulcus in each cheek, curving downwards from the alæ nasi. Fig. 14 shows him with an appliance supporting two vulcanite plates between antral wall and cheek; the plates, of course are not visible. These were destined partly to obliterate the external sulcus, which they did, as seen in Fig. 15. But it was hoped that the cheek, thus lifted out, would remain

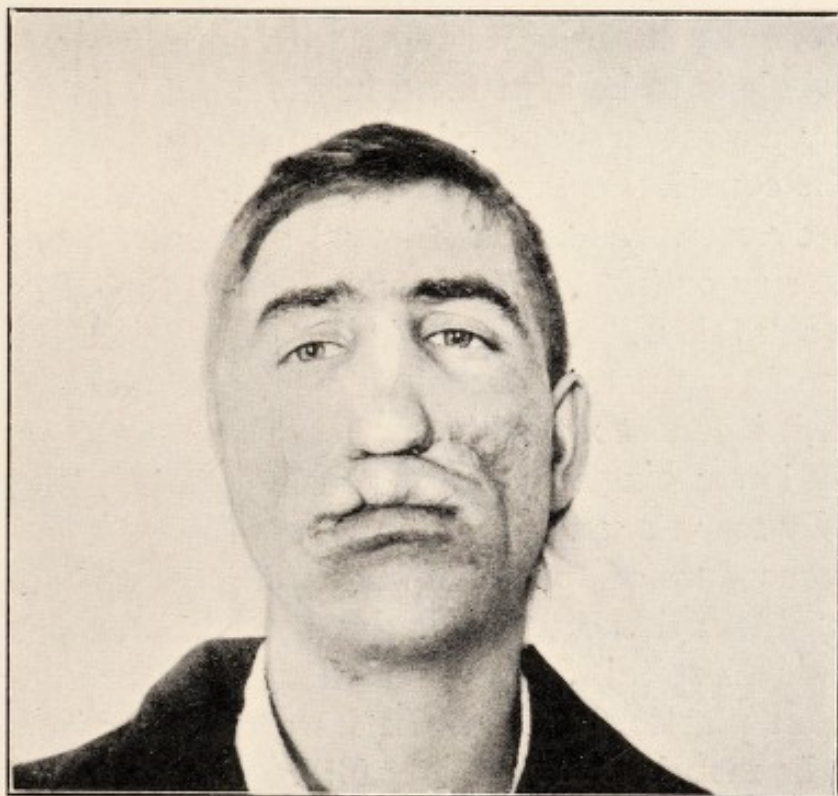


FIG. 15.—The prosthesis has succeeded in partly obliterating the sulci, especially on the right. But the cheeks formed fresh adhesions to the antral walls.

so. But a long time after the removal of the vulcanite plates, the deep scar-tissue between the cheek and the antrum began to contract slowly and continuously; so that the sulcus, although not nearly so obvious as before, returned in part, producing a slightly prognathous appearance. The correct procedure, which I now employ, would have been to insert an "epithelial inlay" beneath the cheek before I re-formed his upper lip.

The following is an epitome of the principles underlying

this method: If any skin or mucous surface be narrowed in any diameter, it may be incised transversely to this diameter to the desired extent. A Thiersch graft, wrapped around a piece of moulded "Stent"* or shaped vulcanite, raw surface outwards, is now placed in the depth of the incision, so as to cover the raw surface completely. The size of the supporting core of Stent and the area of Thiersch graft will vary with the depth of incision made—that is, with the additional area of skin or mucosa required.

The graft should be stretched fairly tightly over the supporting core by suturing its edges with horsehair.

The whole is to be kept fixed in the depth of the incision either by a prosthesis attached to a denture (Fig. 86), or it may be completely buried by sewing the raw edges of the incision over it. After an interval of from four to seven days the supporting core is removed, and in most cases the graft has "taken." This method may be applied to the junction of tongue and buccal floor for tongue-tie. But in the mouth its most valuable application is in deepening an upper or lower gingivo-labial sulcus which has been made shallow by scar tissue.

This procedure of epithelial inlays, for the elaboration of which credit in this country is due to the heads of sections at Queen's Hospital, Sidcup, constitutes a most important advance in plastic surgery. In its application to shallow sulci in the mouth it may revolutionize the science of fitting dentures after a loss of part of the alveolar margin.

The Œsophagus.

Injuries of the œsophagus are among the most formidable problems with which a surgeon may be faced. They are not so urgent as laryngeal wounds, for the obvious reason that breathing is a more immediate necessity than feeding. But when, for instance, as frequently happens, both larynx and œsophagus have been injured, and the immediate contingencies provided for—that is, when tracheotomy has been

* The chief components of Stent's composition are kouri gum, stearin, and French chalk.

performed and an œsophageal tube passed—the œsophagus becomes thenceforth the outstanding source of anxiety to the surgeon. It is, compared to the larynx, difficult of surgical access. The fluids which leak from it escape into deeper planes, are more copious, and more septic.

By reason of its depth there is a greater probability that other important structures—vessels, nerves, or the thoracic duct—will in the course of the case show evidence of injury.

For the purpose of reparative treatment, surgical observations on œsophageal wounds necessarily apply chiefly to the cervical gullet. The œsophagus below the thoracic inlet is, of course, accessible by endoscopic methods. But the heroic transpleural route has few, if any, applications in war surgery; the patient would usually be dead either before the operation was undertaken, or as its immediate result.

Feeding.—A counsel of perfection would be that from the moment a man receives a perforating wound of his gullet no food or drink of any kind should be allowed to pass over the wound. The gravity of sepsis leaking through into the neck increases from above downwards; but even above the œsophagus, for the hypopharynx (post-arytenoid and post-cricoid regions), this would be a good rule. A tube should be passed at the earliest possible moment, and fluid food given. This may be temporarily impossible even through the nose, owing to swelling of the parts or because the tube catches on the edge of the wound, and, an œsophagoscope not being available, the feeding tube cannot be passed under direct vision. Dextrosed rectal feeds and subcutaneous saline should then be given until surgical repair can be undertaken.

Apart from the necessity of feeding the patient, there is another reason for the early passage of a tube. The œdema of pharynx, tongue, and neck may, after a few hours, make this impossible. The following case illustrates this:

Private M., wounded by shrapnel November 1st, 1914, admitted to No. — General Hospital, November 3rd, with a gaping wound in the thyro-hyoid region. The epiglottis was severed from its root. Epiglottis, tongue, and remains of the hyoid were displaced upwards and the larynx down-

wards. The œdema was such that in doing high tracheotomy the trachea was found 2 inches deep from the skin. This œdema absolutely prevented the passage of an œsophageal tube through either the mouth or nose.

It was decided to perform gastrostomy on the next day, when the patient had had a rest. At the moment he was given saline rectal infusions. Next day, however, the œdema was less, and on November 5th the œsophageal tube could be passed. He was eventually sent home for laryngeal intubation.

In this case the patient narrowly escaped gastrostomy; whereas, if a tube had been passed soon after his injury there would have been no question of this operation.

Gastrostomy should, indeed, but rarely be required for wounds of the neck. In the case of severe wounds with such gross laceration of the œsophageal wall that the tube cannot be passed without serious risk of making a false passage which would extend the rent, the external wound may be enlarged, and a tube passed through it and sewn to the skin of the neck. During the following days the wound is to be cleaned up, and time allowed for protective granulations to form a barrier in the fascial planes of the neck, after which the œsophagus may safely be exposed and repaired.

In other cases the tube may be passed from the mouth and piloted past the rent by a finger in the wound, whose edges are meanwhile retracted widely, so that the tube end may be guided under direct vision. This plan, and the one above mentioned of feeding through the neck, I have used with success on various occasions.

If a tube can be passed from the mouth or nose without risk of danger it is better to pass it anew for every feed. The alternative course of fixing it in the gullet generally fails, whatever means be adopted to hold it there. The tube slips out while the patient sleeps, or he pulls it out.

On the other hand, if the introduction of the tube is very painful, or so hazardous that it requires direct endoscopy or an anæsthetic to avoid tearing the gullet, every effort must be made to retain it, and a special nurse or orderly should watch it constantly.

In œsophageal wounds drainage must be not only free, but prolonged in time. No attempt should be made to close the wound in the neck until at least two weeks after the œsophagus has been firmly healed.

In tracheo-œsophageal fistulæ the patient should breathe through a tracheotomy tube, and be fed through a rubber tube, until protective granulations have quite sealed off the site from surrounding areas. Then, and then only, will plastic repair be undertaken through a wide incision giving a good exposure. For large fistulæ, or large losses of œsophageal wall, a flap of skin (previously depilated by X rays if hairy) should be used to fill in the gap, in the same way as is done after pharyngeal operations for carcinoma.

When it is necessary to open the cervical œsophagus the classical method of approach by the anterior triangle is usually adopted.

For some time before the war I had considered it wiser to select the posterior triangle of the neck for œsophagotomy. I had used this route on several occasions, and have adopted it in the only two cases which have come to me in the war. One of these cases I shall recount almost immediately; the other will be described in speaking of œsophagoscopy.

The anatomical obstacles to a deep dissection in the anterior triangle become progressively more formidable as we pass down the neck towards the clavicle; from the level of the thyroid isthmus downwards the hindrances multiply. The sternal and part of the clavicular heads of the sternomastoid have to be divided and the thyroid lobe retracted. Before the œsophagus is exposed the carotid sheath, recurrent laryngeal nerve, and perhaps the vertebral artery must be avoided. And when the gullet is reached, it is so deep that a good exposure of a reasonable length is most difficult.

Meanwhile, owing to the necessary retraction of the trachea and rotation of the head, the patient is probably dyspnœic and slightly blue, and the anæsthetist is seriously hampered. To obviate this a laryngotomy tube is of little use, being above the situation of the torsion and compression of the trachea; and if a tracheotomy tube be inserted, it

is difficult to retain it while the trachea is twisted and dragged on, and awkward for the surgeon to avoid touching the tube in operating.

The difficulty of anæsthesia is only partly overcome by giving intratracheal ether through an intratracheal tube, because the rotation of the head and traction on the trachea still embarrass the patient.

By comparison with these difficulties ample access in the posterior triangle is simple.

The incision is made along the posterior border of the sterno-mastoid on to the anterior clavicular surface. The thin clavicular head of the muscle may be transversely divided. In proceeding with the dissection the cutaneous branches of the cervical plexus will be cut, a matter of no great moment. The spinal accessory nerve must be identified and gently retracted upwards and backwards. The suprascapular and transversalis colli veins are usually plexiform, and must either be retracted downwards or, more rarely, divided between ligatures.

A wide retractor is now inserted behind the sterno-mastoid to pull it forwards; and with the muscle the carotid sheath and prevertebral fascia are dragged forwards *en masse*. This fascia is incised and then split by blunt dissection. Another layer of fascia is now encountered, and may be mistaken for the œsophageal wall. Having incised this last fascial layer, the hypopharynx, posterior (dorsal) part of the larynx, and œsophagus are beautifully exposed.

On each side of the line in which the œsophagus is to be longitudinally incised a row of from two to four silk guiding sutures is passed through the muscular coat; the rows are $\frac{1}{2}$ inch apart.

The œsophagus is lifted up by these sutures, and opened. When intra-œsophageal manœuvres are complete the opening in the gullet is sewn up, and the outer wound left widely open and daily packed. Before closing the œsophagus a rubber tube is passed from the mouth by an assistant, for feeding. Very little rotation of the head or traction on the trachea is necessary, and intratracheal ether works admirably.

I have had it given through a No. 12 urethral catheter (from which the distal end had been cut off), attached by a 4-foot rubber tube to a muslin-covered glass funnel, on which the ether was dropped. Or, if available, the motor apparatus may be used.

But in both my war cases the anæsthetic was given on an ordinary mask. In any case, preliminary laryngotomy or tracheotomy is unnecessary. An additional advantage is that the remaining scar is almost, if not entirely, hidden by ordinary clothing.

The following remarkable case was dealt with in the way I have outlined:*

Gunner S., in October, 1914, while drinking the gravy out of a tin of bully beef, swallowed the "solder-plate." This is a circular piece of tinned iron, rather larger than a half-crown, which is used to seal off the beef-tin, and it was lying loose in the gravy. He did not come under my charge until eight days later. The skiagram showed, impacted opposite the first dorsal vertebra, the foreign body (Fig. 16). Its shape appears to be irregular, not circular; this is because, as was discovered later, it was bent and jagged at the edges.

Operation.—The patient's peace-time vocation was playing the oboe in a professional band, and for this reason he especially asked that tracheotomy should be avoided. The anæsthetic was therefore given on an ordinary mask, and the foreign body removed, as above described, through the left posterior triangle. It had moved down 1 inch lower than appeared in the skiagram. The dissection occupied only half an hour; but the œsophageal mucosa was so folded around the jagged edges of the metal that its extraction occupied another hour. When this was complete, an œsophageal tube was passed. The patient later learnt to pass this for himself.

The œsophageal opening was closed. The external wound was repacked every day. At the operation the cervical sympathetic cord and its middle ganglion were clearly exposed; and at the dressings the left pupil was seen to dilate. Recovery was uneventful.

* This case was reported in "Injuries of the Nose and Throat," p. 141, Oxford War Primers. (Oxford University Press.)

When this patient was exhibited at the Royal Society of Medicine, in February, 1915, wearing ordinary civilian clothes, the operation scar was not noticeable.*

In all penetrating wounds of the œsophagus it must be remembered that there is a great likelihood that other deep structures in the neck have been injured or divided. The great vessels may bleed, or later form arterio-venous ancu-

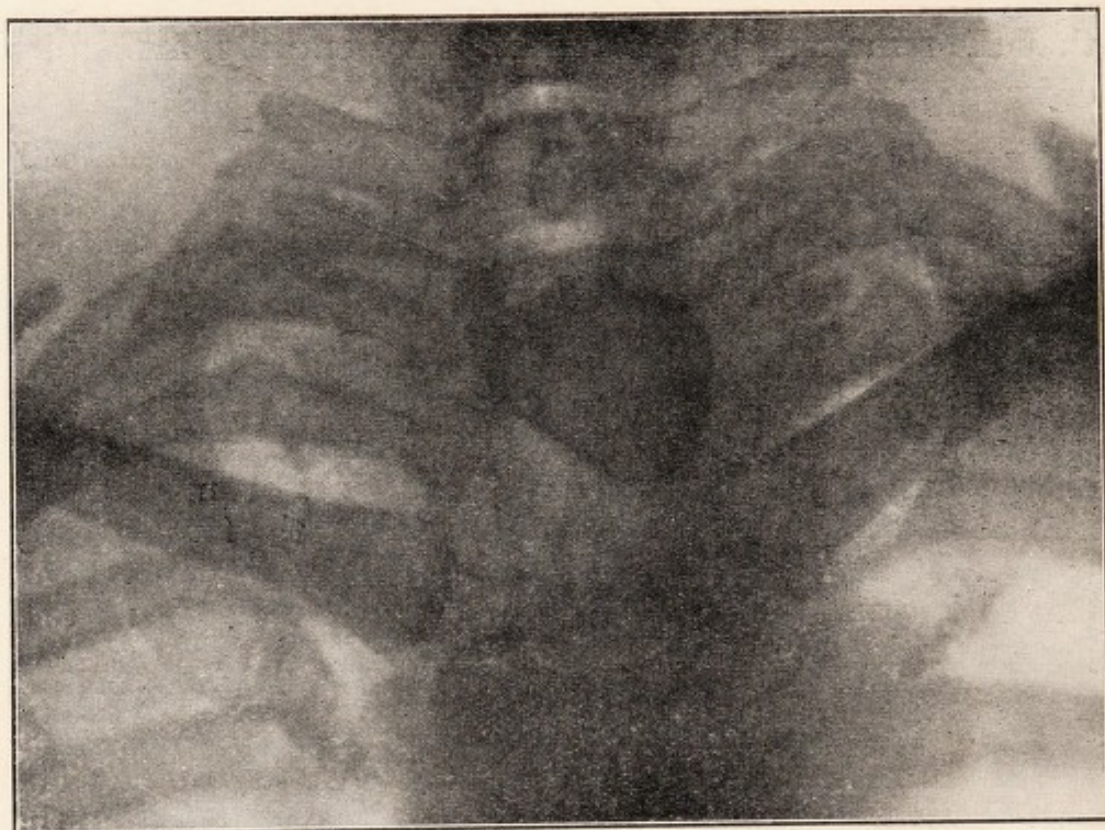


FIG. 16.—A bent and jagged circular piece of tin, slightly larger than a half-crown; removed, by œsophagotomy in the posterior triangle of the neck, nine days after it was swallowed. The anæsthetic was given on an ordinary mask, and no laryngotomy or tracheotomy was required. Uneventful recovery.

(Reproduced from the "Oxford War Primers," by kind permission of the Oxford University Press, and Dr. Dundas Grant, with whom I then collaborated.)

rysms. The vagus, recurrent laryngeal, or sympathetic nerves may suffer. On the left side division of the thoracic duct is likely to end fatally, because, owing to the bruising and laceration of the parts, this structure is difficult to find and suture. Case Private P., p. 34, is an example of this.

As regards the thoracic œsophagus, access across the chest

* Proc. Roy. Soc. Med., February 5th and March 5th, 1915.

cavity is hardly a justifiable procedure. Œsophagoscopy helps in diagnosis, but gastrostomy is the only practicable treatment.

Endoscopy.—Endoscopy is at times of the greatest value in war surgery. In dealing with the localization and removal of shrapnel I quoted a case (p. 25) where it is reasonable to surmise that the patient's life might have been saved by timely instead of tardy bronchoscopy. Even when a negative result is obtained, the negative evidence—that is, the exclusion of the air-passages or œsophagus—is of the greatest value in localizing foreign bodies in the neck or thorax. I have been able to send back forthwith to the line a man who, with an inability to swallow solids and a constant retro-sternal pain, persistently declared that a mutton knuckle-bone had stuck in his gullet. The gullet was empty and normal. An œsophagoscopic tube is very useful for passing a feeding tube under direct vision past a wound of the œsophagus. When a man who has been wearing a tracheotomy tube for a long period, and has had it removed, comes before a Medical Board for disposal, it would assist the Board in assessing him if they had a definite report (derived from endoscopic examination) on his larynx and trachea.

Here, again, the direct method would be of value.

In fact, it is remarkable that a complete endoscopic outfit is not included in the instrumentarium of a Base hospital.

In this connection the following case is of interest:

Private G. swallowed his tooth-plate on August 15th, 1917. On August 17th, at 8 p.m., I was telephoned for to go and see him; but, since he was a hundred miles away, I did not arrive there until 9 a.m. on August 18th. The skiagram showed, opposite the fifth dorsal vertebra, a complete upper denture with four hooks, two of which projected well to the left of the spine.

Through an œsophagoscopic tube it was easy to seize the mass; but by lateral pressure of the tube it was clear that the two hooks on the left were lying in the pleural cavity. With each respiration air bubbled into the œsophagus around the denture. The latter could not be dislodged, and my outfit did not include any forceps to cut it in half.

I proceeded to open the œsophagus in the posterior triangle of the neck. The tooth-plate, being now nearer, was still easier to seize, and could be rotated so that the four hooks pointed up and down instead of laterally. Even so I could not pull it up. But it was easy to push it towards the stomach, keeping the hooks pointing up and down. I guided it down to the cardia, while Colonel Pilcher performed gastrostomy and gave a feed of milk into the stomach. The patient's general condition had now become so poor, and the cardia of the stomach was so spastic, that it was decided to leave him until next day. The intention was then to perform retrograde stretching of the cardia and extract the denture through the gastrostomy wound. But thirty hours later the patient died.

Autopsy.—At the original site of lodgment there was a perforation into the left pleura, and a pyo-hæmo-pneumothorax.

CHAPTER IV

THE LARYNX

FOR many days, sometimes weeks, after the infliction of a gunshot wound on the larynx detailed endolaryngeal examination is impossible.

On the finer points, as to movements of cords, fixation of arytenoid joints, no man, as a rule, can give an opinion of any value.

Even in the rare exceptions when an asymmetry of position, size, or movement of endolaryngeal structures or movements can be demonstrated, it will often be impossible to assign the result definitely to a lesion either of the nerves (vagus, superior, or inferior laryngeal) or of the intrinsic laryngeal muscles. And since no prognosis or treatment can be adopted for the voice until this point is settled, the laryngologist may ask himself what he can do to help the patient meanwhile. He can do something, as will be clear if we realize what are the very factors which determine the difficulty to which I have just referred in diagnosing and treating the lesions of the endolaryngeal structures.

Let us take these factors separately. First of all, there is the intolerance of the patient, who has been subjected to the nerve-racking ordeal of being under fire, and, moreover, has usually various abrasions in the parts all around the larynx, so that the use of a laryngeal mirror, tongue depressor, or tongue cloth, may be quite painful. The use of cocaine may help; and, as in civil practice, it will often be found that at a second or third attempt, at intervals of about two days, a relative success will be obtained. But only a relative success. Whether the parts become less intolerant or not, the cords and subglottic space will certainly, for many days,

probably some weeks, be largely obscured by thickening of the false cords and boggy swelling of the aryepiglottic folds and of the mucosa lining the sinus pyriformis on either side.

Secondly, fracture of the mandible or hyoid bone, or both. These injuries, and to a less extent damage to the muscles attached to them, greatly augment the difficulties of a satisfactory laryngoscopy. In a simple fracture of the jaw there may be no pain on opening the mouth; but the firm depression of the tongue by a tongue depressor, or tension on it with a tongue cloth, which acts on the jaw indirectly through the genio-glossi and genio-hyoglossi, may be very painful. In the more extensive compound comminuted fractures often produced by gunshot wounds, the difficulty is still greater, and temporarily insurmountable. The tongue, unsupported, falls back, retroverting the epiglottis over the laryngeal inlet. Or, if the forepart of the tongue sag downwards and forwards out of the mouth across a smashed symphysis, the root of the epiglottis comes forward with it, while the sides and tip of the epiglottis are held back by the aryepiglottic folds—the result here, again, being that the epiglottis is retroverted over the larynx. Moreover, the supports of the laryngeal box are damaged. The supra-hyoid muscles and the thyro-hyoid normally sling up the front of the thyroid cartilage. When any of these, or the hyoid bone or jaw, are grossly damaged, the larynx sinks, not only by gravity, but by the now unopposed action of the infrahyoid muscles.

It may be said, then, that the diagnostic value of laryngoscopy is largely discounted, after recent neck wounds, by two factors over which the laryngologist has no control—intolerance, general and local, and the displacement of parts due to the action of gravity and unopposed muscular action on the mandible, hyoid bone, thyroid cartilage, and tongue. The same complications handicap us in direct laryngoscopy, to which I shall refer later.

But besides these two complicating factors there is a third, which arises chiefly out of the damage to soft parts

and bone, a complication which not only makes a decision as to the laryngeal condition difficult, but which, at the same time, it is the laryngologist's duty to control promptly—I refer to laryngeal œdema.

Laryngeal œdema is, like hæmorrhage, septic pneumonia, and mediastinal abscess, a bugbear of wounds of the neck. It may show itself any time after the infliction of the wound, being most usual on the second or third day. The rapidity of onset, severity of course, and duration vary with the situation and depth of the wound, with the degree of infection and dirt carried in by the bullet or shrapnel, and with the promptness with which this is removed. It is often aggravated by the inhalation of general anæsthetics, especially ether. It may be of slight degree and slow onset—so mild that it is only discovered many days after the infliction of the wound, and then only because huskiness of voice directs attention to the glottis. In such cases, not at all infrequent, the infiltration is enough only slightly to narrow the glottic chink and mask the outline of the arytenoids and false cords. These patients are treated for subacute or chronic laryngitis, but their larynx only becomes normal many weeks after their evacuation to England.

The severer degrees have all the characters of acute laryngeal œdema. The diagnosis, for reasons already given, may have to be made without laryngoscopy. Even in small insignificant wounds of an otherwise healthy looking throat the condition is, of course, easily recognized by the loss of voice, dyspnœa, and mental distress of the patient. In a larger wound, with or without a brawny angina of the neck, the state of affairs is still more obvious. In all except the mild cases simulating ordinary subacute laryngitis the treatment will be more or less urgent. The larynx is not accessible for internal medication, scarification, or cautery; and in the continued presence of an infective focus it is doubtful if these would do any good. From the moment that a case of a wound in the neck is admitted to hospital, tracheotomy and laryngotomy instruments should be ready to hand for that patient.

In cases where, judging by external signs and symptoms, or more rarely by the laryngoscopic image, the œdema is of mild degree and not rapidly increasing, ice may be tried. This should not only be sucked, but also placed on the neck; the most convenient method of application is a mackintosh bag.

As a rough generalization I have found that œdema coming on immediately after the wound, say in the first forty-eight hours, is less serious than if it appears later; less serious in that it is more likely to subside quickly, and so attempts to tide over the critical period by the use of ice, and the avoidance of tracheotomy, are more likely to be successful. The later onset of œdema is more usual when a foreign body has for some reason been left in the neck; and with this later onset the œdema of the laryngeal mucosa is accompanied by an external brawny cutaneous œdema more often than is the early type. As an adjuvant to the use of ice, hypodermic injections of atropine sulphate, gr. $\frac{1}{100}$, repeated cautiously in four hours if the pulse has not been much accelerated by the first injection, are useful.

If the patient's distress after the adoption of ice treatment still increases, if after a few hours it does not sensibly diminish, if for any reason whatever the surgeon is not satisfied that the treatment by cold is going to suffice, it is better to open the air-passages at once. It cannot be too strongly emphasized that this latter course is preferable in any case of doubt. The operation is performed deliberately in daylight, with all necessary equipment ready, with the surgeon and nurses not fagged out, with the advantages of local anæsthesia, and, above all, on a patient whose dyspnœa and mental distress is as yet by no means alarming.

Whereas, if a wavering decision has been given against operation, and this has, nevertheless, to be undertaken a few hours later as an emergency, the conditions are very different. The preparations involve either delay in getting ready for the operation or, what is worse, haste in its actual performance. The surgeon is tired out, probably having been called from bed; there is no time for deliberate and

careful local anæsthesia; and by now the patient, who for several hours has been kept awake by increasing dyspnœa, is in a state of dire apprehension.

There is no doubt that it is often very difficult to decide whether to open the air-passages or not. This is one of the questions in which the judgment and special training of the laryngologist, if he has obtained even an incomplete view of the larynx, gives him an advantage over the general surgeon. On the whole, I have been surprised, whether in the field, at the overseas Base, or in England, at the small number of tracheotomies and laryngotomies performed. It is not possible to ascertain statistically whether mortality would have been reduced by more frequent operation. But the converse criticism—that is to say, that these operations are adopted more often than necessary—is not admissible. I have heard it said, when a man is admitted to a Base hospital overseas wearing a tracheotomy tube for which there is on his arrival no necessity, that the operation in this case was superfluous. The obvious answer is, that in a rush of work at the front a surgeon needs must take rapid decisions; that although to insert a breathing tube unnecessarily in ninety-nine out of a hundred cases would be a pity, nevertheless, to lose one case in a hundred through omitting to insert a tube would be a tragedy; and, above all, that the man who was in charge of the case at the moment when the tube was inserted is the only judge as to its necessity, and of his judgment at that moment no criticism is valid or justifiable.

Operation.—As regards the technique of opening the air-passages, the only special remark I would make is that local anæsthesia is eminently desirable. The reasons are the same as those which I have given when referring to lung infections. Intradermic infiltration with 2 per cent. novocain is sufficient for laryngotomy. For tracheotomy, a minimal amount will also be required for the deeper structures. Injection of the anæsthetic into the tracheal mucosa, as is done in a tracheotomy preliminary to a set laryngeal or pharyngeal operation, is not necessary nor even desirable for traumatic laryngeal œdema. For in the former case we wish to abolish

cough; in the latter, cough is useful, since the patient more often than not has an accumulation of bronchial mucus which, owing to the glottic stenosis, he has been unable to eject.

Choice of Operation.—Since the provision of an artificial airway holds such an important place in the treatment of laryngeal œdema (and, as has been mentioned, in the treatment of or prophylaxis against other complications of head and neck injuries, such as septic infection of the lung), it is necessary to have a clear idea as to which part of the passage to open, and why.

The essentials are that the operation should be reasonably easy of rapid performance; that it should effectually combat the dangers of the œdema, and even allow for a possible slight downward spread of the latter; that it should add the minimum possible of immediate additional risks to the patient; and that allowance must be made for the tube having to be retained much longer than is anticipated at the time of its introduction.

If we consider from the point of view of their suitability in the treatment of neck wounds the several stereotyped textbook operations for opening the air-passages, we shall see that subhyoid pharyngotomy has no place, as being on the wrong side of the usual site of threatened or existing danger.

Occasionally a missile has performed a sort of laryngofissure by destroying part of the thyroid crest. In such cases an artificial airway will be necessary to avoid hæmorrhage into the trachea, and also if the surgeon wishes to explore the cavity of the larynx. Instead of making a separate tracheotomy wound, he may then with advantage prolong the fissure in the thyroid cartilage downwards through thyro-hyoid membrane and cricoid. The advantages will be that he avoids initiating the new septic focus which would be provided by a tracheotomy wound, and he simultaneously obtains freer access above, because he can separate the thyroid alæ more widely. The following case illustrates my meaning:

Private M. (Fig. 17), admitted to No. — General Hospital, France, October 5th, 1917, with an entrance wound just below the left great cornu of the hyoid bone. There was no exit wound. The pomum Adami was fractured.

A probe could not be passed more than $\frac{1}{4}$ inch.

The skiagram showed a piece of shrapnel about $\frac{1}{4}$ inch in every dimension, opposite the junction of the body and transverse process of vertebra C 3, on the right side.

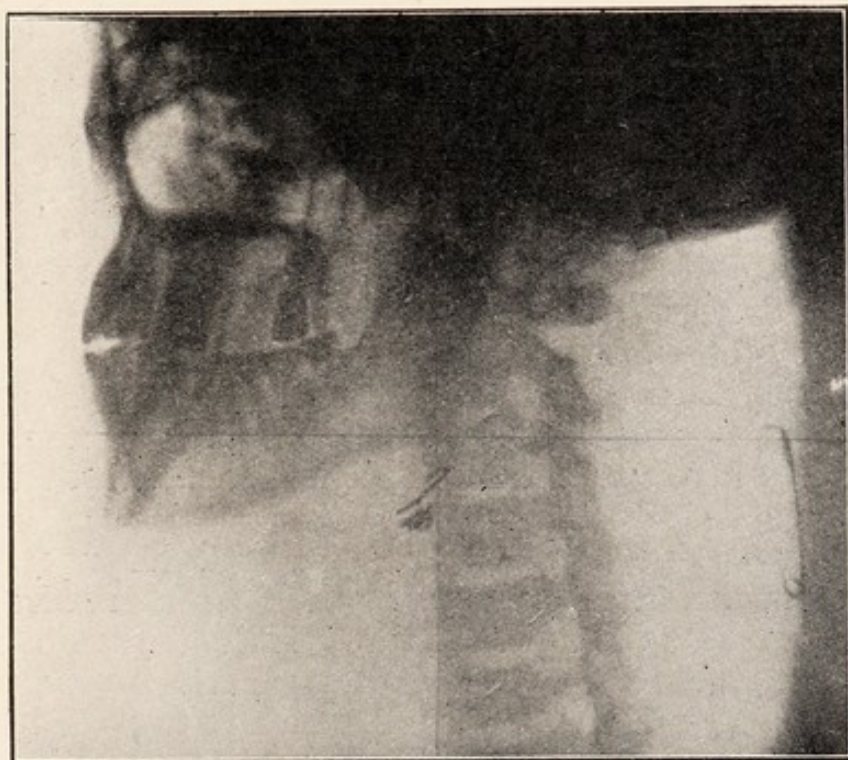


FIG. 17.—Shrapnel wound of larynx. The metal hook, lying on the neck, was used by the radiographer for localization.

The voice was strong. There was no dyspnœa or dysphagia. Temperature, 100° ; pulse, 90; respiration, 24. Extremely restless.

October 10th.—The patient lost half a pint of blood from the mouth, and I was asked to see him.

October 11th.—Operation. High tracheotomy under local anæsthesia. Chloroform and ether was now given through the tracheotomy tube.

Thyro-fissure was now performed, and a gauze plug packed down on to the top of the tracheotomy tube.

Through the widely retracted alæ of the thyroid cartilage the parts could now be carefully inspected.

The shrapnel had entered just above the pomum Adami on the left side, passing through the thyro-hyoid membrane.

It then grazed the right arytenoid, and lodged deeply in vertebra C 3, at the junction of the body and transverse process. From here I levered it out; there was smart venous bleeding (? from vertebral vein), controlled by pressure.

The plug was now removed from above the tracheotomy tube, and an œsophageal tube passed.

The thyroid cartilage was left widely open and ribbon-gauze plugged on to the bleeding-point in the vertebra. In the evening he tore the dressing out of his larynx, and refused to have it replaced; but there was no more bleeding.

October 12th.—Dressed. Temperature, 100° ; pulse, 28.

October 13th.—Temperature, 100° ; pulse, 120; respiration, 36. Restless, dressed under light chloroform anæsthesia.

October 14th.—Respirations changed from 30 to 48 several times. Dressed.

Midnight.—Colour became ashy. Temperature, 100° ; pulse, 140; respiration, 50.

October 15th.—Died at 4 a.m.

Autopsy.—Post-pharyngeal gangrene, and sloughs in prevertebral space; confined to mid-line except in one place, where they involved the right vagus for 1 inch at thoracic inlet.

Commentary.—I would have preferred laryngotomy to tracheotomy in this case, so that the opening might simply have been prolonged upwards through the thyroid cartilage. But it was uncertain how far down the wounded area extended, and whether a laryngotomy tube would be well below the bleeding site, so a tube was inserted below the cricoid.

Although no note was made of the pupils, this case exemplifies most of the points dealt with under Mediastinitis.

Except when the laryngeal box has been directly injured, the cricoid cartilage is not divided unless by accident when the operator carries his tracheotomy incision too high.

Median or transthyroid tracheotomy, in which the isthmus of the thyroid gland is deliberately divided and its two lobes held aside, has no place as an orthodox procedure in opening the air-passages for laryngeal œdema. It may be required for the removal of a foreign body deep in the supraclavicular triangle, between œsophagus and trachea.

Low tracheotomy seems to offer one tempting advantage: if the œdema affects the submaxillary and infrahyoid areas

of skin, of the type of a Ludwig's angina, and relieving incisions require to be made in these regions, the breathing tube is inserted at the maximum possible distance from the upper septic area. But, as against this, it is to be remembered that, should sepsis spread in the facial planes of the neck, a low tracheotomy wound assists the infective spread by opening the tissues in the very region where this spread is most dangerous—the thoracic inlet. Moreover, in any necks other than the long, thin type, low tracheotomy is not so easy of rapid performance as any of the other procedures under consideration.

By a process of elimination, we have now arrived at two operations as being desirable in the treatment of laryngeal œdema—and, indeed, the only two operations universally suitable in wounds of the neck. These two are laryngotomy and high tracheotomy. And, with the reservation that if the air-passages are in any part shot away or opened a tube must be inserted at the most convenient site, these two are the operations of choice.

Of the two, laryngotomy is the easier and more rapidly done, and at the outset would seem to fulfil all the essentials as above laid down (p. 60). But on consideration it may fail to satisfy certain of these. Firstly, if the tube has to be retained longer than was originally expected, a laryngotomy tube has disadvantages. Whatever the indications for laryngotomy in civil or military practice, there is one definite limitation: the tube must not be retained for a long time. When used in civil practice as a preliminary to operations on the pharynx its residence is measured by hours. When used in an emergency it should never be left in for more than two days, or a most intractable subglottic laryngeal stenosis is likely to result.

Now, in warfare the total residence of the tube in the neck is often impossible of prediction. If there be deep septic wounds, or a foreign body embedded, it may be many days. Secondly, of the œdema spread downwards a laryngotomy tube will not pass low enough. Thirdly, there is one other factor which discounts the value of laryngotomy: in taking

flaps for subsequent plastic operations on the face, the fistula is likely to handicap the plastic surgeon.

To sum up, high tracheotomy is the operation of choice in the treatment of traumatic laryngeal œdema, and, indeed, of most traumatic cases requiring an opening into the air-passages.

Surgical Emphysema ; Gas Gangrene.—Before leaving the subject of laryngeal œdema and angina, these two conditions, surgical emphysema and gas gangrene, require mention as being other possible causes of a thickening of the soft tissues of the neck.

Surgical emphysema is fairly frequent. In most cases it subsides rapidly and unaided. If deep sepsis ensues, incisions must be made without delay, as a prophylaxis against spread to the mediastinum.

Gas gangrene in this region is more usual on the dorsum of the neck. I have seen the whole trapezius and erector spinæ muscular block affected right up to the occiput. When it spreads ventralwards, this extension usually occurs deeply along the floor of the posterior triangle, and so to the prevertebral muscles, without showing itself superficially in front. The infection then rapidly descends to the mediastinum.

In this chapter on wounds of the larynx I have dwelt at some length on œdema of the larynx for several reasons. The lesions which cause it are at the same time an obstacle to laryngeal examination and an urgent indication for relief; and the arguments and principles adopted as to laryngotomy and tracheotomy are fundamental in the treatment, not only of laryngeal œdema, but of many lesions and complications of wounds of the neck.

Signs and Symptoms of Laryngeal Injuries.—I have nothing to add to what is common knowledge as regards hæmorrhage, aphonia, cough, expectoration, dyspnœa, or the escape of air and mucus from the external wound. But I have seen three cases where a non-perforating blow on the larynx produced results simulating an intrinsic lesion of laryngeal muscles. A recognized sign of damage to the crico-thyroids,

the external tensors of the cords, is known as "phonatory waste of air." The patient can control all the movements of his cords normally, but cannot render them tense. The result is that in adduction there is always a residual glottic chink; and each syllable spoken by the patient is accompanied by a sensible rush of air. In the three cases referred to this sign was obvious, but cleared up entirely. The blow received was in all three cases on the side of the thyroid cartilage, well above the crico-thyroid muscles; and there was no possibility of a lesion of the superior or external laryngeal nerves.

General and Special Principles—**EARLY TREATMENT.**—The general principles—as to removal of foreign bodies and drainage of wounds—underlying the treatment of laryngeal injuries in their early stages differ nowise from that of wounds in other parts of the body.

Certain special principles exist, depending upon the facts that, firstly, the larynx is the portal to the lungs; and, secondly, that it is an inelastic box containing the delicate mechanism of speech.

Out of the former fact arises the principle that when the larynx is wounded the portal must be kept open or a substitute provided, and the lungs protected from infection. This problem has already been partly dealt with under œdema of the larynx, and has also been referred to when speaking of lung infections.

Out of the second fact, that the larynx is an inelastic box containing the speech mechanism, arises the principle that its injured parts must be carefully conserved. In wounds of many other parts of the body this rule is not so important. The long bones after considerable loss join up with shortening. Part of a lung may be excised without inevitable detriment. Resections and anastomoses have long been practicable and practised procedures in the case of tendons, arteries, nerves, and certain abdominal viscera.

In the case of the larynx there are certain plastic methods to which I shall refer again; these, however, are not yet fully worked out nor firmly established in the domain of

practical surgery. And so we must make it a rule, in treating laryngeal wounds, to discard or excise as little tissue as possible.

Our aim must be, as far as possible, to reconstruct the damaged organ. The following case exemplifies this (Fig. 18):

Private J., aged 20, wounded on April 9th, 1917, admitted to No. — General Hospital, B.E.F., April 11th, with a shrapnel wound transversely and symmetrically across the hyoid region.



FIG. 18.—Photographed as the patient lay on the operating-table; the respiratory excursions have therefore blurred the image, as is seen from the double appearance of the tracheotomy tube. In this case a shrapnel wound resulted in a lesion closely resembling a suicidal or homicidal cut throat. Both the air-passages and the gullet require reconstruction, all the while maintaining an air-entry.

The hyoid bone was fragmented and the epiglottis severed at its root. The prevertebral muscles were widely exposed, and no details of anatomical structure could be made out. There was no sign of present or recent hæmorrhage; the carotid vessels had receded dorsalwards with the sternomastoids. The lesion exactly resembled a bad "cut throat." On admission he was collapsed.

Patient was given morphine and atropine hypodermically at once, and lightly anæsthetized with a mixture of chloroform and ether. With the idea of reconstructing the damaged parts, the procedure adopted was as follows:

1. A tracheotomy tube was inserted in the glottis.
2. An œsophageal tube was passed from the mouth.
3. High tracheotomy was performed, and another tube inserted here.
4. The upper tracheotomy tube was removed from the glottis, and replaced by a gauze plug attached to a piece of silk. The other end of the silk was then passed from the wound into the mouth, emerging at the lips.
5. The epiglottis, and then the muscles, were sutured with catgut; the skin with salmon-gut, except the median 4 inches, which were left open and packed with gauze and sodium chloride. The gauze plug in the glottis was removed by pulling on the piece of silk. Subcutaneous saline and other appropriate remedies were applied. He was fed through the tube.

In the after-history the most noticeable feature was a series of rapid alternations in pulse-rate from 80 to 160. On April 14th he died.

Post-mortem.—Pus around both vagi just deep to the jugular bulbs.

Commentary.—The coincidence of a rapidly changing pulse-rate with pus around the vagi has been alluded to in speaking of mediastinitis.

In the early treatment of laryngeal wounds the principle of conserving tissue must be rigidly adhered to. There is only one part of the larynx which may be excised with a reasonable hope of avoiding bad after-results, and that is the ala of the thyroid cartilage above the glottis. In the early stage the partial or complete sacrifice of any other structures will lead to stenosis, or aspiration of food, or impairment of voice.

LATE TREATMENT.—The remarks made above as to the conservation of the laryngeal boundaries or contents in the early stages apply to a more limited extent later. Soon after the injury we must save everything possible, because it is impossible to forecast what will be useful and what useless. Later, on the other hand, it will be obvious that some parts have healed so as to be useful; whereas in other places scarring has resulted in either stenosis of the airway, or fixation of the cords or arytenoids. The indications for

treatment of stenoses or fixation of cords become clear; the conditions and the steps necessary for their correction are described in works on laryngology.

For stenoses at the level of the glottis removal of one cord, with or without the arytenoid cartilage, will be necessary; or the excision of a web in the anterior commissure; or intubation of the larynx.

For subglottic stenoses intubation may be indicated. If these stenoses occupy a great length of the windpipe, and extend from the supraglottic region downwards, a **T**-shaped tube may be used, the two transverse limbs of the **T** extending up and down the airway, and its removable vertical limb emerging from an anterior opening. In extensive tubular strictures involving the trachea the whole affected area may be opened up, and kept open by a rubber tube; and it is in such cases that plastic methods promise the best results.

It is not a difficult matter to insert a flat slaver of cartilage, taken from the superficial surface of the junction of the eighth, ninth, and tenth costal cartilages, into the skin of the side of the neck. Three months later a flap of skin and fascia, including the embedded cartilage, is raised and folded over the tracheal opening; and the raw surface of this flap is covered by another slid over it. The skin under which the cartilage is grafted should be either hairless or previously depilated by X rays. This cartilage grafting is, unfortunately, most difficult in the region where it would be most useful—that is, the anterior glottic commissure. Possibly further advances may soon be made here.

Functional Aphonia.—Our old and somewhat rigid conception of the laryngeal image seen in so-called functional or hysterical aphonia has now widened. It can no longer be described as pathognomonic of this affection that the patient, usually a woman, should present an elliptical or diamond-shaped glottis indicative of paresis of the tensor muscles of the cords.

Active service in the war has been largely responsible not only for shifting the relative sex-incidence from females to males, but also for our recognition of the fact that this

condition does not necessarily select the tensors; that other groups of muscles may be picked out, producing other laryngeal appearances.

Several observers have seen frequent cases, and I myself have noted many in France, in which the cords in phonation adduct normally in their anterior two-thirds or three-quarters, leaving a three-cornered gap posteriorly; that is to say, there is a selective lesion of the inter-arytenoidei muscles.

But while the war has broadened our ideas as to the diagnosis, it has added little to our knowledge of treatment. Patients are said to have recovered under anæsthetics when being operated on for some condition unconnected with the larynx. I will not here enter into the various methods of treatment which have been tried, and which have long been well known, beyond saying that in my experience simple suggestion, repeated, patient, has resulted in the largest number of permanent successes.

In this war it has been recognized that the pareses of functional aphonia are accompanied by a subacute or chronic laryngitis more often than was thought. And in such cases where the interference with speech has two causes, of course both causes must be treated. But the prognosis is rendered additionally difficult by the double causation.

The cases alluded to earlier, where, after a blow on the larynx, the man has pareses of tensors, are difficult to refer to any certain pathogenesis; and a diagnosis of "functional aphonia" in these traumatic cases might at first seem unwarrantable. But this diagnosis may be arrived at by a process of exclusion. For they often recover too quickly to have been due to a neuritis. And if they are due to bruising of the crico-thyroid muscles, I can only say it is the sole instance I have heard of where attempts to use a recently damaged muscle are not painful—for these men have no pain on trying to speak. Perhaps "traumatic functional aphonia" would be a suitable designation.

As I have said, I do not propose to enter into the question of treatment, since little has been added on the point to our

patchy knowledge of it before the war; but, in the light of our extended ideas of the forms the affection may take, a simple classification such as the following may be helpful:

1. The classical form: paralysis of the tensors of the cords, resulting in an oval or diamond-shaped glottic chink. The voice is usually entirely absent; more rarely a feeble whisper is possible, or certain vowel and consonant sounds may be made.

2. Paralysis of the inter-arytenoidei muscle. The cords are separated only posteriorly in the form of a triangle. Although any type of functional aphonia may co-exist with a subacute or chronic laryngitis, such is more likely to be found in this form than in the others. The power of speech is curtailed, rarely absent; such voice as remains is husky.

3. The traumatic form, following a non-penetrating blow on the larynx. The lesion produced is as in form 1, above; but may be of greater degree, so that attempts to speak are accompanied by a "phonatory waste of air" (see Cases, above).

Mustard Gas.—During the Somme fighting in July, 1917, I had an exceptional opportunity of studying the effect of this irritant gas on the larynx.

For the Records Department in France I examined all men whose larynges were affected, out of a large batch of gassed men. My conclusions may be of some use apart from the war, because they may be applicable to any soluble volatile irritant when inhaled.

The total number of patients examined was 61.

The period elapsing between gassing and first examination was from eight to twelve days.

Those cases which had not recovered by the sixteenth day were re-examined between the sixteenth and twentieth days after gassing.

Diagnosis.—In every case the laryngoscopic image, whatever else it did or did not show, was clearly indicative of simple subacute laryngitis. The cords were of a muddy grey-pink colour, here and there streaked with minute punctate or linear ecchymoses, their free edges rounded off

and ill-defined. The aryteno-epiglottidean folds and the walls of the vallecula and sinus pyriformis on either side were suffused. There was in some patients a copious secretion of laryngeal and tracheal mucus, which in the post-cricoid region was sufficient to remind the observer of that seen in carcinoma of the larynx. It suggested that in an earlier stage the patient had been in danger of being swamped in his own secretions.

This exaggerated mucoid secretion was quite independent of the bronchitic fluid found in such of the patients as suffered from bronchitis.

The *voice* was husky in 54 cases (88 per cent.).

Speech was reduced to a whisper in 6 cases (10 per cent.).

In one case there was absolute aphonia; the larynx showed subacute laryngitis, but, in addition to this, there was paralysis of the tensors, and the glottis had the typical elliptical shape of the ordinary hysterical type.

The laryngoscopic findings were varied and interesting; they came under the following headings:

1. Larynx absolutely normal in 1 case (1.7 per cent.).
2. Simple subacute laryngitis. The cords dull, rough, with injected vessels here and there; the arytenoids swollen, so that their outline was obscured; in fact, the typical appearances of subacute inflammation. This was found in 33 cases (54 per cent.).
3. Laryngeal œdema of a degree which might require tracheotomy at any moment (but, as a fact, did not), with œdematous arytenoids and ventricular bands obscuring the cords, 6 cases (10 per cent.).

4. Laryngitis presenting certain special features:

(A) Ulcers, 3 cases (5 per cent.). These were found on the posterior hypopharyngeal wall and epiglottis. As regards their colour, bases, or edges, there was nothing noteworthy or characteristic about these ulcers. They were shallow, and appeared to be simply patchy losses of mucosa. Comparing their appearance with that of false membrane found in other cases (Class B, below), it seemed clear that false membrane had recently occupied these ulcerated areas.

In one of these 3 cases the true cords showed small ulcers resembling those of tuberculous laryngitis; there were no other local or general signs of tuberculosis.

(B) Membrane, 5 cases (8 per cent.). This was greenish, only slightly adherent, and the subjacent surface after removal was dull red, not bleeding. The membrane did not form a raised area, but was flush with the adjacent surface—that is to say, it was obviously false membrane, produced by necrosis of mucosa; on culture it yielded several strains of streptococci. It occurred on the posterior hypopharyngeal wall, in the sinus pyriformis of one or both sides, and more rarely on the epiglottis; its tendency was, therefore, to form on the posterior dorsal aspects of this region.

(C) Demarcated laryngitis. In 3 cases (5 per cent.) the posterior part of each cord was intensely injected; this injection, ending abruptly in front in an irregular transverse or oblique line, was sharply marked off from the anterior part of the cord. Here, again, the maximum effect of the gas was manifested posteriorly.

(D) Submucous hæmorrhage of the cords, 4 cases (6 per cent.). This condition, possibly in part due to violent coughing, was only an exaggeration of Class C, above.

In none of the 61 cases was tracheotomy necessary. And no patients, as far as I know, passed through the Base who had been tracheotomized at the front for gassing. It is, of course, possible that fatal cases, never reaching the Base, had been tracheotomized.

The average period of recovery from acute laryngitis appeared to be twenty-one days, and the ultimate prognosis good.

The dorsal situation of ulcers, false membrane, and demarcated laryngitis suggest that gravity plays a part; the patient lying supine, or half sitting up, the irritant, dissolved in mucus, would trickle down backwards. This idea is strongly borne out by the post-mortem findings in one fatal case not included in the above series. In this case, of which, unfortunately, I have no photograph, the ulcers and false membrane extended continuously from the larynx to the

primary bronchi, and were confined to the posterior aspects of these tracts.

Treatment.—In my report I recommended that antiseptic sprays should be strongly alkaline, to loosen false membrane. And that, with the same object, these aqueous sprays should be preceded by oily.

The profuse secretion of mucus should be met with repeated hypodermic injections of atropine sulphate, $\frac{1}{200}$ to $\frac{1}{100}$ grain. Posture is important. As far as dyspnoea allows, the patient should be kept prone or semi-prone, so that the mucus holding the corrosive gas in solution may the easier be coughed up.

The Final Removal of a Tracheotomy Tube.—When a tracheotomy tube has been worn for several weeks or months after a gunshot wound the procedure for its safe removal is the same as when a tube has been worn after any other accidental or surgical trauma; that is to say, the patient is gradually accustomed to breathing through his glottis. First the tube is closed for a few moments with a pad of gauze, to remove any doubt in the patient's mind as to whether he can breathe past it. Next, the lumen of the tube is partly closed with a split cork for several hours, and finally for the whole day. Then the split cork is placed in the tube at night.

The process of gradual corking is now repeated with a cork which entirely closes the lumen.

When the patient is thoroughly accustomed to this the same gradual education is repeated, except that, instead of closing the orifice of the tube for increasing periods, the tube is taken out. This is first tried for a few minutes in the day-time. When he can breathe without a tube, and with the tracheotomy wound (if it does not close spontaneously) covered by a gauze pad, for the whole day, he begins to discard it at night. Finally, he dispenses with the tube altogether.

If the tube has been worn for a very long time the wound may not close, in which case its edges should be freshened and sutured.

Although the procedure in discarding a tracheotomy tube is the same in war as after other injuries, the responsibility in the former case is greater.

In civil practice, when a man is rid of his tube and the wound closed he is still kept under the regular supervision of a laryngologist for some time, either as a private patient or in the out-patients' clinic of a hospital.

In military life the man is either an in-patient in a hospital or convalescent home, or he is discharged to duty, or discharged from the army. As soon as he finally leaves hospital it is uncertain whether he will always have skilled help at hand in case of accidents. This will, of course, make the medical officer additionally cautious as to when to discharge such a man, and whether to duty, light duty, or from the army. If to duty, the patient may require regrading. When a man shortly after the final removal of a tube is given sick-leave, he should carry a piece of paper in his pocket briefly stating the facts, so that if seized with dyspnoea and unable to explain he may quickly receive help.

If there is any suspicion of the existence of a stenosis, his larynx and trachea should be endoscopically examined before a man is finally discharged back to any sort of duty.

CHAPTER V

THE EAR

THERE is no part of the head and neck, except the brain, where such grave results may follow a small injury as the neighbourhood of the ear. In immediate relation there is, in front, the temporo-maxillary joint; above, the middle and posterior cranial fossæ; internally and below, the jugular bulb and internal carotid artery. And when these near neighbours have escaped injury there remain the structures which belong anatomically to the ear itself—the apparatus for hearing, for equilibration, and the intrapetrous part of the facial nerve.

Any lesion, therefore, although seemingly trivial, to the pinna, tragus, or mastoid, demands a routine examination from the point of view not only of the general surgeon, but also of the aurist.

Skiagraphy should never be omitted. Unfortunately, details of the mastoid and petrous portions of the temporal bone, owing to their density, are not often shown on a skia-gram. The cellular structure of the mastoid process can be made out, and occasionally the handle of the malleus seen. But definite evidence of a fractured petrous cannot, as a rule, be obtained; and no evidence at all of injury to the labyrinth or facial canal.

The only type of case in which, as far as the mastoid and ear are concerned, apart from the rest of the skull, I have been guided by radiography, has been an antero-posterior wound of the mastoid in its lower third. From the situation of such a wound it is possible that, if apical mastoid cells be few, small, or absent, the wound may not have penetrated deeply enough to lay open the cellular structure of the

mastoid. A skiagram may be of definite assistance in this case by giving a better idea of the direction and track depth of the track across the mastoid process (Fig. 19, p. 85).

A *probe* will generally be required, and must, of course, be used with extreme caution. Evidence will be obtained, not only from the direction and maximum depth to which the probe passes, but also from whether it seems to traverse a bony canal through its whole course, or whether at some part of its track it seems to pass through soft structures or traverse a small cavity; also, whether it finally impinges against bone or soft tissues.

Considerations of this kind may enable the surgeon not only to form an idea as to whether the wound communicates with the mastoid antrum or tympanum, but also as to whether extraneous neighbouring regions or structures have been involved, such as the digastric fossa, the middle cranial fossa, the temporo-maxillary joint.

The value of probing and radiography is often much enhanced by combining them—that is, by having a skiagram taken with a probe *in situ*.

Facial paralysis will naturally be looked for. If there be none, and any radical operation on the mastoid is required, paresis or paralysis should be looked for again as soon as the patient has recovered from the anæsthetic. Its absence at this time, together with the fact that the anæsthetist reported no facial twitching during the operation, will exclude any gross lesion to the nerve or its canal. So that, if paresis supervenes after this, it is due to a neuritis. This is obviously important as affecting the prognosis.

All this is common knowledge, and in the routine practice of otologists in civil practice.

But there is after gunshot wounds an additional importance in establishing the presence or absence of a lesion to the facial nerve. If the mastoid requires operation, it is quite impossible to dogmatize beforehand as to how extensive this operation will be. It may be trivial and superficial; on the other hand, the operator may have to explore or cut away bone considerably beyond the limits of a

stereotyped radical mastoid operation. And the fully established presence or absence of previous facial paresis will in such cases guide him as to what he is or is not justified in doing.

Hearing Tests.—There are many factors which obscure and confuse the significance of these after-gunshot wounds. I have found this especially true in testing air conduction, whether employing speech, tuning-forks, acoumeter, or whistle. Air conduction in these patients varies greatly from day to day.

The same is true of bone conduction, but to a less extent, possibly because the patient's attention may require more concentration when air conduction is being tested.

The subject of war deafness is better left to those who have made a special study of it. The factors which seem to invalidate the results of hearing tests include inflammatory or cicatricial stenosis of the external meatus, tears of its lining membrane, dirt or debris in the external ear or tympanum—these impair air conduction. When bone conduction is under consideration the question of a hæmorrhage into the cochlea must be borne in mind.

But whether air or bone conduction is in question, probably the most confusing factor is the psychical. After the severe strain to which the patient has been subjected he cannot concentrate his attention sufficiently to give reliable information. In putting a patient through the usual tuning-fork tests after a gunshot wound of the ear it is very rare that a pure result is obtained—that is to say, the type of deafness is usually neither “middle ear” nor “internal ear,” but mixed.

On the whole, although hearing tests should always be applied as part of routine, their results will affect the question of surgical intervention far less after gunshot injuries of the ear than in deafness occurring in civil practice. In any event, a universal and international standardization of hearing tests is highly desirable.

Labyrinth Tests.—I have made a practice, in any wound in the immediate neighbourhood of the ear, to test the patient

for spontaneous nystagmus on deviation of the eyes. This test occupies very little time, and may, of course, give most valuable information. If a positive result is obtained, the rotation chair or caloric test should be used as soon as the patient's condition allows it, and a careful note made as to his gait. If, from the nature or direction of the nystagmus or gait, or the existence of dysdiadokokinesis, a cerebellar injury is suspected, a neurologist will be called in.

General Signs.—The temperature chart, absence or presence of vomiting, or neck rigidity, condition of pupils, and reflexes, will be sharply watched so as not to miss the earliest indications of intracranial complications of a wound of the ear.

The External Ear.

The whole pinna may be torn almost completely from the head, but heal up well if sutured soon after the injury. But when a part of the pinna has been lost it is very difficult by plastic methods to imitate it. A flap of adjacent skin may be grafted on, but unless cartilage can be implanted the result is amorphous.

To make a good imitation of the curves of the helix and antihelix and of the fossæ of the auricle will be a triumph for any plastic surgeon. I have not yet seen a good result, and regard this part as even more difficult for plastic repair than the alar curves of a nostril.

If part of one pinna has been shot away and healing occurs, so that the result is fairly shapely, or, at any rate, the deformity not very noticeable, the patient's disability is simply that this ear is smaller than the other. To remedy this there have been successfully performed various simple plastic excisions of parts of the pinna. These are described in textbooks on plastic surgery.

The most important and far-reaching result of wounds of the soft tissues of the pinna and external auditory meatus is stenosis of the passage. This should be corrected in any case; for it not only interferes with hearing, but leads to the accumulation of wax, sebum, epithelial debris, and dirt in

the meatus; it prevents even the examination of the tympanum or drum, and makes the prognosis much worse in the event of an otitis media.

Whether the stenosis be tubular, or confined to a small part of the meatal circumference, the mere excision of the scar tissue will, as a rule, fail, and be followed by recurrence. I have in several cases excised the scar tissue most carefully, and brought the edges of healthy skin together accurately; but the plan does not succeed. No doubt the difficulty of keeping the part quite free from infection has something to do with the secondary fibrosis and contraction which always occurs.

The only safe plan is to make a post-aural incision. The soft parts lining the meatus are now elevated from the periosteum as far inwards as necessary. Bone is then cut away from the superior or posterior walls so as to enlarge the meatus in this direction. Finally, one or more conchal flaps are cut, as in a radical mastoid operation, and sewn up and back to the subcutaneous tissues deep to the post-aural incision. The latter is now closed. Just as at the conclusion of a radical cure of mastoiditis, the meatus must be made about one-third larger than it is intended eventually to be, for it will contract.

A post-aural incision, with elevation of the meatal lining, is also required to remove callus resulting from injury to the bony meatus.

If the wound has traversed the anterior cartilaginous or bony wall, it is highly probable that the temporo-maxillary joint has been injured. I have seen this several times; and on one such occasion we removed the condyle of the mandible through the external auditory meatus.

The Middle Ear.

Rupture of the Membrana due to an Explosion.—It is well known that the treatment of an ear-drum ruptured by a sudden noise is in civil practice, as a rule, speedily successful, and the prognosis good. Every aurist is familiar with the

appearance of the tear. If it is seen at once it takes the form of a linear slit in the direction of the radial fibres of the middle layer. If it is not seen for some days the slit is spindle-shaped, or, later, oval; but the long axis of the spindle or oval is always a radius of the membrane. The alteration in shape with time is assigned to fibrosis and retraction of the circular fibres of the middle layer, which pull the margins of the slit apart. In any case, it is only in a neglected case that a circular or irregular perforation is seen.

And with simple treatment—keeping the membrane and meatus dry and clean—healing is rapid, often occurring in a week.

It is quite otherwise with membranes ruptured by shell-fire. We must believe that these cases pass through a stage similar to those seen in peace time. But when they are examined we find a circular or irregular perforation at the bottom of a profoundly dirty meatus; and when the latter has been cleaned so that the former may be well inspected, the hole in the membrane is often indistinguishable from that seen in chronic otitis media except by one difference—that is, its edges are not yet thickened.

The treatment and prognosis of these war ruptures is naturally very different from that of the peace time cases. The middle ear is usually actively secreting through the perforation, which will not heal by merely keeping it dry and clean. Usually the ear must be irrigated; in fact, the average case has to be treated like a chronic suppurative otitis media of about two months' duration. Many of these cases are eventually sent home to the aurist at a military hospital, to whom they present all the appearances of an ordinary "running ear."

The unfavourable course taken by these cases is due, firstly, to delay. If they were seen sooner their chance would no doubt be better; and this is one of many arguments for the presence of specialists at casualty clearing stations.

But to say that if treated earlier these cases would not only be better, but would take as favourable a course as

they do in civil life, is not a fair criticism; for it quite disregards the fact that the patient often has his attention absorbed by such much graver injuries, or is so incapacitated by shock, that he himself does not notice for several days anything amiss with his ear or his hearing. This is a factor which would be quite uninfluenced by the existence of specialists' centres near the front.

Moreover, delay will not entirely account for the unpromising aspect of these ruptured drums in war. I have seen a large number of these men at the Base in France, and have questioned them to ascertain how long standing the rupture is, and have taken pains to exclude the previous existence of otorrhœa, and, although I cannot quote figures in support of my opinion, I am sure that patients in civil practice who had been neglected for an equal time would not have nearly such large or unhealthy looking perforations. So there must be a second cause, and this is obviously dirt. The man may not have been able to get a wash for several days, or he may have been buried; or, if he was wounded about the head or neck, his meatus is clogged with old septic blood-clot.

As regards treatment, this depends on the appearance of the drum. A very few resemble peace time ruptures when seen, and are similarly treated with equally good results. The vast majority are as I have described, and will be treated as early perforating chronic otitis media—with the same chance of recovery with good hearing.

Wounds of the Tympanum and Mastoid.—If it were possible for a man to be wounded in his tympanum only, there might be large numbers of cases which would be treated expectantly and without operation. The middle ear would simply discharge pus through the ruptured membrane. But, obviously, this cannot happen; and, whatever direction the missile has taken, some other important structure will have been perforated, and will require surgical drainage.

If the track is transverse, the brain, medulla, meninges, or cranial nerves have been injured, and, for the moment,

the tympanum takes a place of secondary importance. But if the course taken by the bullet or shrapnel was exactly or nearly in a sagittal plane, the brain will have escaped, and we have to deal with the middle ear, plus neighbouring structures. How should this be undertaken? Should the wound be regarded as one, or should the middle ear and any other injured parts be drained separately and independently of each other?

To use a hackneyed phrase, each case must be considered on its own merits. Nevertheless, I think it is possible to formulate a general rule of procedure.

To drain the tympanum in any case where this is required, there is obviously one universal route—a post-aural incision and access through the mastoid antrum.

Other regions damaged may be the following: above the ear, the floor of the middle fossa; behind, the lateral sinus and descending part of the facial nerve; or below, the jugular bulb, internal carotid artery. Any of these should be simultaneously approached by an extension of the post-aural incision forwards above the pinna, backwards horizontally along the lateral sinus, or forwards below the lobule.

But if the structures in front of the ear, the parotid gland or temporo-maxillary joint, also require drainage, the incision to obtain this should be separate and independent of the post-aural wound.

This counsel may seem superfluous on the ground that a single incision to drain all these parts would encircle the external meatus for three-quarters of its circumference, nearly cut the ear from the head, and result in gangrene. But this is not what is meant, nor is it true. Cases of almost complete severance of the pinna, which remains attached only below, heal up well, showing that an inferior pedicle, including the posterior auricular artery, provides ample blood supply.

The reason for keeping the anterior drainage wound separate is that, having provided external drainage, it is quite possible that the communication between tympanum or external meatus, and parotid gland or temporo-maxillary

joint will close, whereas, if these wounds be widely thrown into one, a permanent fistula is quite probable.

I alluded above (p. 79) to a case in which we removed the condyle of the jaw through the external meatus. Unfortunately, I could not keep track of that case; but I should think it quite likely that a permanent fistula resulted.

If we now revert to the wound of the middle ear and the treatment necessary, it may be said that all such wounds, whether the mastoid be involved or not, should be drained by a post-aural incision if any operation at all is required.

The technique is exactly that of the earliest steps of a radical mastoid operation. The pinna and soft tissues of the posterior and superior meatal walls are elevated forwards, and then the periosteum incised. This also is elevated, and its edges retracted backwards and forwards. Bleeding is largely stopped by the tight pressure of the mastoid retractor; but bleeding vessels from the cut edge of the temporal muscle above, or branches of the posterior auricular artery below, may require ligature.

The whole mastoid process is now exposed to view. Two points must at once be looked for: the mastoid wound, if there is one; and, whether the mastoid has been wounded or not, the spine of Henle. An aurist almost unconsciously identifies this most helpful landmark instantly. Its importance is so obvious that I only mention it because it has helped me so greatly in difficult cases. If other landmarks have been blurred or destroyed—if, for instance, the posterior meatal wall is smashed, the meatus full of bone debris, the lower part of the mastoid comminuted, or the lateral sinus bleeding—so long as Henle's spine is there the surgeon knows at once where to begin gouging. In the absence of this landmark, he must look about and begin more warily if relations have been marked by comminution. From this moment onwards the nature and extent of the operation will be indicated by the findings.

The antrum should always be opened. This is practically a rule without exception. The only debatable point is whether all the mastoid cells should be exenterated; and

whether the facial ridge should be spared as in a Schwartz operation, or cut away as in the Stacke "radical mastoid."

If the track of the missile which damaged the middle ear passes directly upwards or downwards, an operation may sometimes be so planned that the facial ridge is left intact, and the mastoid antrum drained through the post-aural wound.

But in many of these cases, and a vast majority of cases where the mastoid process has itself been penetrated, the facial ridge will require cutting down. The operation will be a more or less stereotyped "radical mastoid."

In the treatment of war injuries, just as the Caldwell-Luc is the prototype of most operations on the maxillary antrum, and the Killian bridge technique the type of frontal sinus operations, so the radical mastoid, more or less modified, should be the standard procedure for wounds which have injured the tympanum or mastoid, or both. For if any of the mastoid cells be left they will usually suppurate later. And if for the drainage of these suppurating cells the aditus and tympanum be relied on, this drainage will probably be proved insufficient by a later mastoiditis, and the facial ridge will require removal so as to throw antrum and middle ear into one cavity. So that in a majority of instances a "radical mastoid" will eventually be required.

Occasional exceptions to this generalization will be met with. If a wound in the sagittal plane involve the mastoid process in its lower third without opening the tympanum, especially if the injury be not very deep, and if apical cells are small or absent, it may suffice to remove the mastoid apex up as high as the wound, and drain the digastric fossa. In the case of such a wound the operator cannot tell how far the cellular structure of the mastoid is involved until he explores. He may find that simple drainage of the wound, down to the mastoid cortex, suffices; or that the tip must be removed, and the remainder of the bone spared; or that the tip may be left, and the antrum and cells cut away from the upper two-thirds; or, lastly, that the whole process must be removed. Whatever the surgeon expects to have to do he will often find he must do something different.

Fig. 19 is a skiagram taken of a patient whose right external auditory meatus, many months after the mastoid wound had completely healed, was invaded by granulations. These obscured the tympanum, and persisted despite patient intrameatal treatment. They appeared to spring from the posterior wall about half-way along the meatus, and at this point the probe detected bare bone. The tip of the mastoid—that is, all that part below the horizontal healed wound—was movable. On the whole, after observing the case for a month, I inclined to think that the granulations indicated a sinus leading down to a necrosed portion of the mastoid

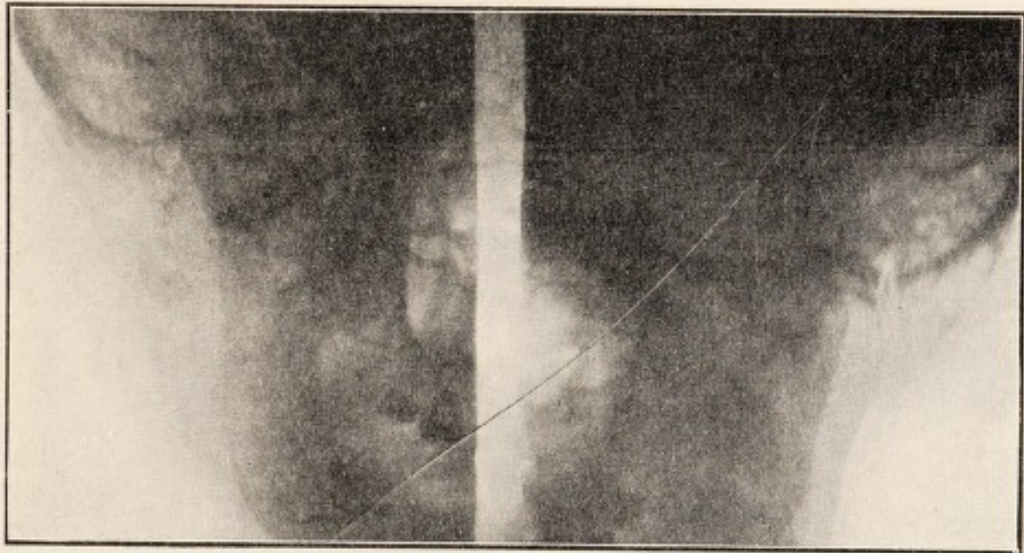


FIG. 19.—On the right side (left-hand figure) a bullet has separated the tip from the remainder of the mastoid process.

apex; and when I operated I expected to remove this and leave the upper part of the mastoid untouched. But I was mistaken. The necrosis was in the antrum and upper cells; I was obliged to perform a radical antral operation, and found the lower, movable, apical portion healthy. I left this part alone, and recovery was uneventful.

As regards intracranial complications of mastoiditis, I have not found that these or their treatment differ at all from those seen in civil practice. When an extensive mastoid comminution has involved the sigmoid sinus widely, and right down to the jugular bulb, I have twice seen recurrent hæmorrhage after some days—probably from the petrosal

sinuses. In such cases the wound may granulate up, leaving a deep pit at the site of the mastoid apex; at the bottom of the pit it is difficult to see how far granulation has proceeded. And hæmorrhage may always recur until the region of the jugular bulb has been completely covered in.

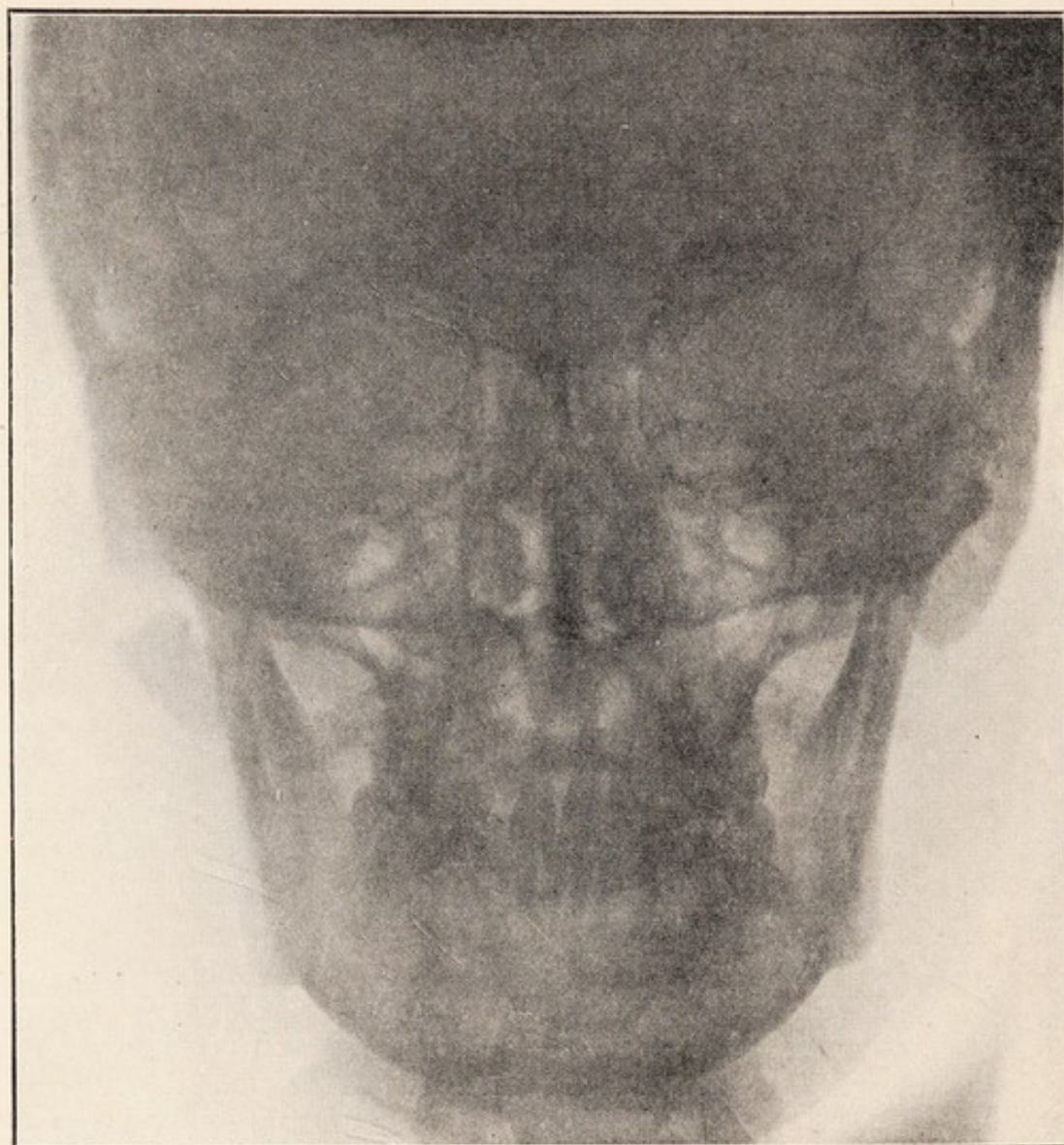


FIG. 20.—Antero-posterior bullet wound of the right mastoid process, separating the lower third from the upper two-thirds.

Following operation, the dressing and after-treatment of a case of mastoid wound is similar to that of a radical mastoid operation in civil practice; but a word of caution is necessary.

When discussing the nose and accessory sinuses allusion was made to the risks of using effervescing solutions, such as hydrogen peroxide.

This applies with still greater force to injuries of the ear unless they are clearly quite superficial. For it is impossible to be sure whether there is a fractured base. A fissure may place the middle cranial fossa in direct continuity with the antrum or middle ear, or may connect the posterior fossa with mastoid cells. In any such event the mechanical action of the bubbles would increase the risk of meningitis.

A sound routine is to ban hydrogen peroxide for the first week; after the lapse of this period a protective barrier of granulations will have formed.

At the close of a radical mastoid operation after gunshot injury the cavity should never be packed from the external meatus, but invariably drained by tube. One end of the tube should be cut off obliquely, so that this end hitches beneath the tragus, while the deep end passes upwards and backwards beneath the flap which has been cut from the concha, to lie in the antrum. It is a matter of common knowledge that, although this tube is to be gradually shortened at intervals of a day or two, it must not be replaced by a tube of smaller diameter, because the meatus will narrow subsequently. For the same reason, in cutting the conchal flap at the end of the operation, the meatus is made about one-third larger than it is eventually intended to be, and the tube used of course fits this meatus. This provision against subsequent contraction must be rather exaggerated after gunshot injuries, because, owing to the sepsis of the parts, the subsequent fibrosis and contraction is likely to be more than in non-traumatic cases. Owing, again, to the excessive sepsis, in many of these patients it is not wise completely to close the post-aural wound at once, even when the facial ridge has been entirely cut away in operating; temporary drainage, by a small tube or wick of gauze, may also be necessary from the bony cavity representing the mastoid antrum and cells, through the post-aural wound, or from the digastric fossa.

The Internal Ear.

In the routine examination of a patient wounded in the neighbourhood of the ear there are various signs which will suggest that the internal ear has suffered injury. Tinnitus may be present. A sensation of giddiness may be complained of. This may be subjective, the patient complaining that he himself seems to be moving, and falls laterally in trying to right himself; or objective, when he complains that external objects move across his field of vision.

There may be a certain amount of inco-ordination; this passes off eventually, as the functional labyrinth on the sound side gradually accommodates for the injured one.

Deafness exists. Earlier in this section the fallibility of hearing tests after recent gunshot injuries was emphasized. I have found Barany's noise apparatus gives the most reliable information.

Nystagmus on deviation will be looked for; first, spontaneous nystagmus, and, failing that, nystagmus on stimulation by the caloric method, or by rotation if a chair be available.

The most certain evidence is afforded by a dribble of cerebro-spinal fluid from the external meatus. The fracture of the base signified by the flow must have crossed the petrous bone; and whether or not the line of fracture passes through the internal auditory meatus, the labyrinth capsule or the cochlea will have been injured. The risk of meningitis is manifest.

The patient will now be treated expectantly, kept absolutely still, not even moved to have a skiagram taken; the meatus and pinna cleaned and painted with iodine. A light sterile wick of gauze is laid into the meatus, and covered by a frequently changed sterile dressing. No attempt is to be made to stop the flow.

In the absence of cerebro-spinal otorrhœa the diagnosis must be made from the other tests, as outlined above. But to perform all these tests fully on a man recently wounded is quite impracticable. It is necessary to choose those which can be carried out on a man too ill to stand or walk;

and a procedure on the following lines will give much information.

A skiagram is required. If a portable apparatus is available this may be taken at once. But if not, and the patient has to be taken on a stretcher to the X-ray room, this should be deferred until last; because the other tests are best made when the patient has been at rest, undisturbed, in bed, for some little time.

The meatus is cleaned out, as far as any tags of meatal skin allow, and bone conduction tested with a tuning-fork. If the wound prevents the fork being placed on the centre of the mastoid, it should be placed as near to this as possible. The tone of the fork should not be lower than 512 double vibrations per second. Loss of cochlear function is what is chiefly being examined, and this, of course, shows itself mostly in the loss of perception of high tones. Moreover, the lower tone forks have a vibration which can be felt as well as heard; and it is difficult for a recently injured man—whose efforts at mental concentration at best only just enable him to answer questions rather vaguely—to distinguish between a vibration felt through the head and vibration actually translated into sound.

If the hospital equipment is to include only one tuning-fork, a 512 double vibration is the most serviceable. If two, the higher note may be 1,024, and the lower 128 or 256.

Giddiness should next be looked for if the patient can sit up; he sits as nearly as possible upright, and then removes the support of his hands by holding them out in front of him. If he sways, it will generally be to the affected side.

Spontaneous nystagmus on deviation of the eyes may be demonstrated without disturbing the patient much. The rotation test is out of the question; even if a chair were available, the patient is not fit for this ordeal.

Stimulation of the labyrinths of the two sides by running warm or cold water into each meatus alternately, and comparing the nystagmus reactions produced, may be carried out if the patient is able to sit up and bend his head forwards

and backwards. The fistula test (p. 95) may rarely give information, and may be performed with a Siegle's speculum and rubber ball and tube.

Finally, unless he has been skiagraphed in bed with a portable apparatus, the patient is taken to the X-ray room on the chance of demonstrating a fracture of the temporal bone.

By these various rather rough tests, taken in conjunction with the nature and direction of the wound and the temperature chart, it will be possible to have a very fair idea as to whether the meninges or interior of the labyrinth are in communication with the exterior. Supposing it is considered that they are, the question is, how to proceed? If there is cerebro-spinal otorrhœa, and it is probable that the external wound does not communicate with the fractured base, the ear is, as has been said, merely kept strictly clean, and the patient at rest; and only when it is judged that the fracture has been completely healed for some weeks—by which time he will be in England—will any surgical measures be taken for his ear (except the opening and draining of sinuses in the scalp).

The more grave cases, where the wound actually passes down to the meninges, come under the heading of brain injuries; but they may concern the aurist also.

Cases of gunshot labyrinthine injury to the internal ear, judged in the light of the clinical tests and the operative findings, seem to fall into three groups:

1. Clinical tests definitely implicate the labyrinth, without any suggestion of meningeal or cerebral complications. The radical mastoid operation is performed, but the internal ear not touched. The labyrinthine signs thereafter disappear.

2. Clinical tests are vague, but suggest that either a labyrinthitis or a more gross cerebral complication is present. The radical mastoid operation is performed, but neither the internal ear opened nor the meninges exposed. The indefinite signs of labyrinthine or cerebral complications disappear.

3. Cases where the tests definitely implicate the labyrinth, and during the mastoid operation specific evidence of laby-

rinthine injury is obtained. The treatment at once becomes the same as that of a labyrinthitis, serous or suppurative, in civil practice. If necessary, labyrinthine drainage is carried out. This class of case is rare.

The following is an example of Group 1:

Sergeant W., admitted to No. — Stationary Hospital, France, on July 16th, 1917. A rifle bullet had entered the left maxillary antrum and made its exit in the left sub-occipital triangle.

Condition on Admission.—The skiagram gave no definite information. There was a complete infranuclear left facial paralysis. Cerebro-spinal fluid dribbled constantly from the external auditory meatus. He was quite conscious. There was a fine spontaneous nystagmus, pure horizontal, of the first degree, on deviation of eyes to the left. There was no neck rigidity or vomiting. The right plantar and knee-jerk reflexes were sluggish. Kernig's sign was absent. The optic discs were natural; pupils 3 mm., with a sluggish reaction to light. There was no muscular atonia, ataxia, dysdiadokokinesis, or giddiness. There was a swelling in the parotid region. Air and bone conduction to the tuning-fork on the left were nil. Fig. 21 shows the appearance of the wound.

July 18th.—The parotid swelling increased. Pulse, 110; temperature, 105°, with rigor.

July 19th.—Parotid swelling nearly disappeared, but he had another rigor (temperature, 103°). Operation decided upon.

July 19th.—Operation. Post-aural incision. The mastoid process was seen to be cracked, and its cortex removed. The posterior bony meatal wall and facial ridge were found crushed, many fragments lying in the meatus. Behind this the sigmoid sinus was lying bare for a small area. This area was enlarged.

There was no extradural pus, and the dura anterior to the sigmoid sinus pulsated normally. The sigmoid sinus itself was dark, inelastic.

Bone was cut away backwards along the lateral sinus until healthy sinus was reached 1 inch back; and downwards to the bulb until this was found to be healthy.

At the upper and posterior part of the bony opening a ribbon-gauze plug was now inserted between dura and skull to control bleeding. The unhealthy sinus was opened, and thrombus cleared out; the upper end of the lateral sinus was

now allowed to bleed for about ten seconds before finally plugging.

Finally, the internal jugular and common facial veins were tied in the neck.

July 20th.—Temperature, 101° ; pulse, 126. Cerebrospinal fluid from post-aural wound, and also freely into the mouth (? by Eustachian tube). From this day the flow gradually ceased until, on July 26th, there was no flow into

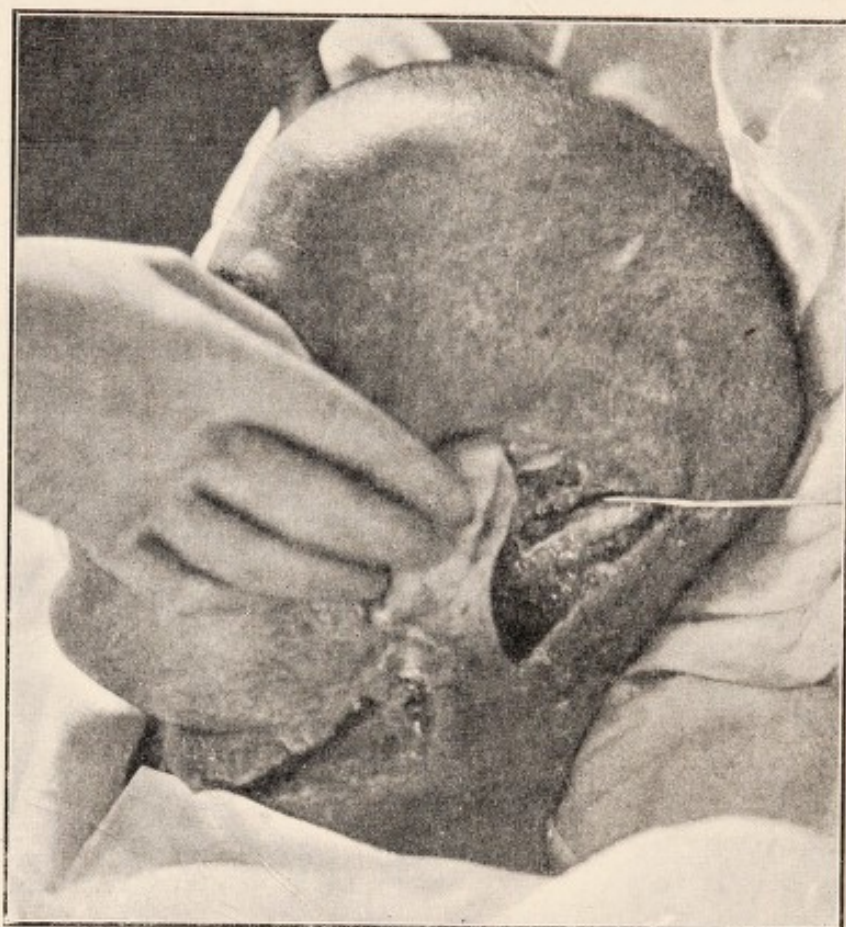


FIG. 21.—Traumatic thrombosis of lateral sinus. The curved dark wide line, with a probe in its upper angle, shows where bone has been cut away to remove the thrombosed sinus.

either wound or mouth. Temperature, 99° ; pulse, 106. Fig. 21 is a photograph taken at a dressing during the first week.

July 27th.—He was weaker, and his pulse feeble. Colonel Burghard saw him with me in consultation.

Blood-culture yielded a few streptococci. Until an autogenous vaccine could be prepared he was given Wright's antiseptis vaccine, 1 c.c. (repeated in three days), champagne, etc.

He continued in this condition, temperature hovering between 99° and 102° for four days.

August 1st.—Sudden hæmorrhage, half a pint of blood, arterial in colour but not pulsatile, from the lowest angle of post-aural wound. He died in a few minutes.

Post-mortem.—Except a fatty heart, there was nothing noteworthy in the thoracic or abdominal viscera.

The lateral sinus was occluded, back as far as the torcular. The straight, occipital, and superior longitudinal sinuses were clear. The bulbar opening of the inferior petrosal sinus was well occluded. Brain: slight bruising of right cerebellar and temporo-sphenoidal lobes (*contre-coup*). There was no fracture of the base of the skull. When granulations were removed from the inner tympanic wall no fistula could be found in the labyrinth. The left external carotid artery, at its final division into internal maxillary and superficial temporal vessels, had been cleanly divided by the bullet. From this point in the parotid gland to the region of the mastoid apex there was a fine clear track, from whence the bleeding had proceeded.

Commentary.—The parotid swelling, which subsided before operation, was believed to be inflammatory. It must have been due to a deep hæmatoma, which was absorbed later, and proceeded no doubt from the divided artery. Had this been suspected the external carotid would have been tied with the internal jugular. For the injury to cause cerebro-spinal otorrhœa and labyrinthine disturbance there must have been an undiscovered fracture of the temporal bone.

As an example of Group 2 the following case is related:

Private B., aged 21, admitted to — Hospital on August 25th, 1918. Wounded on August 8th; nature of missile unknown.

Entrance wound middle of left cheek; exit wound immediately behind the middle of posterior border of left mastoid.

Condition on Admission.—Temperature, 97° ; pulse, 54; respiration, 18. Patient was lethargic. Tuning-forks showed deafness of a mixed type, partly obstructive, partly cochlear. There was a slight amount of cerebro-spinal otorrhœa on admission, but it ceased the next day. The external auditory meatus was blocked by debris, and in it loose bone could be felt. There was complete facial paralysis. On deviation of the eyes to the right there were rather indefinite nystagmoid movements.

August 27th.—Operation. Lumbar puncture yielded a slightly turbid fluid, under a mild degree of raised pressure (2 to 3 drops per second); a culture was not taken of this. The radical mastoid operation was now performed.

The posterior wall of the external meatus was found comminuted and driven into the external meatus. The whole mastoid except the tip was removed. The sigmoid sinus was found bare at one point, and the bone was chiselled away over the greater part of its extent. The sinus was healthy.

The floor of the middle cranial fossa was removed, and the dura bulged here. At times it seemed to pulsate very feebly, at other times not at all. There was some bleeding from a small branch of the posterior division of the middle meningeal artery, easily controlled by light plugging.

Between the opening in the floor of the middle fossa and that over the sigmoid sinus a narrow bridge of bone was left to check excessive prolapse of dura. There was no gross evidence of injury to the internal ear.

The dura was not incised, but it was expected that this would be necessary in the course of the next twenty-four or forty-eight hours. The post-aural wound was left widely open, and lightly packed with ribbon-gauze. Calomel, 3 gr., to be given every other night.

August 28th.—Temperature, 99°; pulse, 76; respiration, 20. Dressed lightly with "Bipped" gauze.

August 29th.—Temperature, 97°; pulse, 60; respiration, 20. Lethargy distinctly less. Dural bulge is much less. Distinct pulsation in dura, both of middle fossa and over lateral sinus. Re-dressed with Bipp.

August 21st.—No change, except that pulse is 76, and dural bulge has entirely subsided.

September 18th.—Temperature, for the first time since August 28th, rose to normal. Getting up daily. Wound rapidly healing. Feels well.

October 1st.—Going home on sick leave.

Commentary.—Whatever the true explanation, there was certainly a temporary rise of intracranial pressure due to tension of the cerebro-spinal fluid. Similar cases with a similar happy result are not uncommon.

The cases in Group 3 are rare. The following is an instance:

Private B., admitted to No. — Auxiliary Hospital, France, October, 1914. It was impossible to ascertain the date of

his wound. A bullet had entered at the tip of his nose and emerged just above the right mastoid apex.

Condition on Admission.—The bullet had traversed the right maxillary antrum, and the right cheek was swollen. The nasal septum was deviated to the right, and the right inferior turbinal partly crushed. The right external auditory meatus contained inspissated pus.

Hearing Tests.—No tuning-fork was available. Right ear completely deaf to watch by air and bone conduction; completely deaf to speech. Left, completely deaf to watch by air and bone conduction; hears shouting. Patient states that his left ear became deaf suddenly two days after the injury. Complete right facial paralysis.

Labyrinth: the signs were observed for a week, during which there was constant subjective giddiness to the right. This then ceased, and was replaced by objective giddiness to the right.

Spontaneous nystagmus, fine, pure horizontal to the right, was elicited by turning the eyes to the right (1st degree).

The caloric reactions were as follows:—

Neither cold nor warm water appeared to aggravate or diminish giddiness.

Cold water, at 10° C., irrigation, lasting forty-five seconds, resulted in: On *right*, no nystagmus to the left, and no diminution of spontaneous nystagmus on deviation to the right; on *left*, after thirty seconds there was an increase of violence and rapidity of nystagmus to right; this increase lasted only ten seconds after the cessation of irrigation.

Warm water, at 25° C., for a similar period: *Right*, no effect; *left*, spontaneous nystagmus to right nearly cancelled.

Fistula symptom tested on right. Compression had no effect. Rarefaction caused an increase in the spontaneous nystagmus to the right.

The only explanation of these tests which I could suggest was that there was a fistula in the external semicircular canal towards its posterior end, and possibly granulations blocking the canal between the fistula and the ampulla. Rarefaction would induce a current of endolymph from the ampulla, through the utricle, and out of the fistula.

There were no signs of inflammation in the mastoid.

Operation.—After a week's observation. Radical mastoid. A fistula into the horizontal canal was found, as anticipated, about 1 mm. behind the posterior bend of the facial canal. The fistula was considered to be possibly large enough for drainage, and was not enlarged. The lateral sinus was

forwardly placed, and its wall exposed in operating. The whole tip of the mastoid was found comminuted, and was removed. Two weeks later he was reported to be free from giddiness, and to hear ordinary conversation on the left; he walked downstairs to his meals.

Commentary.—The temporary deafness on the left was apparently due to shock.

This type of case, in which the finer manœuvres of otology can be made use of both for diagnosis and treatment of internal ear injuries, is not common.

The other two groups include the vast majority of cases, and they serve to illustrate the value of conservatism; in all cases of doubt it is best simply to perform the radical mastoid operation and then await further events.

CHAPTER VI

THE NOSE AND ACCESSORY SINUSES

The Nose.

THE complete correction of damage to the nose involves several distinct stages, which may be separated by days, weeks, or months. First, there is the early and late treatment of intranasal lesions. Next in order follows the eradication of any suppuration in the accessory sinuses. And, lastly, the plastic correction of losses and deformities of the soft parts of the nose.

Intranasal Treatment : Early.—The treatment of intranasal injuries in their earliest stages is simple, and chiefly preventive. It will, however, repay care and thoroughness, not only from an æsthetic point of view, but also because much of the man's health and comfort in after-life may be influenced thereby.

This early treatment is chiefly preventive in that it is a prophylaxis against certain undesirable happenings—namely, accessory sinus disease, intranasal adhesions, and loss of certain parts of the nose which are difficult to imitate by plastic surgery.

I. *The Prevention of Accessory Nasal Sinusitis.*—In cases where the nose has been partly or wholly destroyed, but the sinuses have apparently escaped direct injury, the nasal cavities should be very thoroughly cleaned out as early as possible by swabbing. Mere douching is insufficient; and copious douching is undesirable, as being likely to carry infection to the sinuses. This latter remark applies also to the use of effervescent solutions such as hydrogen peroxide. An absolutely bland fluid must be used, because the delicate

Schneiderian membrane is very easily damaged, and this results in anosmia or parosmia. The ordinary old-fashioned alkaline nasal wash, "Dobell's solution," or some variant of it, is the best. It should be applied with small gauze swabs in every available nook and cranny of the nasal cavities. Wool swabs should not be used: they tear more easily than does gauze; and if a wool swab catches on a projecting spicule of a fractured bone a piece may be left behind, and be a fertile source of sepsis. I have seen this happen several times.

But the prevention of infective spread to the sinuses is not the only reason for cleansing the cavities at the earliest possible moment: there is another reason. Whether stitches are used to repair the nose or not, injury to any of its soft parts will be followed by stenosis. This applies not only to the margins of the nostrils, but to any part of the nose in front of the nasal bones. And to cause this inconvenience the injury need not necessarily be perforating. I have seen an external cicatricial band narrow the vestibule so that a small speculum could not be introduced past it.

If the nasal cavities are not cleansed at once, sewing up will make this difficult later; or, whether stitching has been employed or not, subsequent stenosis will make efficient cleansing practically impossible.

2. *The Prevention of Intranasal Adhesions.*—Having satisfied himself that the walls and, in as far as they are accessible, the meati of the nose have been thoroughly cleansed, the surgeon's next care will be to anticipate adhesion formation. This is effectively done by interposing between raw mucosal areas which might adhere any convenient non-porous substance covered with oil. If the only route of access is the nostrils—that is, if there is no gross loss of nasal walls—a piece of rubber tubing 3 inches long in each side may answer the purpose. But tubing usually leaves some raw areas uncovered. If it lies along the nasal floor all structures above the inferior turbinate are free to form adhesions. And if it lies tilted obliquely upwards and backwards across the inferior turbinate, the posterior end of

the latter, and the whole of the middle turbinate, are still available for adhering.

I have found it better to use thin sheet rubber when procurable. When, as usually, this is not obtainable, the best thing is a flat piece of soft vulcanized rubber cut to the necessary shape with rounded corners. Dental "rubber dam" is too thin. The same substance may be used, on either side between the septum and middle turbinate, as an internal splint after reducing fractures or dislocations of the nasal bones. Wearing these, a patient can be sent from France to England with a note on his field-card that they should be removed on arrival. In the case of a fracture or dislocation they may be left *in situ* at most for five or six days, and the nose douched twice daily.

When used to prevent adhesions they may be removed at least every second day, cleansed, re-oiled, and replaced under direct vision.

As regards the oily substance used, this does not matter so long as it is mildly antiseptic. Eucalyptol, 5 grains to the ounce of liquid paraffin, or the stock nebula hydrarg. nitratis, work excellently.

3. *The Salvage of such Parts of the Nose as are most difficult to imitate by Plastic Surgery.*—These are, briefly, the columella, alæ, and lobule. I shall refer to this point later when speaking of rhinoplasty, and will here content myself with the bare statement that in trimming up the edges of wounds these parts should be preserved whenever possible.

Intranasal Treatment: Late.—The late treatment of intranasal injuries, considered apart from the accessory sinuses, simply amounts to the re-establishment of the airway. In order to do this all the ordinary operations of rhinology will be used—turbinectomies, septal resections, and removal of spurs.

But there is another procedure which is often required, which can hardly be considered as included in the rhinologist's schedule, unless it be regarded as the removal of an enormous nasal spur. I refer to the large masses of callus which have so often to be cut out of the nasal cavities. For

these a nasal saw may be used, but often gouges and chisels are requisitioned.

For the patient's sake great care will be taken not to fracture the maxilla. But such cases, of course, often occur after wounds involving the upper jaw and palate. And for his own sake, the surgeon must be quite certain before he operates that a fracture which is ununited or has only fibrous union does not exist. For if it does even a gentle operator may refracture it, and so be wrongly held responsible for the damage (see p. 277).

It is not in the scope of this book to describe the ordinary stereotyped operations of rhinology. The only remark I would make is a caution to spare the tissues of septum and turbinals as far as possible.

The rhinologist, confronted with a nose which requires internal correction some weeks after injury, will naturally not find the regular cavities with salient landmarks to which he is accustomed in civil practice.

The inferior turbinate may merge into a mass of callus in the nasal floor; the free end of the middle turbinate may end in a horizontal shelf which shuts off the ethmoidal gallery. Either of these adventitious bony masses may be widely adherent to a septum which is twisted and thickened almost beyond recognition. The deviations of a septum nasi may be corrected by submucous resection even when the resection has to be prolonged beyond adhesions. In these cases it is best to resect first and divide the adhesions at the end of the operation. If the adhesions be divided first there is a high probability that in performing the resection a perforation will be made at the site of the divided mucosa. Whereas, if the adhesions be left until the last, they do not interfere with the submucous resection nearly so much as would be expected, and the risk of creating a perforation is less.

The difficult types of septa are those which are thickened rather than deviated. This may occur from callus formation following a perforating wound, or after a non-perforating blow on the nose. The only similar condition seen in civil practice is that sometimes found in boxers.

There are cases in which even a badly deviated septum may be better left alone: if there is a history of earlier attempts at resection, if there is a good-sized perforation, or if the cartilage may be later required for building up the bridge by the plastic operator. This reference to plastic operations brings me back to the remark just made, that, although confronted with amorphous masses of turbinals and septum, it is wise to be conservative. The ordinary argument for conservatism—the fear of atrophic rhinitis—of course applies. But there is an additional reason, in that pieces of turbinals and septal cartilage may later be of use in rhinoplasty.

Accessory Sinuses.

Early Treatment.—Of the immediate treatment of injuries to the nasal accessory sinuses the war has not added much to our knowledge. Free surgical drainage, the removal of large sequestra and foreign bodies, and a watchful eye for sequelæ sum up the situation.

I have already mentioned, under the section Removal of Foreign Bodies, that in external incisions the ultimate cosmetic results should, as far as possible, be respected; also, the possible later requirements of the plastic surgeon. The latter may wish to translate large flaps, which will need a good blood-supply. It may handicap him if the deep scar tissue resulting from an earlier bold incision crosses the pedicle of his flap.

When obliged to make external incisions for the immediate treatment of sinus injuries, the surgeon can usually form some idea, from the nature of the lesion, of what incisions will least interfere with later plastic work. Some illustrations of plastic flaps will be found in this book under Rhinoplasty and Facial Injuries. Here I would merely repeat that for all sinus injuries except the frontal, and in all cases of doubt, a curved incision in the infra-orbital crease is far the best. It has the following advantages:

The scar is imperceptible. Bleeding (from the facial, angular, and infra-orbital vessels) is easily controlled. Wide

retraction of the cheek, giving admirable access, is easy. The facial nerve is not endangered. The opening made in the antral wall may be kept well above the alveolar margin, so that there is no risk of breaking the maxilla or of opening up the gingivo-labial sulcus and thus creating an obstinate antro-buccal fistula. The inner antral wall may be cut away at the same time to the desired extent, providing such good drainage of deep regions that the external opening may be closed at once. Lastly, the object for which the incision is made—good access to very deep regions with a minimum of risk—is attained; the deep regions alluded to include the postero-internal or orbital angle of the antrum, the ethmoid, the sphenoidal sinus, and even the pituitary fossa.

As regards the lotions used for swabbing and irrigating: it is well to avoid the infection-bearing effervescence of hydrogen peroxide in any but gross lesions; but in the latter, when there is obviously already a multi-sinusitis, if not a pan-sinusitis, I see no harm in it, and have used it freely.

For an injury of the frontal sinus exposing the dura, Bipp on ribbon-gauze may safely be packed in, and the wound even left sewn up, over the gauze, for several days; this is often useful.

When transporting a wounded man; as regards the maxillary antrum, it is rarely necessary to make an external opening. In hyperacute cellulitis of the cheek this may be required, or in a brawny œdema spreading downwards from an antral focus, and threatening an angina of the neck with laryngeal œdema.

In such fulminating cases I have several times been obliged to make one to three free incisions, parallel to the branches of the facial nerve, and simultaneously to perform laryngotomy or tracheotomy as a precaution.

In one such case the infection was so acute and rapid that I found the facial vein thrombosed to the size of a pen-holder, and resected the thrombosed part, about 3 inches in length.

But the vast majority of injuries to the maxillary antrum do not require external incision; they may be treated just like an empyema in civil practice. To make sure that until

the infection subsides the drainage is sufficient, and to prevent any possibility of a flare-up while the wounded man is being shipped home, I have often adopted the following plan:

The two usual openings are made—one in the outer antral wall through the gingivo-labial sulcus; the other in the inferior nasal meatus, usually after a partial removal of the inferior turbinate bone.

A piece of tubing, about 6 inches long and $\frac{1}{8}$ inch in diameter, is taken, and one lateral hole cut exactly in its middle. The tube is now passed through the opening in the canine fossa, through the antrum and the opening in its inner wall, to emerge at the nostril. The single lateral opening in the tube must lie in the antral cavity.

The nasal end of the tube is stitched to the upper lip near the angle of the mouth.

Irrigation is carried out from this end, and the solution comes out from the other end, which lies just below the cheek. As soon as the patient is settled in a Base hospital the tube may be removed.

Late Treatment.—The late treatment of injuries of the nasal accessory sinuses, as compared with the earlier treatment, gives the rhinologist much greater scope to use his special knowledge and adapt it to the peculiar circumstances created by gunshot wounds. I use the word "late" merely in contradistinction to "immediate." It is not for a moment implied that the late treatment should be delayed longer than is necessary; indeed, it is lamentable that this should ever occur.

As soon as ever the patient is ensconced in a Base hospital at home, the thorough correction of any accessory sinus disease or injury should be undertaken.

If, as is so usual, there has been a concomitant injury of the soft parts of the face, sufficient to demand plastic repair, the surgical manœuvres directed against the sinusitis will be modified accordingly—that is to say, the position and extent of any unavoidable external incisions will be limited by the subsequent necessity for flaps. And the amount and

position of bone cut away will be similarly limited. If the rhinologist himself is going to finish the plastic work later, he should make up his mind on such points as these before he begins. If the plastic work is to be undertaken by another, the rhinologist will confer with him before undertaking anything which could invalidate it.

There are several arguments for the prompt systematic examination and treatment of accessory sinus disease due directly or indirectly to gunshot wounds.

1. *The avoidance of late complications and sequelæ.* I do not, of course, intend to dilate upon the sequelæ of sinus disease, which are familiar to the reader. Early treatment naturally makes for the avoidance of complications, be they medical—such as bronchitis, gastritis—or surgical, such as cavernus sinus thrombosis, optic neuritis, and intracranial infections of meninges or brain.

But in the case of surgical sequelæ there is a factor which does not occur in simple non-traumatic sinusitis. As I shall mention shortly, apropos of the maxillary antrum, the bony lesions produced by penetrating missiles are often anatomically of much greater extent than is apparent. And an undiagnosed radiating fracture of the facial bones, or of the floor of the anterior cranial fossa, may give entrance to a slow infective process of which the results only declare themselves later. This, then, is a supplementary reason for early treatment of traumatic accessory sinusitis.

2. *If, as is quite common, part of the face is destroyed, access is far easier before the gap becomes narrowed, or its margins closed by scar tissue.* I have seen examples of this self-evident truth repeatedly in France and at home.

The most deft and experienced specialist is occasionally balked of a complete success at the first attempt to deal with the deeper regions *per vias naturales*. The ethmoidal cells and sphenoidal sinus rarely conform rigidly to anatomical type. And partly on this account, and partly because of the difficulty of access, and therefore of discovery, aberrant cells are often overlooked. Orbito-ethmoidal, fronto-ethmoidal, and infundibular cells perhaps do not show in the skiagram.

An antral recess, unsuspected, may extend into the malar bone. The sphenoidal cell is rarely typical or symmetrical with its fellow; and its antero-inferior wall is often so strong that it cannot easily be broken down; wherefore the ostium is insufficiently opened by the surgeon, who has perforce to operate again.



FIG. 22.—As a first step, dead tissue was cut away, and the remaining important parts of the nose (lobule, columella, alæ) sewn to the left cheek, which region happened to promise most as regards vitality. Later, the patient developed a multi-sinusitis.

For in these regions he cannot take risks. He may not open a cell unless he is quite sure it is a cell. And it is better to operate in several stages than to perforate the os planum of the ethmoid, fracture the cribriform plate, or to damage the optic nerve, cavernous sinus, or even pituitary fossa, in zealous efforts to cure the patient in one séance.

For reasons such as these it is admittedly not only justi-

fiable, but often expedient, to attack the nasal sinuses in several stages. All this is true of civil practice. But in war injuries, if there is a hole in the patient's face, the matter stands quite differently. From nasal vestibule to sphenoid



FIG. 23.—Shows the clean condition of the parts resulting from conscientious drainage of the sinuses. The rescued soft parts of the nasal tip, grafted on to the left cheek, would have been invaluable for plastic work. But, for private reasons, the patient elected to go home and wear a prosthesis to fill the gap.

is easily visible, sometimes without a speculum, often without using cocaine and adrenalin. It has repeatedly struck me how relatively easy it would be on such a case to demonstrate the regional anatomy to students.

Fig. 22 is one of many illustrative cases which I have seen. At one operation, easily and quickly, I exenterated his ethmoid, opened the right sphenoidal sinus and both frontal sinuses. The latter I drained by means of a **T**-shaped metal

tube; the lateral horizontal limbs passed into the sinuses, the vertical limb projected downwards. Fig. 23 shows his condition after thorough drainage.

3. *Access to the sinuses is very difficult after rhinoplasty.* We have just seen that, compared with civil practice as a standard, accessory sinus manipulations are relatively more simple when a gap exists in the soft parts of the face, especially of the bridge of the nose. It remains to add that, taking civil cases once more as the standard or average as regards ease or difficulty, these manipulations are infinitely more difficult after rhinoplasty. Indeed, although others may have been more fortunate, I have never seen a case of total rhinoplasty in which satisfactory access to the sinuses was subsequently possible. For in these cases the alæ are inelastic to a speculum; and the unyielding lumen of the nostrils is not a feature only of their margin, but extends right through the vestibule; the inelasticity is tubular, not annular.

Plastic surgery is steadily making advances; and with improved methods of constructing thin alæ and columellæ, and of obtaining a permanent growth of cartilage within these, no doubt the nostril will become more amenable to dilatation. But at the moment, I think my criticism of total rhinoplasty is a fair one.

And with a partial rhinoplasty we are not necessarily much better situated for dealing with the sinuses.

Suppose, for example, there is a subtotal loss of the nose, the alæ, columella, and lobule remaining. The rest is constructed from a flap containing a rib-cartilage. If this flap be not lined with skin its deep surface naturally proliferates into an obstructing mass of granulating tissue, which, although not interfering with the cosmetic result, largely fills the anterior part of the nasal cavity. And even if the flap be lined, such a flap, with the inserted rib-cartilage, will, in any event, be thicker than the natural parts. So that, either the nasal cavities are encroached on or the nose is, externally, too big. Moreover, if the septal cartilage or the turbinals have been partly shifted to form a support, they may cause additional obstruction.

It is, therefore, of paramount importance to correct sinusitis early.

There is yet another cogent reason. A nasal discharge due to rhinitis, with or without sinusitis, may actually interfere with the healing of rhinoplastic flaps. I know of a case in which a rib-cartilage placed in the forehead down as far as below the glabella, preliminary to rhinoplasty, necrosed and sloughed out; and the surgeon considered the infection arose from suppurating anterior ethmoidal cells.

It is obvious that, for the reasons given, the treatment of sinusitis must be completed before rhinoplastic efforts are begun, and as early as possible.

CHAPTER VII

THE ACCESSORY SINUSES CONSIDERED IN DETAIL— THE LACHRYMAL SAC

The Sinuses considered in Detail.

The Maxillary Antrum.—The extent of damage suffered by the antrum as the result of a gunshot wound may vary from the trifling to the most gross. In the former case a bullet or piece of shrapnel may traverse both antra and the nose, and after the wounds have healed there is absolutely no evidence of any sinusitis whatever. Such through and through antral wounds have been seen, I suppose, by every surgeon in this war. In the latter case, a missile, which may be quite small, fractures one wall of the antrum; and if this cavity is not explored for drainage, a few weeks later it contains pus, and its lining mucosa is degenerate and friable, perhaps polypoid.

These curious inconsistencies in the reaction to injury of the antral lining are difficult to correlate with any varying attributes of the missile. It is not possible to say that size, velocity, direction of wound, has this or that influence on the result. The decisive factor can hardly be infection, for all such wounds are necessarily infected.

Apart, however, from the amount of disease initiated in the mucous membrane lining the antrum, there is another respect in which the results of injury vary widely, and that is in the extent of bony damage. And in this regard it is to some extent possible to correlate the seriousness of the lesion with the direction and nature of the missile. The harm inflicted may vary from a small depressed comminuted fracture of the antral wall to extensive multiple fissures radiating widely. These radiating cracks extend most frequently

into the floor of the orbit; next in frequency into its inner wall; and much more rarely into the malar bone. This latter becomes disarticulated from the superior maxilla much oftener than smashed.

The extension of fractures into the alveolus will be referred to under Injuries to the Jaws.

Now it will be found that the site from which radiating fractures are least likely to spread is the middle of the outer antral wall. There is nothing striking in this observation; it is what we should naturally expect, bearing in mind the thinness of the bone here. But, further, I have repeatedly noticed that a bullet here does less harm than an irregular piece of shrapnel. The latter, even if it passes into or through the lower part of the antral cavity, is much more likely to produce fractures radiating into the orbital floor. This floor may be found comminuted, and picked out piece-meal nearly as far back as the sphenoidal fissure, after a wound by a piece of shrapnel, which, from its course, has obviously not touched it. I observed these points about bullets and shrapnel in the first three months of the war, in France, and ventured to generalize from them. And my deductions were right very much more often than not.

In speaking of the early treatment of wounded antra I mentioned the use of a continuous tube to drain simultaneously from nose and mouth. This is, after all, merely a variant of the Caldwell-Luc operation. And, with the exception of cases which require only drainage by the nose, the Caldwell-Luc will be the basis of the late treatment of suppurating antra also.

Intranasal Drainage.—When it is designed to drain the antrum into the inferior nasal meatus of an intact nose, the technique is in most respects the same as that in civil practice. The operation consists essentially in cutting a window through the naso-antral wall at the lowest available level. And the only variations which have been practised in peace time work consist in attempts to conserve the nasal mucosa by various artifices.

Thus, instead of adopting the usual method of partial

resection of the inferior turbinate, a few surgeons have preferred to fracture this bone at its synostosis with the antral wall. The fracture is made without damaging the mucosa, by forcibly turning the turbinate upwards, as on a hinge; a window is now cut into the antrum, and the inferior turbinate bent down again into its normal position.

Others preface the excision of the naso-antral wall by the reflection of a mucosal flap, which is then tucked into the antrum around the edges of the bony opening, the object being, by epithelializing a large part of its circumference, to encourage rapid healing of the opening without any narrowing by granulations or cicatricial tissue.

Such refinements are not often practicable on a traumatic case. As I remarked earlier in this section (p. 100), normal landmarks and nasal contents are commonly blurred into a mass of callus. The mucosa lining the passages and overlying this callus has shared in the injuries received, and is scarred, fibrous, adherent to bone. To make neat little flaps is a counsel of perfection; they prove to be friable even in process of making them, and they slough afterwards. The upshot is that intranasal drainage of the antrum after war injuries comprises, as a rule, the simple operation of removing the anterior part of the inferior turbinate, and then, with nibbling forceps and various burrs, cutting a fenestra in the naso-antral wall.

But this remark applies only to a patient with an intact nose, on which any operation must be carried out through the nostril. On the other hand, when so much of the nose has been destroyed that the surgeon can manœuvre through the gap, he has a scope which is unknown in ordinary rhinology. Fig. 24 exemplifies what I mean. The man suffered from a chronic sinusitis. Through the external wound I was able to cut away the naso-antral wall as far back as the internal pterygoid plate, and right down to the nasal floor. Perfect access such as this is afforded by many of these large facial gaps.

Radical Operation on the Antrum.—As remarked above, the type of operation indicated is the Caldwell-Luc. And

in this book it is necessary to consider in what way variations or limitations of the stereotyped technique are imposed by war injuries.

In the Caldwell-Luc operation two openings are made: one into the nose, and one, which is designed to be only temporary, into the canine fossa. If the latter opening remains patent the operation is at best only a partial success. The patient is disappointed at the persistence of a discharge, even though slight and mucoid, into his mouth; and the

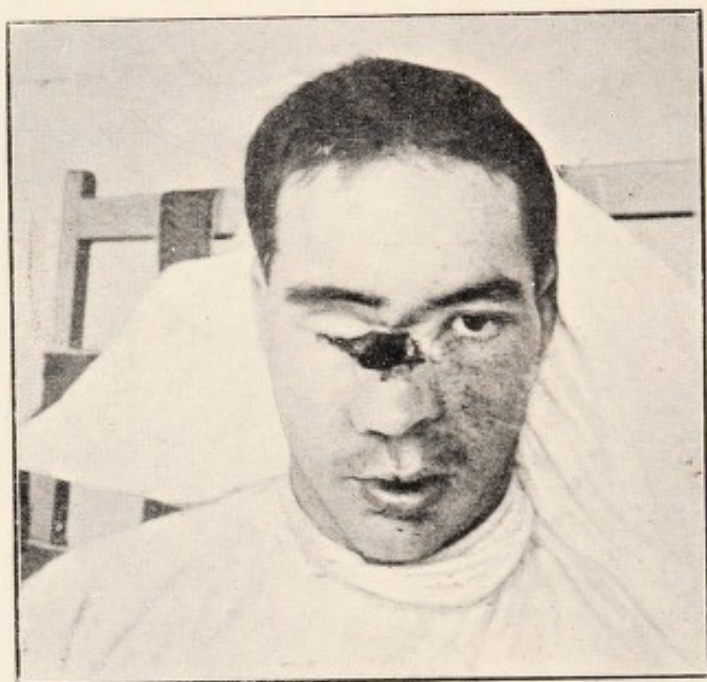


FIG. 24.—Operated on with Lieutenant-Colonel H. S. Newland, D.S.O. The naso-antral wall, as far back as the internal pterygoid plate, was completely cut away. This plan, which is not at all stereotyped, gives admirable antral drainage, and is recommended by the author for cases of obstinate sinusitis with a large hole in the face.

dental expert, who expected to have a clean mouth to work on, is handicapped in the fitting of a denture, and has a just grievance. Indeed, if the opening into the canine fossa remains patent after this operation, one of its chief advantages over the prehistoric operation through a tooth-socket is lost.

Now, there are certain happenings incidental to war injuries which militate against the closure of this opening in the gingivo-labial sulcus.

1. Scarring and fibrosis of the mucosa of the sulcus, preventing healing after incision. When a wound of the cheek or mouth has produced this condition without injuring the outer antral wall, it is wiser first to put in an epithelial inlay to deepen the sulcus with healthy mucosa; or else to avoid the canine fossa entirely, and elect one of the other procedures mentioned below.

2. The alveolar bony margin may have been shot away. This, to which allusion will again be made in reference to injuries of the maxilla, of course makes the gingivo-labial sulcus more shallow. Consequently, the margins of any incisions in the mucosa tend to gape, and will probably not heal completely. Added to this, the muco-periosteum has to be elevated from depressions which represent old tooth-sockets, to which it is closely adherent. Under these circumstances an opening into the canine fossa has a poor chance of healing.

3. The outer bony wall of the antrum may be missing. This, which I have encountered repeatedly, may come as a surprise. For the skiagram may not have been fully informative; and the thick cheek tissues prevent any external deformity.

The absence of bone in the region of the canine fossa should be looked out for. When it occurs, the outer fleshy and inner bony walls are more or less nearly in contact; the antrum is only a potential cavity. Any opening made under the cheek will lie close to the inferior nasal meatus, constantly infected by nasal discharge. As a fact, the oral mucosa in these cases does not usually heal completely.

In any of the circumstances outlined above the typical Caldwell-Luc technique is relatively contra-indicated. If then in such a case simple nasal drainage is insufficient, if a more radical procedure and a wider opening is called for—either by the mere necessity to inspect the cavity, or because a diseased or polypoid lining necessitates thorough curettage—some other route must be selected.

There are two routes available. In both the internal nasal wall and the external facial wall of the antrum are simultaneously cut away from before backwards to the

desired extent, at the level of the inferior meatus; that is to say, the anterior angle of the antrum, at the margin of the *apertura pyriformis*, is opened.

In Canfield's operation this is done through the nose, by dividing the mucosa at the articulation of lateral cartilages with bone.

In Denker's method the bone is attacked from under the lip. The incision is made farther forward than in the Caldwell-Luc operation; it may even divide the *frænum* of the upper lip, so that the region where the outer antral wall is missing is avoided. The nose is retracted a little upwards (as in Rouge's route of access), and, when the bone has been cut away, allowed to fall into place.

Either of these methods is preferable to the stereotyped Caldwell-Luc under the exceptional conditions detailed above.

Deformity after Injuries to the Maxillary Sinus.—The skin, the buccal pad of the fat, the muscles, and the mucosa together constitute so thick a covering that great deformity after gunshot wounds is rare.

In the cases referred to above, when the outer bony wall is to a great extent missing, the cheek is sometimes flattened. This flattening may amount to a deep dent if the malar bone has also been shot away.

The dent, of course, only becomes obvious late in the course of the case, when all active inflammation has subsided, sequestered and comminuted bone has been removed, the wound has healed, and its site has been replaced by scar tissue.

There are many cases in which the missile which has comminuted the malar bone or outer antral wall, or both, has also destroyed a greater or less amount of the facial nerve. In such patients the sinking in of the cheek on the injured side is much more noticeable during laughing, eating, or any other movements of the facial muscles on the sound side.

If the deformity is unsightly enough to handicap the patient in his success in after-life, or to distress him or his relatives, a plastic correction may be made. But the unsightliness of these cases is very much less repulsive than that of a man

whose nose or mouth is deformed; and I am of opinion that the more moderate degrees of depressions in the malar and antral regions may well be left alone.

It will be understood that the bony lesion in the cases under consideration is confined to the outer antral wall and malar bone. If the loss extends down to the alveolar process, we are, of course, concerned with an injury to the upper jaw. This will be corrected by a prosthetic appliance, as will be mentioned under the section on Jaw Injuries.

Assuming that in a given case it is considered advisable to fill up the cheek depression, this may be accomplished in several ways.

1. In the least marked cases a small linear or irregular-shaped scar forms the base of the depression, but the remainder of the cheek is plump and well nourished. The technique is simple and as follows:

The scar tissue is excised from the skin, and from the narrow linear gap thus produced skin flaps are raised. The flaps are turned up and down or forwards towards the nose and backwards towards the ear, depending upon the vertical or horizontal direction of the scar; whatever the direction of the scar, the flaps will be raised in a direction at right angles to it. Thus a roughly circular area of fat and fascia is exposed; owing to the injury, there is a certain amount of fibrous tissue in the fascia. But if the method here described is to succeed, this fibrosis must not be extreme, for if it is the method will fail, and the case should rightly be dealt with as described under one of the methods, 2, below.

A flap of fat and fascia is now dissected up, beginning at the extreme upper end of the bared area. The tissue is raised as far down as $\frac{1}{2}$ inch from the horizontal diameter of the area, which will be about $\frac{1}{4}$ inch from the line where the original depression was deepest. This $\frac{1}{4}$ inch thickness of fat, in the horizontal axis of the depressed area, will form the pedicle of this flat-flap.

A second flap of fat and fascia is now similarly raised upwards, beginning at the extreme lower limit of the bared area, and having its horizontal pedicle above.

The pedicles of the two flaps are separated by the original area where the dent was deepest. The upper flap is now turned down to meet the lower, which is turned up, and the free edges of the two are sewn together with three or four catgut stitches. This row of stitches now lies over the space between the pedicles—that is, where the dent was deepest—and the dent is covered by these joined flaps. The skin flaps are now replaced and sutured.

It will be noted that the skin flaps were turned up and down, forward and backward, or obliquely, depending on the direction of the excised scar. But the fat-fascia flaps are always to be turned up and down, because they must have a horizontal pedicle. The object of this is to interfere as little as possible with branches of the facial nerve.

According to the precise part of the cheek on which the surgeon is working, the axis of the flaps will be made to deviate slightly from the horizontal, always bearing in mind the branches of the nerve.

2. In slightly worse cases, when the fat has mostly disappeared from the cheek, and especially when the depression is high up and far back towards the malar region, a flap of temporal muscle may be used. There are two methods of carrying this out.

As a preliminary, the side of the head is shaved to the sagittal diameter in either case.

(a) An inverted **U**-shaped flap of skin is raised, concavity downwards and forwards. The maximum height of its loop is 1 inch above the outer canthus of the eye. Its anterior limb descends to just above this canthus. Its posterior limb extends to $\frac{1}{2}$ inch in front of the tragus.

A piece of the temporal muscle and fascia is now detached from its anterior margin. The detached piece is of the size necessary to fill the depression, and its pedicle is at its lowest point. It is now swung downwards and forwards to fill the depression, and sewn to adjacent fascia. The skin flap is replaced.

(b) Instead of an inverted **U**-shaped flap, the operation may be performed through two parallel incisions, directed

from above and in front, backwards and downwards—that is, parallel to the upper fibres of the facial nerve. The skin behind the posterior incision is undermined, and a flap of muscle, pedicle downwards, raised. The skin in front of and below the anterior incision, over the depressed area, is also raised, to make a bed for the muscle-flap.

The skin between the two incisions is entirely undermined, and the muscle-flap passed simultaneously to its new position and sutured there. The skin incisions are finally closed.

(c) In very bad cases, with a broad depressed area of scar tissue in the cheek, there is more skin as well as fascia required. After excising the scar tissue, a pedicled flap of skin—for instance, from the neck—will be fitted, and the pedicle divided after fourteen to twenty-one days. These cases are not merely antral deformities, but belong properly to the class of facial injuries, so they will not be further considered in this section.

(d) If there is a deep hollow ending in a sinus into the nasal cavity, even a pedicled skin flap may not suffice. A bed is first required, to shut off the nasal passages and form a foundation for the skin flap. This foundation may be made by swinging forward, as on a hinge, the remains of the naso-antral wall, and inferior or middle turbinal.

For the correction of deformities in this region I have not referred to *free* fat grafts, because I have not found them successful. The fat tends to liquefy and emerge through the incision and stitch-holes as oil.

The Ethmoidal and Sphenoidal Cells.—It is by no means rare for these to sustain injury, and even for a foreign body to lodge in the ethmoidal gallery. Under the section Localization of Foreign Bodies I have already referred to one case (p. 22), in which a piece of shrapnel passed into the alimentary canal from the ethmoid, between the moment when the skiagram was taken and the moment of operation, and was subsequently passed *per rectum*.

This occurrence must, however, be exceptional. The rule is rather that the shrapnel fragment gets firmly jammed in the body of the ethmoid, and the difficulty is to dislodge it.

Unless there is a perforating wound into the nose the intranasal route will always be adopted. Careful skiagraphic measurements—stereoscopic, or combined lateral and antero-posterior—are required.

The nose is then thoroughly cocainized and adrenalinized. But, owing to œdema of the more accessible parts, the deeper ethmoidal regions will rarely be properly anæsthetized by local means, and a general anæsthetic is usually necessary.

Precautions are to be taken against the foreign body becoming dislodged and falling into the trachea. To guard against this a post-nasal plug is inserted, and the patient placed in the Rose position—head maintained hyperextended by a sandbag beneath the nape of the neck. In this position respiratory distress is often noticed, but is overcome by the anæsthetist making full traction on the tongue.

To search for the shrapnel the middle turbinate will, as a rule, require removal. The ethmoidal cells are now inspected and probed.

If the shrapnel is impacted in the lateral mass of the ethmoid, the cells may be punched away with forceps; if it has fractured the os planum and partly perforated the orbit, the same applies; in the latter case orbital cellulitis, requiring free external drainage, will be watched for. But if there is any possibility that it is partly impacted in the cribriform plate, the greatest circumspection is necessary. On such an occasion, although an external incision may not be absolutely essential, the surgeon can certainly not be adversely criticized for adopting the external route.

Similar principles apply to the drainage of wounds of the ethmoid, apart from the extraction of foreign bodies. In general terms, the intranasal route suffices always when only the ethmoidal cells have been injured, sometimes when the os planum has been pierced, very rarely when the cribriform plate has been perforated.

The surgeon is often relieved of the responsibility of deciding on a route by the existence of an external wound.

Many gunshot injuries of the ethmoid (and the same applies to the frontal sinus) will have destroyed one eye.

This quite eliminates any difficulty as to the choice of route.

By cutting away the inner orbital wall a perfect exposure is, of course, obtained, and the patient suffers no disability.

When satisfactory access to the deeper regions of the nose cannot be obtained through the nostrils owing to adhesions and other causes already mentioned, there are, in fact, two routes of choice. If one eye has been destroyed, operate through the inner orbital wall. If both eyes are intact, proceed through Moure's incision, as detailed in the section on Routes of Access.

The absence of one eye must be fully taken advantage of for the thorough cure of ethmoiditis and sphenoidal sinusitis, by very free removal of the inner orbital wall. For it is well known that these infections may cause optic neuritis, and since the patient has now only one eye, its function calls for the most thorough prophylactic protection.

Whether or not the foreign body has finally lodged in the ethmoid, any war injury to this bone is more often than not accompanied by lesions of the septum, agger nasi region, and vestibule. This will have resulted in adhesions, which must be divided before access to the ethmoidal cells is possible. There is one shape and situation of adhesion which I have found very often. It is in the form of a shelf, either horizontal or sloping from above and in front, downwards and backwards. It stretches across from the agger nasi region to the highest part of the cartilaginous septum, or to the lowest part of the bony ethmoidal part of the septum, and quite prevents inspection of the middle turbinate region.

Any such adhesion as this, which has a considerable transverse extent, should not be merely divided; such a course will be followed inevitably by readhesion, no matter how carefully the surfaces be kept from contact during the days following the operation. It is necessary to excise these wide adhesions, or punch them out piecemeal with nibbling forceps; the usual oily dressing for a few days will then be followed by successful healing.

Having then cut out what may be called the "shelf,"

adhesion, the middle turbinate and ethmoidal cells may be dealt with. Sometimes another wide adhesion, previously invisible, will now be found between the posterior end of the middle turbinate and the vomerine septum, or between the latter and the outer nasal wall. This also should be removed, as it interferes with the drainage of the posterior ethmoidal and the sphenoidal cells.

Whenever this posterior shelf adhesion has been found, suppuration may be expected in the posterior ethmoidal group or sphenoidal sinus.

As was remarked earlier, the access obtained to the deeper nasal regions when the wound has produced a large hole in the cheek or a complete loss of the nasal bridge, is admirable.

The sinuses are dealt with through this gap.

In any such case where there is suppuration in the anterior or middle ethmoid region, and a wide adhesion shutting off the posterior ethmoidal and sphenoidal cells, it is best to assume that these are infected.

The surgeon should accordingly cut out the adhesion, and then punch out any posterior ethmoidal cells he can find, and enlarge the ostium of the sphenoidal cell.

Under the most favourable circumstances in civil practice it is often difficult to cut away the antero-inferior wall of the sphenoidal sinus for the purpose of enlarging its ostium. The wall of the sinus is hard and strong.

If, then, in a nose with normal landmarks, after repeated observation, careful cocainization, and removal of the middle turbinate, there is this difficulty, it will be readily understood that the obstacles to accurate diagnosis and treatment are vastly greater after a gross neighbouring lesion. Adhesions, granulation tissue, a crushed vomer, a stenosed vestibule—any of these contribute to make the difficulty enormous.

In such cases, undoubtedly, the whole ethmoid should be exenterated if it is diseased; and, while the gap in the face is still available for access, the sphenoidal sinus drained. Every cell that can be seen—upwards to the cribriform plate, outwards to the inner orbital wall, and backwards to the basi-sphenoid—should be opened and drained. Other-

wise, if the surgeon be as conservative as he would in peace time, and open a few cells, intending later and in several stages to open any more which may require it, he will probably regret it. Some months later he will be asked to deal with a sinusitis in a patient who has been through the many operations necessary to make a plastic nose; to reach

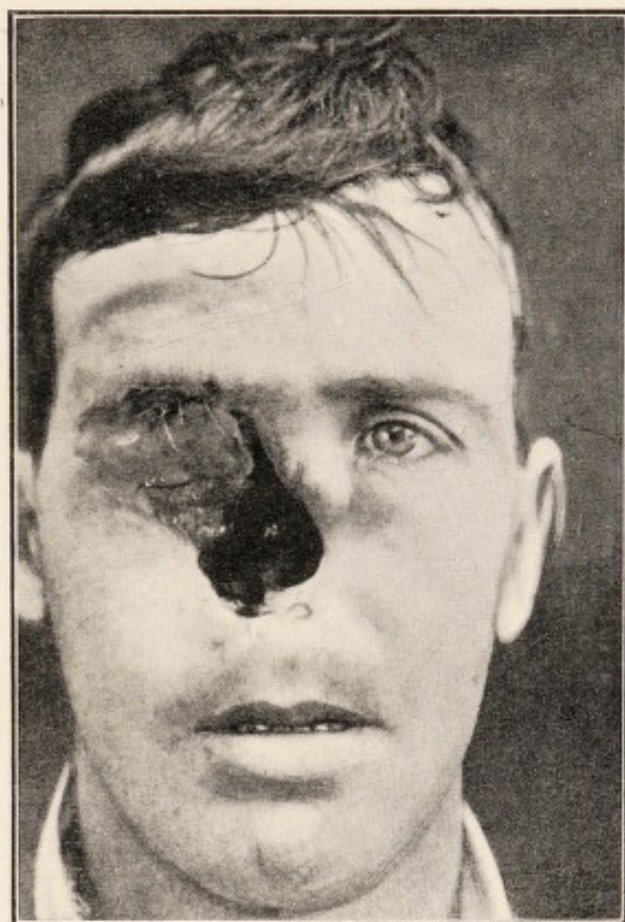


FIG. 25.—The vertical incision at the summit of the gap was made into an inflammatory swelling, believed to be an empyema of the lachrymal sac. It proved to be a collection of suppurating ethmoidal cells. The whole ethmoidal gallery on this side was exenterated up to the cribriform plate, and the view so obtained revealed an unsuspected flow of pus from the sphenoidal sinus. This also was nibbled away. Result, excellent.

the infected cells will then be an impossibility. I have pointed this out earlier, but regard it as of sufficient importance to merit repetition.

Fig. 24 (p. 112) shows a man whose naso-antral wall I cut away for two-thirds of its extent, operating through the facial gap. The result was most gratifying; naturally his sinusitis was cured.

Fig. 25 is a man for whom I opened, through a similar route, all the ethmoidal cells and the sphenoidal sinus on the right side. The result again was perfect. I publish these two photographs merely as examples of a large number.

The Frontal Sinus.—Gunshot injuries to the frontal sinus are not uncommon.

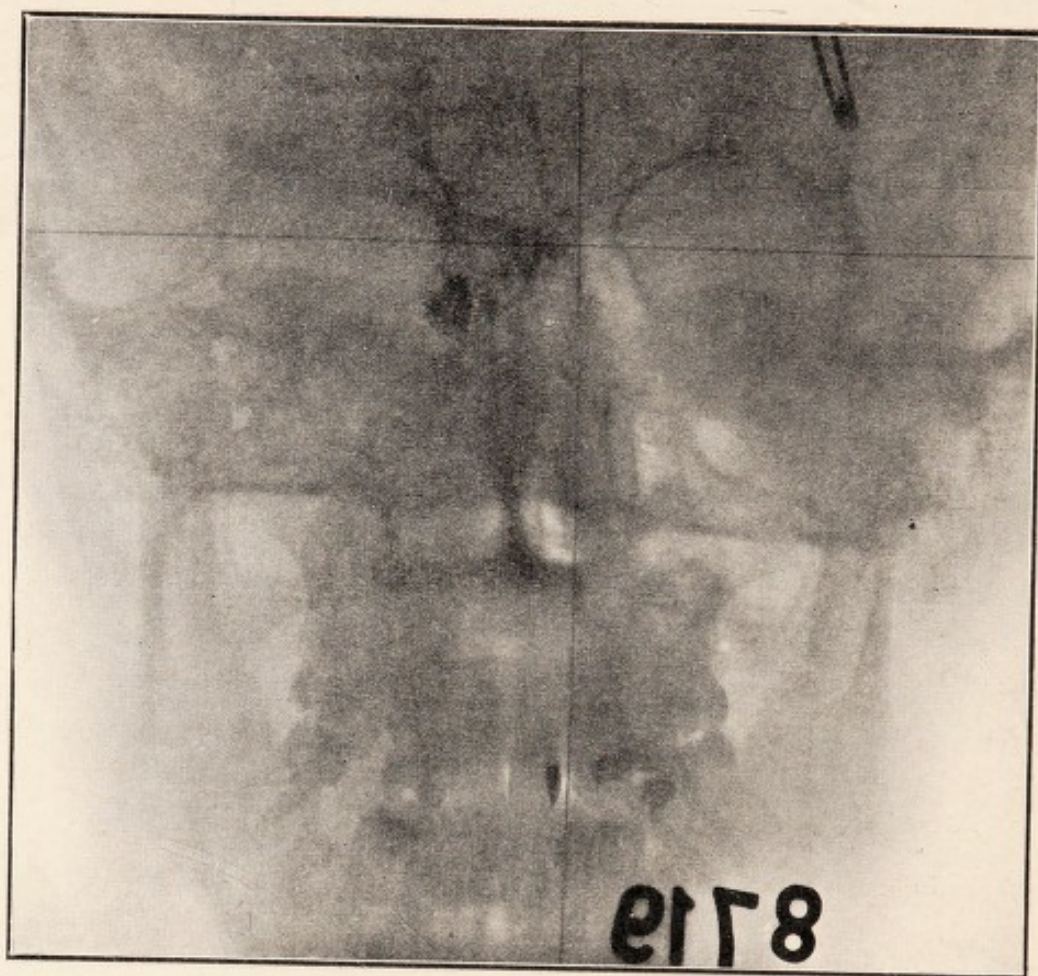


FIG. 26.—The piece of shrapnel had made a very small entrance wound, and rested in the middle ethmoidal cells. The patient took a general anæsthetic badly, and the foreign body was easily removed by slightly enlarging the wound, through the external route, under 5 per cent. novocain.

When first examined, the most urgent question will be whether the adjoining eye or the frontal lobe of the brain has been damaged. If these have escaped, it will usually be considered that there is no good reason to keep the patient in a hospital overseas (which might be necessary to save his sight, or operate in case of a meningeal or cerebral injury). He will be sent home as a wound of the frontal sinus.

The most important point to establish at this stage is whether or not the posterior sinus wall has been fractured.

To settle this point unequivocally is often not easy. The mere position or outline of the posterior wall as seen in a skiagram is not conclusive. Frontal sinuses vary greatly in depth, and a slight depression in the posterior wall may closely resemble a depressed fracture. Moreover, it is difficult to obtain such a view of one sinus that the outline is not blurred by other parts of the skull. If the rays be directed through the occiput in a sagittal direction a small punctured fracture will often escape detection. If the rays be directed transversely the walls of one sinus overlap and blur those of the other. The expert knowledge of the radiographist will decide how best to show a given point or stratum of bone; probably rays sent through from the sound side of the skull, not quite transversely, but at a slight angle to the coronal plane, give most information about the posterior wall of the sinus. This position also shows the ethmoidal cells. In fact, it is only a slight variant of the "oblique ethmoid" position of Iglauer.*

When there is an external wound into the frontal sinus, a probe cautiously used will give great help; and a transverse skiagram taken with the probe *in situ* impinging against the posterior sinus wall perhaps gives the most valuable information available.

Fig. 28 is a skiagram exemplifying this point.

If the posterior wall has been fractured, operation is likely to be necessary very soon; it is unsafe to rely for drainage on the external wound unless very large, and the normal channel of drainage into the nose by the infundibulum may be regarded as utterly inadequate.

If the posterior wall has entirely escaped injury, the question as to whether external operation will be required, or when it will be required, depends again on drainage; but less ample drainage is called for in this case, and the original

* Iglauer: "Oblique Ethmoidal and Sphenoidal Position" (*Journ. of Amer. Med. Assoc.*, December 23rd, 1916).

wound may be sufficient. In cases of doubt the patency or otherwise of the infundibulum is of moment.

Suppose, then, that there is a punctured wound over one frontal sinus draining fairly well, and by probe and skia-gram the surgeon has quite satisfied himself that the posterior wall is intact; and suppose, further, that there is no foreign body lodged in the sinus, necessitating removal by an external route, the patency of the infundibulum becomes a factor of importance.

The nasal mucosa, therefore, should now be thoroughly shrunk with cocaine and adrenalin and this question investigated.

If the missile which injured the anterior sinus wall also traversed or crushed the upper regions of the nose, the infundibulum as a means of drainage is put out of court. The case may be regarded as a sinus empyema, draining only through the external wound; and external operation will be required, although less urgently than when the posterior sinus wall has been fractured. But if the whole nasal cavities are intact, and pus escapes from the hiatus semilunaris, the patient may be treated as in civil practice. That is to say, the anterior end of the middle turbinate should be removed to increase intranasal drainage, and external operation delayed. Although unlikely, it is not impossible that an external operation may be entirely avoided.

In operating on gunshot injuries of the frontal sinus the type of operation should be the Killian—that is to say, the main object should be to leave the supra-orbital ridge as an intact bridge, and to establish free drainage into the nose.

Various special features will be met with, demanding variations and departures from the classical Killian technique. The most usual of these variations will be:

1. The anterior ethmoid has also been injured, and requires clearing out. This may be done intranasally; or the external eyebrow incision may be prolonged down into the cheek in the form of a Moure's incision.

2. The eye has been destroyed. In this case the opening above the supra-orbital ridge may be supplanted by cutting

away the anterior part of the orbital roof; or in very bad cases some bone may be removed in both these situations.

3. Both frontal sinuses have been injured. An incision is made in each eyebrow, and these incisions meet below the glabella. The scalp is turned upwards, and the flap afterwards replaced. The scar is insignificant.

The patients shown in Fig. 23 (p. 106) and Fig. 30 (p. 132) illustrate this.



FIG. 27.—Traumatic frontal sinusitis. Ptosis; downward and outward displacement of globe. Swelling just above inner canthus (orbito-ethmoidal cell). The small sinus exactly in centre of eyelid is faintly visible.

In any case of frontal sinus injury a certain amount of ethmoidal cellular structure will require exenteration. And while doing this a look-out should be kept for sequestra in the higher parts of the nasal cavities. Fig. 31 (p. 129) exemplifies this point also.

The following two cases of frontal sinus injury present unusual features, and will, therefore, be related in full:

Gunner B., admitted to No. — General Hospital on February 10th, 1918, suffering from a swollen eyelid, frontal headache, and double vision. The patient was transferred to my charge from the eye department by Major C. Goulden.

History.—Four years previously a man had kicked him over the right eye. Ever since then he had a slight swelling over the inner end of his eyebrow, and on windy days suffered from epiphora. He never had rhinorrhœa. Diplopia was first noticed after a cold one month before admission to hospital; it was never troublesome.

From this "cold" he also dated a steady increase in the swelling of the eyelid.

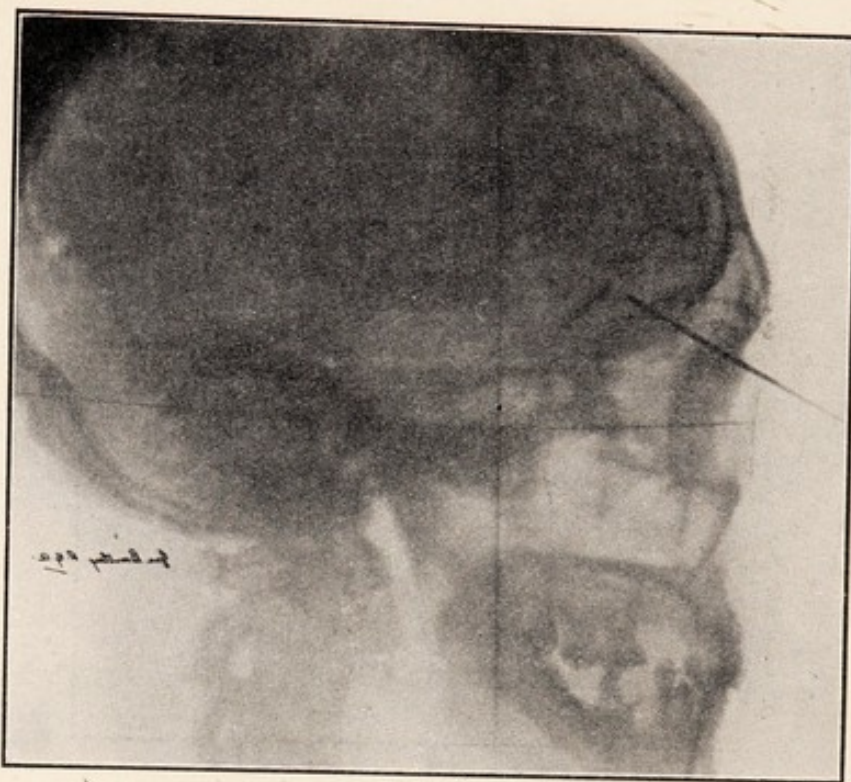


FIG. 28.—The abnormal size of the sinus in its vertical and antero-posterior diameters is evident. The probe obviously traverses the floor; but the entire absence of any bony floor (revealed at operation) cannot be suspected radiographically, because the walls of the left frontal sinus overlap the right in the skiagram.

Previous to his admission under me this swelling had been diagnosed at a casualty clearing station as "œdema and frontal sinus mucocele," and the eyelid incised.

On admission there was ptosis, and the upper lid was œdematous (Fig. 27). Exactly in its middle was a sinus where the incision had been made. A probe passed into this entered a very deep frontal sinus. There was diplopia in all portions of the globe; but it was not troublesome. The globe was displaced downwards as well as outwards.

The lachrymal sac and fundus oculi were normal. Thick pus exuded from the sinus. The nasal cavities were natural.

The lateral skiagram, taken with a probe in the sinus (Fig. 28), shows the right frontal sinus to be enlarged upwards and backwards; its floor is very faint, and traversed by the probe.

February 17th, 1918.—Operation. The anterior half of the right middle turbinal was removed. The whole anterior frontal sinus wall was cut away through an incision in the eyebrow, and a Killian bridge was left. The sinus was destitute of any bony floor as far back as sight or touch could go—seemingly as far as the sphenoidal fissure. But the periosteum of the floor was intact.



FIG. 29.—Three weeks after radical operation. The swelling in the upper lid, due to a temporary post-operative increase of oedema, is puckered in its centre by the scar of the original external sinus.

The sinus was crammed full of caseous pus, which in appearance exactly resembled cream cheese. It was odourless, and had no limiting membrane.

The small remaining amount of mucosa was polypoid.

Two infundibular ethmoidal cells were cleared out, and the infundibulum, which was not blocked, was enlarged with burrs.

The sinus was drained by a tube passing from the nostril, through the infundibulum and sinus, to the external canthus; the remainder of the eyebrow incision was closed at once.

Subsequent History.—Fig. 29 shows the patient just before discharge from hospital, three weeks after operation. The

ptosis was diminishing. So also was the œdema, which had increased greatly after operation. The globe was still slightly displaced, and there was diplopia on looking to the left. The headache had steadily decreased, and there had been none at all for two days. The fundus oculi was still normal.

Commentary.—Whether the trauma was causally related or not, this appeared to be a case of caseous rhinitis. This diagnosis accorded with the contents of the sinus, and the

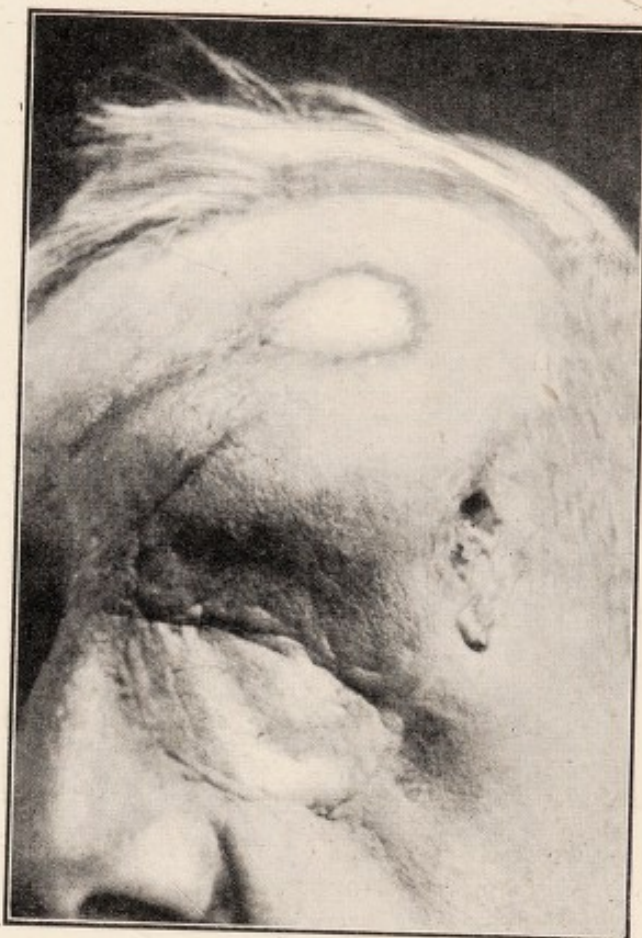


FIG. 30.—To show the exit wound in the left temporal fossa. The white patch on the forehead is a graft which had been placed there to cover a bare patch left by transplanting a pedicled forehead-flap to cover the left eye-socket.

erosion of its floor. The chief point against it was that its contents were odourless. It was not a case of true cholesteatoma, if such a condition exists, because neither by chemical nor microscopic tests could cholesterol be found. The caseous pus was absolutely structureless.

Other suggested diagnoses were tubercle—but there was no histological or bacteriological evidence—and a dermoid cyst invading the sinus from the neighbourhood of the external angular frontal process.

Sergeant W., aged 60, was admitted to — Hospital on June 28th, 1918, with a bullet wound. The bullet had



FIG. 31.—Sergeant W., bullet wound of left frontal sinus. Exactly in the mid-line between the frontal sinuses a faint shadow indicates a small sequestrum. From the centre of the left supraciliary ridge a fracture of the frontal bone curves upwards and to the right; this fracture appears as a faint broad line. From the left external angular process, well up into the temporal fossa, there is a light area, indicating a complete absence of bone here. A denture closes the entrance wound in the hard palate.

smashed his palate, traversed his ethmoid and left eye, and emerged from the left temple $1\frac{1}{2}$ inches above and behind the external angular process.

Between July 19th and August 8th plastic operations were performed to cover in the eye-socket with skin; and the sinus in the temporal fossa, along which a probe passed for only an inch, was curetted, and subsequently healed.

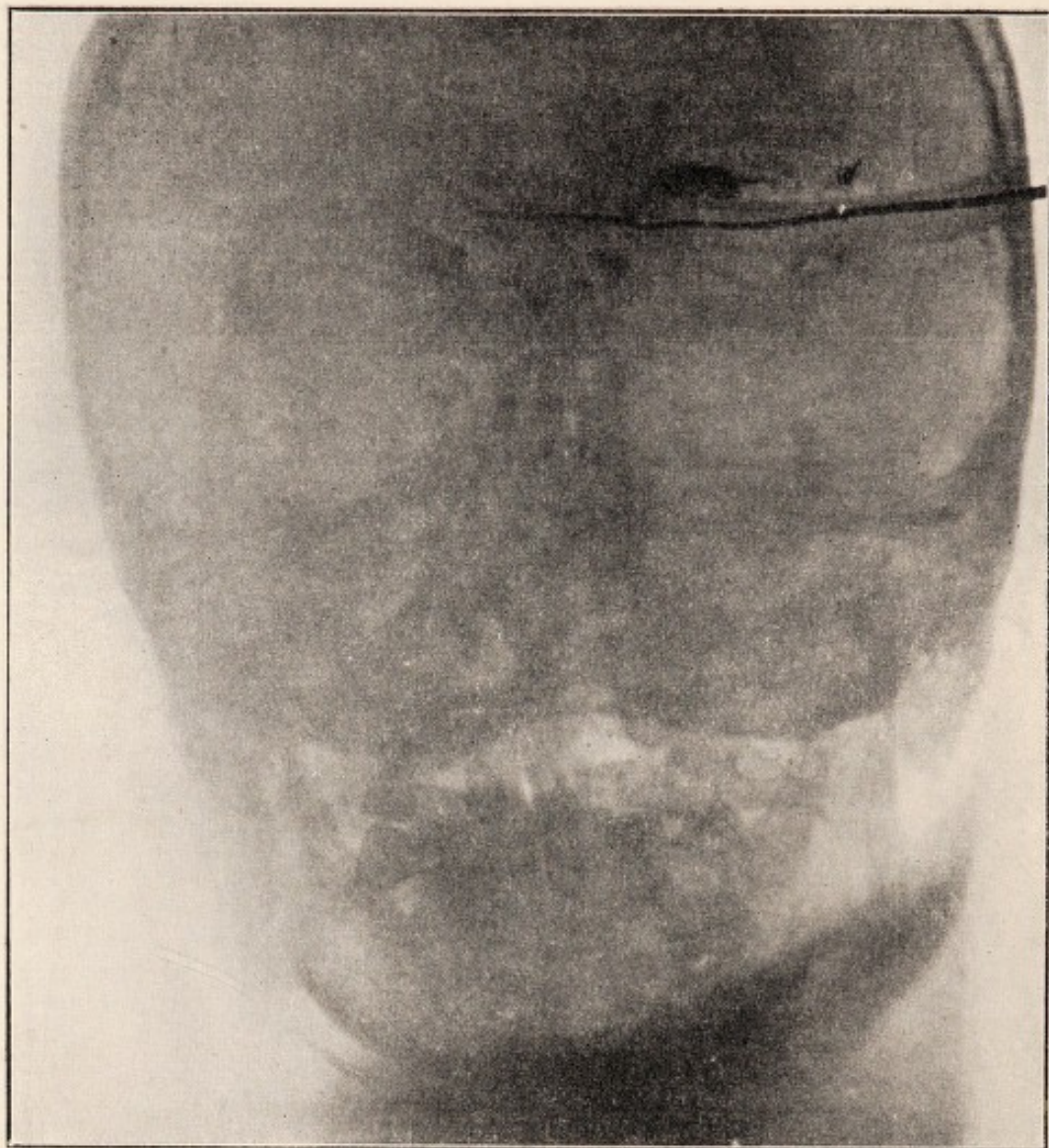


FIG. 32.—Sergeant W., after operation. One vertical rubber tube drains the right frontal sinus and emerges at the left nostril. A second, horizontal tube, drains the extra-dural space along the antero-inferior border of the left frontal lobe; and emerges from the exit wound in the left temporal fossa. The left frontal sinus no longer exists; its walls have been removed, partly by the bullet, partly by the operation. A probe has been placed in the horizontal tube; and the scattered shadows represent Bipp used in dressing. The palate obturator has been removed for cleaning.

On September 10th, 1918, he was first sent to me, because it was thought possible that the external wound (Fig. 30), which had reopened and now never ceased discharging thick pus, might communicate with the frontal sinus.

A skiagram (Fig. 31) now showed (1) a sequestrum, the size and shape of a pen-nib, in the mid-line between the frontal sinuses; (2) an entire absence of bone from the

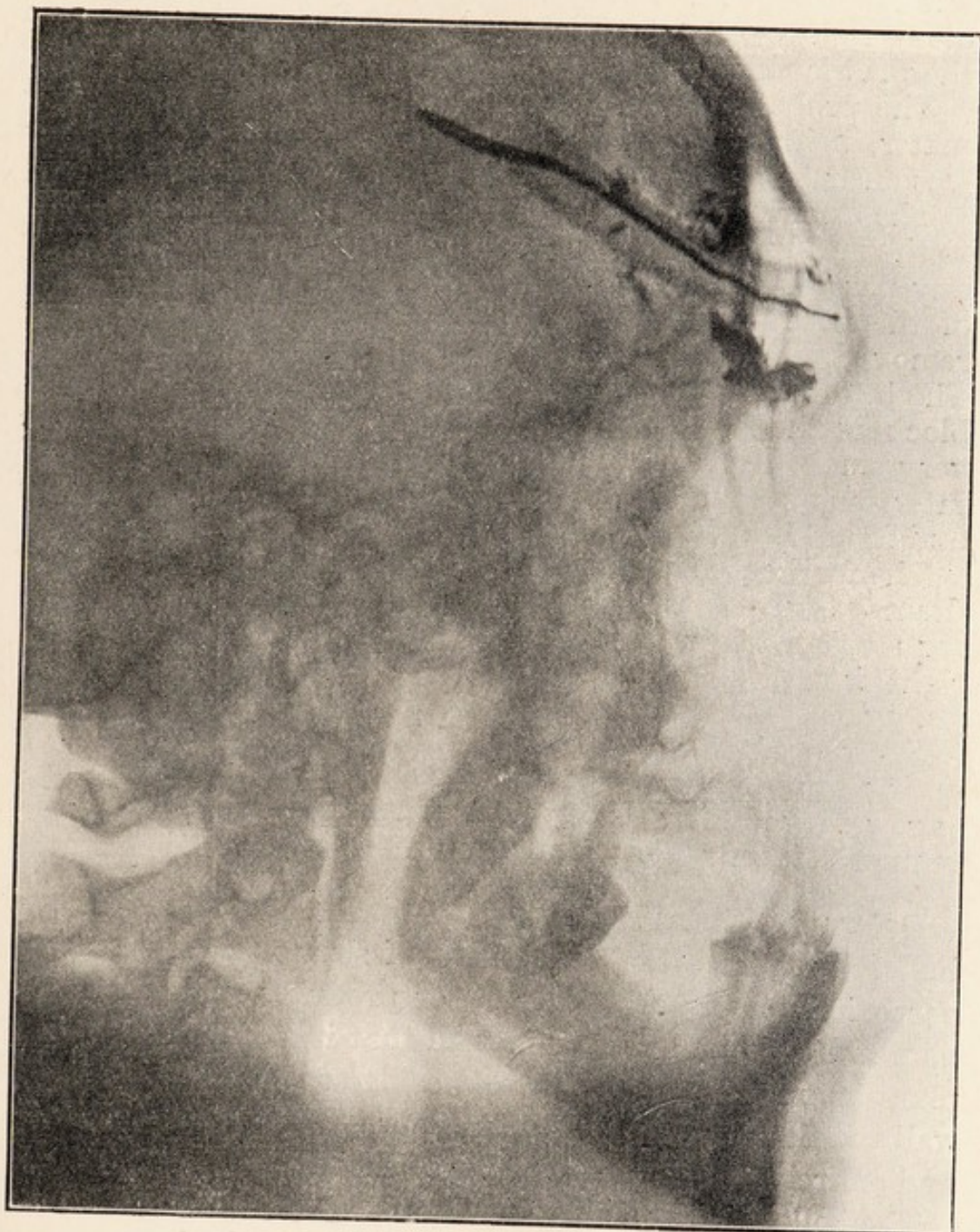


FIG. 33.—Sergeant W. A lateral view of the condition shown in Fig. 32.

external angular process to the region of the exit wound; (3) a fissured fracture, passing upwards and to the right from the centre of the left supraciliary ridge.

September 16th, 1918.—Operation. A probe passed from

the external wound 4 inches in the direction of the opposite (right) frontal sinus.

An incision was made from exit wound to outer end of left eyebrow; thence in eyebrow to glabella; thence half-way along right eyebrow. The forehead flap was elevated, and the plastic skin flap closing the left eye-socket depressed.

The probe was now found to pass in front of the dura mater, behind the left frontal sinus, whose posterior wall was entirely missing.

The anterior wall of the sinus was now entirely cut away to the mid-line; I did not attempt to leave a bridge nor spare any part of the supra-orbital crest. From the upper part of the nose polypi and a mass of foetid caseous pus was removed, in which was embedded the loose sequestrum. The latter was $\frac{3}{4}$ inch square, and lay in the sagittal plane, blocking the right frontal sinus; in the skiagram it looked very small, being seen on edge. There was no trace of an intersinus septum. The right frontal sinus was examined and found healthy.

The forehead flap was replaced and stitched up, leaving a drainage tube passing horizontally from the old site of the sequestrum to the exit wound. Another tube drained the right frontal sinus, and emerged at the left nostril (Figs. 32, 33).

Subsequent History.—On the third day he was sitting up eating solid food. Recovery was uneventful. The tubes were removed after three weeks, whereupon the sinus in the temporal fossa rapidly healed.

Deformity after Frontal Sinus Injuries.—In some cases a bullet, or more often a fragment of shrapnel, carries away part of the supra-orbital crest, or produces such extensive damage to the anterior sinus wall that it is impossible so to plan the operation as to leave a bridge of bone beneath this wall and the floor. The resulting depression is very unsightly, and entirely alters the character of the face.

The hollow may be filled by a graft. The crux of this procedure is to close off any communication with the nose. I say *any* communication advisedly; for a canal leading into the nose in these cases is often not the infundibulum. The latter may have entirely closed up, but a canal connects the depression above the eye with the nose, either directly or by passing into the maxillary antrum. Such sinuses are espec-

ally likely to exist when the corresponding eye has been destroyed. The communication must be definitely closed by a plastic operation. A few weeks later the cavity may be filled with chips of bone from the patient's tibia, and a covering flap of skin brought down from the forehead.

After-Treatment of Sinus Operations.—I have purposely omitted all mention of this when discussing the individual sinuses for two reasons: firstly, it is so usual for more than one sinus to have to be operated on; and, secondly, the injuries and operations being usually atypical, the dressings are atypical also.

In civil practice the surgeon may formulate rules for himself, his dressers, and his nursing staff. He may say that after a submucous septal resection the plug is to be removed after one or two days; that the plug is to be of oil-silk, or rubber, and so on. Or that a maxillary antrum shall be douched for the first time on a given day, and with a specified frequency. But after war injuries, assuredly hardly any two cases are quite alike; and I see no useful purpose in the formulation of rules.

Nevertheless, certain principles stand out as the result of experience.

After the division of intranasal adhesions an oily dressing must be interposed between the two raw surfaces for a much longer time than would be thought—say a week longer—otherwise readhesion is fairly certain.

After opening an antrum, removing the ethmoidal cells, or draining a sphenoidal sinus, a temporary packing of gauze is required to check bleeding. This should be removed next day, and douching begun the day following.

It might appear superfluous to give any warning against leaving a gauze plug too long in a maxillary antrum. But I have seen one case of septicæmia, and several of grave facial cellulitis, in this war, from no other cause.

I have already mentioned the disadvantages of using wool instead of ribbon-gauze in the nose; also the risks attendant on the use of hydrogen peroxide.

In the after-treatment of frontal sinus operations there is a detail to which allusion may be profitable.

The safest, and a very usual, way of dressing these cases is by a rubber tube sewn to the skin above the external angular process. From here the tube, bearing one or more lateral openings, passes through the opened sinus and down the infundibulum—which the surgeon has enlarged—to emerge at the nostril.

Now this enlarged infundibulum later, when the tube is removed, gradually narrows by the inevitable contraction resulting from the fibrosis of granulation tissue. Therefore, the infundibulum is made as large as possible, and I know of no limitation to the statement that the larger the tube used the better. Personally, I am dissatisfied if my tube has a diameter of less than $\frac{1}{3}$ inch; and the longer it is left in the infundibulum the better, up to one month, at any rate. But a large tube left *in situ* for a long time leaves an ugly scar at the outer end of the eyebrow. The following simple plan meets this difficulty:—

As soon as it is deemed that nasal drainage is sufficient, and that the external wound may be dispensed with, a piece of thick silk is threaded through the tube at its supra-orbital end.

The distance from the external supra-orbital opening to the upper end of the infundibulum is known within half an inch, or can be gauged from the skiagram.

A piece of tubing 1 inch long is now tied, around its centre, to the silk, so that its axis is at right angles to that of the other main drainage tube. The small piece of tubing forms with the silk a T. And the length of silk between the end of the drainage tube and the middle of the second small piece must be $\frac{1}{4}$ inch less than the distance from the external opening to the upper end of the infundibulum.

The drainage tube is now pulled through the nose from its nasal end until the small piece of tubing at the end of the silk rests against the skin at the external wound; the drainage tube can be pulled no further.

From this moment the infundibulum is kept widely patent.

as before, while the external opening closes up, almost completely, around the silk. This dressing may be kept for another one or two weeks, and the frontal sinus irrigated through the tube. I have used this simple plan repeatedly with entire satisfaction.

The Lachrymal Sac.

Disorders of the lachrymal sac and nasal duct belonged originally and properly to the domain of the ophthalmologist. But of recent years there have been various operations practised for enlarging the duct, or draining the sac, by the intranasal route. So that dacryocystitis began to be treated by the rhinologist, in consultation with the ophthalmologist, and with his sanction. I do not, however, make this brief historical reference as an excuse for having treated a certain number of cases of traumatic dacryocystitis in this war. And, indeed, if an excuse is called for, this one would not serve. For the operations which I have performed for this condition during the war have been excision of the sac by the external route, an operation which in any case belongs to the eye specialist. But, since these cases have been referred to me for treatment, and for no other reason, I am publishing this note of my impressions.

The intranasal drainage of the lachrymal sac after the method of West gave, in my experience, very satisfactory results. But it is impracticable in war injuries of the sac or its duct. Any method draining the sac by the nose demands good access, with clear landmarks. And these two conditions are precisely those which are unfulfilled in traumatic cases. A crushed septum, intranasal adhesions, callus usurping the place of a mangled middle turbinate—lesions of this sort prohibit the delicate intranasal operation. And I have not yet during the war seen a case of traumatic suppurating lachrymal sac, or even non-suppurating dacryocystitis with epiphora due to blockage of the nasal duct, which held out a reasonable prospect of cure by the nasal route. An external operation, then, is always indicated.

First, as regards diagnosis. To differentiate a bulging sac

from a mucocele or empyema of a fronto-ethmoidal or anterior ethmoidal cell is more than usually difficult after gunshot injuries. (See description of Fig. 25, p. 122.) This is simply due to the depression of the inner canthus, distortions of the upper or lower lids, and other deformities consequent on facial injuries, which upset the relations of the swelling to the tarsal plates and internal tarsal ligaments.

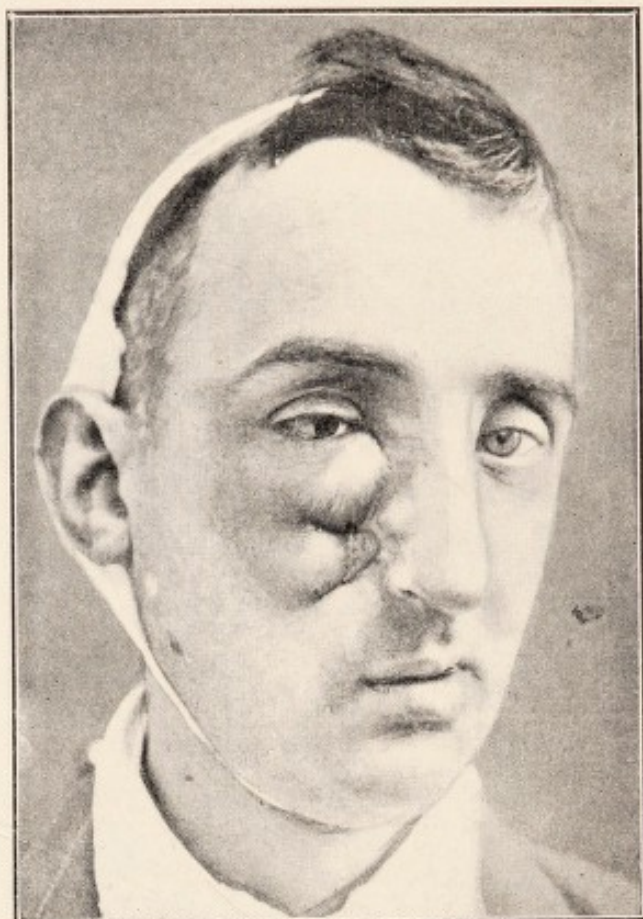


FIG. 34.—Traumatic empyema of lachrymal sac.

Moreover, a bulging ethmoidal cell may co-exist with a swollen sac, and the two require simultaneous operation.

Again, there is frequently a co-existent sinus into the antrum, which hinders the healing of the operation wound after the removal of the sac.

In some cases there is eversion of the lower punctum due to ectropion produced by scar tissue below the inner canthus.

The operation which I have performed in eleven of these cases consists in an excision of the sac through the usual small incision below and mesial to the inner canthus.

Having removed the sac, the nasal duct is enlarged with a burr. It is quite usual that the injury which has injured the sac has simultaneously fractured the nasal bone or ascending process of the superior maxilla, and that the fracture heals only by fibrous union. In this case the bone rocks and yields when a burr is pressed against it to enlarge the nasal duct; and a nasal speculum, or flat instrument such as a periosteal elevator, should be inserted into the nose to give support while using the burr.

A fine rubber tube is now passed through, to exit at the nostril, where it is retained by one stitch. The upper end of the tube emerges from the nasal duct for $\frac{1}{8}$ inch. The external wound is closed with horsehair sutures, and a light external dressing is applied.

On the second day gentle irrigation is carried out through the tube, and on the third day the latter removed from the nostril. After this the nose is douched twice daily, and the stitches are removed on the fifth or sixth day.

Any suppurating ethmoidal cells must be simultaneously opened up. In particular, if there be a sinus leading into the antrum, not only must this be curetted, but intranasal drainage of the antrum provided; otherwise there will certainly remain a fistula at the inner canthus. The skin around the site of the external incision is often scarred and unhealthy, owing to the original trauma. In this case the scar tissue must be excised, and the healthy margins undercut so that they meet without tension.

Following the operation, the eye should be irrigated for two to three weeks. Fig. 34 shows a case which was treated by this method.

The number of cases I have thus operated on by this external route during the war is about the same as of those non-traumatic cases attacked by solely intranasal access before the war; and as far as my experience justifies a comparison, I prefer the latter technique.

CHAPTER VIII

RHINOPLASTY

Introductory.—Even before the war there were many books published on rhinoplasty. The large demand for this kind of surgery which has arisen out of the war has naturally resulted in the appearance of additional textbooks and monographs.

Anyone wishing to refresh his memory as to the earlier evolution of rhinoplastic methods will find a chronological survey in all the earlier publications. An historical synopsis has no place in this book, which sets out merely to give the writer's experiences. The classical prototype methods for repairing or creating a nose by living tissue used always to be referred to as the Italian or Tagliacozzian, in which a pedicled flap was transplanted from the arm; the French, in which cheek flaps were used; and the Indian, which took advantage of any tissues remaining in the soft parts of the nose by inverting them as a nasal lining, and then covering them by a forehead flap.

It is only to be expected that, as the outcome of the enormous amount of valuable work in this direction executed by surgeons from Great Britain and the Dominions in this war, the surgical history of the near future will add a fourth prototype, the British (and Colonial). The historian will, however, find difficulty in classifying and subdividing the types of operations; for the variations employed are legion, and the ingenuity displayed apparently inexhaustible.

If we attempt to criticize the three classical prototypes in the light of modern rhinoplastic experience, the Italian method may be dismissed in a few words. It may be considered that this type includes not only the arm flaps of

Tagliacozzi, but other efforts at rhinoplasty by using the limbs. Such are the grafting of a finger, which is afterwards amputated; of a toe, transplanted directly and without a pedicle (surely the enterprise of an optimist !); of a piece of abdominal skin first grafted on to the hand or arm, and then transplanted to the nose. No such operations are, at any rate in this country, now in use. The writer has attempted this type of reconstruction in one case—a failure—to which reference will be made later, because it is instructive.

What used to be known as the French method has valuable applications. Attempts are not made now to remake the whole or greater part of the nose from the cheeks only. But as a lining for a nose, or as a covering flap for a partial deficiency, the cheeks are sometimes useful.

The Indian forehead method of Keegan is, however, the great prototype of modern rhinoplastic methods, supplemented by the addition of a cartilaginous support as practised by Nelaton.

The Procedure in Treating a Man who has had Part or all of his Nose shot away.—Careful attention to such a lesion from the moment of its infliction is of great importance. At the field ambulance or casualty clearing station the wound will have been cleaned, shreds of khaki and debris removed from the nasal cavities, destroyed skin clipped away, and, if oozing of blood is persistent, the nasal vestibules lightly plugged with ribbon-gauze.

The medical officer having thus obtained as healthy a state of the wound as the patient's general condition at this time allows, should carefully replace any viable soft parts of the nose, and suture them to the neighbouring parts of the organ or to the cheeks. Frequently he will be uncertain of the viability of a piece of skin or cartilage, in which case he should always give the tissue the benefit of the doubt, and sew it to neighbouring parts.

His labour may eventually prove to be wasted. I remember a case in which the nose had been neatly sewn to the cheeks at the front; but when he arrived at the Base overseas the whole nose was absolutely dead; and all that was

necessary in order to remove it was to cut the stitches and lift it from the face. The narrow pedicle had died, and was black, like the rest of the nose.

But more often the trouble taken in carefully suturing clean raw surfaces is not wasted. A part of the tissue, at any rate, survives; and the surgeon who has eventually to undertake the rhinoplasty will be grateful to his colleague up the line who has saved for him half an inch of ala or columella.

When the wounded man reaches the Base the toilet of the parts will be continued. Naturally, the facilities for deliberate treatment are here much greater. Moreover, lines of demarcation will have formed; in some places more dead tissue will have to be clipped away; in others, the tissue is living, but the suture line sloughing and breaking down; the stitches along this line will be removed, the wound edges freshened and resutured.

All this treatment, preliminary to plastic work, is merely a completion or refinement of what was done by the medical officer at the front.

Figs. 22, 23 (pp. 105, 106) are a very good example of the importance of this early sewing up for the salvage of parts.

The lobule of the man's nose, including both alæ and the columella, have been sewn to the right cheek, which happened to look the most healthy piece of neighbouring tissue.

The second photograph (Fig. 23) was taken several weeks after the injury, and it is evident that the parts mentioned are viable and healthy. To have moved them to their proper position, and joined them to a forehead flap representing the remainder of the nose, would have been a matter of no great difficulty. This patient, however, for private reasons wished to return home, and elected to wear a facial prosthesis rather than wait for rhinoplasty. Therefore, I have no other photographs to show later stages of this case.

The subsequent preparations of the candidate for plastic operations have already been dealt with under intranasal lesions and sinusitis. There is only one point to which I

wish to refer again here, and that is, the prevention of adhesions between septum and nasal parietes.

This should be attended to as soon as possible after he reaches the Base overseas, and at the same time as the dead soft tissues are (for the second time since his wound) being cut away, and the soft parts of the nose, if necessary (for the second time), re sewn to healthy adjoining tissues.

By this time the passage on each side of the septum will possibly be blocked with granulations. These are to be broken down, and an oiled piece of vulcanite or rubber tubing, as already explained, introduced on each side (see Fig. 45, p. 154, and Fig. 61, p. 187); the procedure is, as a rule, not very painful, since the nerve endings by this time are mostly covered in by granulations. Local anæsthesia of 2 per cent. novocain, applied either by swabs or submucous injection, usually suffices.

The plates are removed, cleansed, and replaced every three or four days.

As soon as the soft parts of the nose are definitely living and warm the treatment of intranasal conditions and sinusitis will be instituted. The nasal cavities steadily become cleaner; soon pus is conspicuous by its absence. Here and there strings of mucus collect, and are cleared by the use of alkaline douches. The remains of the septum and outer walls lose their tendency to adhere, and become firm and epithelialized. The edges of the hole in the nose become clean, dry, epithelialized, and the scar tissue at these edges is firm and contracted. It is now from one to three months since the man was wounded; he has regained weight, spirits, and confidence; his colour and appetite are good, and there is no evidence of suppuration—not even a boil or acne spot—about his face or neck. The patient is ready for rhinoplasty.

Nasal Support.—The permanence of the nose which is going to be constructed depends largely on the thoroughness with which the question of support has been treated. Any temptation to get to work soon to make the proboscis itself must be sternly resisted. Anyone who has even a modest experience in this branch of work has realized the disappoint-

ment of seeing a shapely nose steadily and irrevocably become an amorphous projection, which is recognized as a nose chiefly by the fact that it occupies the place where a nose had been formerly.

This important matter of scaffolding, or support, may be dealt with in three ways: by using rib-cartilage in the bridge and also, perhaps, in the columella and alæ; by a prosthesis; or by utilizing structures within the nose and along its boundaries. The use of costal cartilage will be discussed when speaking of the making of the external nose proper.

The use of prosthesis as an adjunct is still practised, and is likely to be for a long time, to prevent contraction of the nostrils, and to preserve their shape.

In the present development of rhinoplasty it is difficult to make a new nose of which the nostrils will not shrink and become stenosed unless the tip, alæ, and nostrils be made much too large.

The plan of lining the nose with skin overcomes this difficulty only partly, and gives no help whatever in the matter of *shape* as distinguished from *size*. For the shape depends on the alar cartilages, and we are, let us suppose, dealing with a total loss of the nose.

To imitate the shape of the alar cartilages is an enormous difficulty.

To check the tendency of the nostrils to become stenosed, and circular instead of oval, small prosthetic rings may with advantage be worn at night.

The older and more extensive prostheses for supporting a nose have been discarded, and properly so; the platinum or gold frame invariably sloughed out.

The plan of propping up the nose by a prosthesis supported by a vertical rod, which rod in turn passed through the palate by a hole made by the surgeon, and was there inserted into a denture, is also not seen nowadays. Occasionally we meet with a case where the whole interior of the nose, inner antral walls, and palate have been shot away, leaving some upper teeth. For such a man a nose can be made by a forehead flap and cartilage; but it is obvious that when this has been

done the face and nose will still be only a shell, and the latter must collapse. In such a case, when there are no structures to be used as a nasal scaffolding, it is right to build up a supporting prosthesis from the palate obturator. These prostheses, modern productions of ingenious design and most accurate finish, are built in sections for convenience of insertion, as also of daily removal for cleaning.



FIG. 35.—Lance-Corporal E. Destruction of nasal bridge by shrapnel. The wound over the right inner canthus was superficial, and did not involve the frontal sinus. Before healing had proceeded far, the patient had to be removed to an isolation hospital, having contracted scarlet fever.

On the whole, the more recent patient attempts to support the new nose by using the sufferer's own tissues have made us much less dependent on prosthesis.

Autogenous Support.—All flaps used to form a scaffolding should be pedicled; the only type of free graft which could be expected to take in this situation would be an "inlay" or "onlay" Thiersch or Krause graft (see inlay grafts under Pharynx); this would epithelialize any remaining raw

areas, but could not provide any tissue firm or thick enough for a scaffolding.

The support should consist of bone or cartilage swung from the remaining nasal walls, or of skin with subcutaneous tissue inverted from the soft parts at the margin of the nose.

If bone or cartilage is available it will be some part of the turbinals, the ascending process of the maxilla, or the cartilaginous septum. Of the use of the turbinals I have



FIG. 36.—Lance-Corporal E. This is not a good photograph, but it suffices to show the nature of the nasal deformity on the patient's return from the fever hospital. The bridge is entirely sunken, resembling the saddle-back nose of congenital syphilis.

personally no experience. In one case I removed a narrow vertical sliver of bone from the ascending process of the maxilla on each side by osteoplastic section, and forcibly pulled down the overlying soft tissues and the attached bony strips. This, of course, left a gap above, which was filled by a flap from the forehead. The result was not good, because the nose gradually became pulled up again by shrinkage of the forehead flap. The cartilaginous septum may be utilized

by first making a cut for about $\frac{1}{2}$ inch along the floor of the nose, and from the point where this incision ends making another about $1\frac{3}{4}$ inches upwards and backwards parallel to what the nasal bridge is intended to be.



FIG. 37.—Lance-Corporal E. Shortly after operation. The lower cut, at the bottom of the bridge, extended right through to the nasal floor. The upper cut, a median inverted **V**, at the top of the bridge, went down to bone. The strip of tissue between the cuts was now completely elevated from underlying bone, so as to be nourished only from the cheeks. This strip, and the nasal tip below it, were forcibly pulled down. The sides of the raw triangular space left above the upper cut were drawn together to reduce it to an inverted **T**. Before the parts were sewn into their new positions advantage was taken of the free access to swing forward a strip of septal cartilage for support. To do this the cartilage was freed from the nasal floor for $\frac{1}{2}$ inch in front. At the posterior extremity of this $\frac{1}{2}$ inch a vertical cut was made up to the ethmoidal septum. The vertical strip of cartilage was swung forward to strengthen the bridge, and held there by sutures. The rubber tubes in the nostrils are held there by silk attached to their upper ends, and the free ends of the silk are fixed to the forehead by adhesive plaster.

In the case in which I used this method there was no necessity to bring down a forehead flap. The nose had cicatrized in the form of a bad "saddle-back," resembling a congenital syphilitic (Figs. 35 to 38). The incisions made

in the soft parts were similar to those used by Roberts of Chicago. The result was fair. The photographs and descriptions subjoined explain how the new septal bridge was retained in this case.

If it is considered inadvisable to attempt to obtain a bony or cartilaginous scaffolding, the support may be derived by inverting the soft tissues around the margin. In this case the surgeon relies for maintaining the projection of the nose on thickness instead of rigidity.



FIG. 38.—Lance-Corporal E. Final result.

If two flaps are taken from above, having their pedicle below at the margin of the nasal opening, they are turned down skin surface inwards, and the forehead flaps placed over them; this is an operation on the model of Keegan's original Indian method, as described in the textbooks.

Or the inverted skin flaps to line the new nose may be taken from the cheeks. In one case I had previously placed a thin plate of cartilage in the cheek, abutting on each ala, eight weeks before inverting the flaps with their contained cartilage.

Occasionally we meet with a patient whose nose was partly shot away many weeks or even months previously, and in whom the lesion has been entirely confined to the soft parts of the nose well above the ala; that is to say, the contour of the nostrils is unimpaired, and the nasal bridge intact.

Such a case is pre-eminently favourable for plastic restoration. The flap, if large, may be taken from the forehead; but if only a small addition to the nasal walls is required,



FIG. 39.—Residual deformity after healing of a wound of the nose. The nasal bridge is intact; and the nostril, although changed as regards position, is natural in size and shape. (See text.)

and if the cheek adjoining the injured side of the nose is free from scar tissue, small sliding flaps may be taken from this cheek.

An example is shown in Fig. 39, who came under my care with the wound of his nose entirely healed. The effect of an injury on the side of his nose over the left nasal bone was very remarkable. The margin of the nostril was intact, and the orifice quite innocent of stenosis. But the long axis of the orifice, instead of being horizontal, was vertical; what should have been the anterior angle of the nostril was

superior, and the cavity faced forwards instead of downwards. The lower lateral alar cartilage was certainly intact, but of the upper lateral cartilage it was impossible to be certain. I was anxious, if possible, so to plan an operation that a lining to any flaps used could be dispensed with, and that a single flap slid from the cheek should suffice.

If an incision were made transversely in the most obvious position, just above the alar cartilage, as was done in Fig. 37 (p. 145), my object would not have been attained.



FIG. 40.—The patient shown in Fig. 39 five days after operation.

In this case I had not lined the flap which I had brought down, and the final photograph (Fig. 38) shows that, despite using the septal cartilage as support for the bridge, the latter tended to be drawn inwards and the tip slightly upwards by contraction of scar tissue.

Profiting by this experience I made, as seen in Fig. 39, my transverse incision higher up, over the nasal bone, and then undercut the skin until my scalpel arrived at the lower margin of this bone. The result was that when the left ala was pulled downwards into position there was no gap into

the nasal cavity. There was, it is true, a communication, but this was merely a slit at the lower margin of the nasal bone, and was only visible on retracting the ala. The raw periosteal surface of the nasal bone, therefore, served as a lining to the flap which I had finally slid from the cheek.

In order to mobilize the ala, I carried a vertical incision from the anterior extremity of the transverse cut straight down the dorsum of the nose to the tip, and $\frac{1}{8}$ inch to the left of the middle line; this incision split the columella for its anterior half, and then passed into the nostril.



FIG. 41.—Final condition of the patient shown in Fig. 39.

The displaced part was now depressed into its correct position, and sewn there. The gap thus created over the nasal bone was filled by a sliding flap from the cheek. Fig. 41 shows the final result.

Making the Nose from a Forehead Flap.—The general scheme of this procedure is to twist on itself, without inversion, a flap of skin, subcutaneous tissue, and frontal aponeurosis, which flap contains a strip of cartilage destined to form the bridge of the nose.

When the whole of the nose below the nasal bone has to be constructed, the upper end of the cartilaginous strip in its final position lies in the angle between the nasal bones; and, being wedged there, its alignment is preserved.

But sometimes there is only a short length of nasal bridge to be filled in, requiring only a small flap and a short strip of cartilage. In such cases it is difficult so to gauge the correct position of the cartilage in the forehead that its alignment in the nose shall be absolutely correct when the flap has been



FIG. 42.—Loss of upper and middle parts of nose. The margins of alæ and the columella are intact. The rubber tubes drain the nasal cavities, and tend to minimize stenosis. The rib-cartilage subsequently inserted into the forehead for rhinoplasty was taken from another patient.

turned down. The skin flaps under these circumstances may be used without any cartilage, and the latter inserted subsequently into the nasal bridge. It is quite usual now to insert a strip of cartilage whenever may seem most convenient.

Most cartilage grafts are autogenous, from the patient himself; but Figs. 42 to 44 illustrate cases in which homologous grafts were used, with success, from another man.



FIG. 43.—The cartilage-bearing flap has been turned down. To relieve tension a transverse cut has been made in the upper (right) edge of the pedicle, high on the forehead. It is this edge which is always liable to tension; whereas the lower (left) edge is seen to be redundant, and buckles up.



FIG. 44.—Before discharge from hospital.

Heterogeneous grafts, from a different animal, I have never used; but judging by the experiences of others it seems that the percentage probability of success after their use is very small.

Removal of the Cartilage from the Chest Wall.—The costal synchondroses are approached by an oblique incision over the cartilages of the eighth, ninth, and tenth ribs. These are chosen because here they expand into a wide plaque, and any size or shape of cartilage may be taken. We are dealing for the moment with a strip of cartilage for the nasal bridge, which will not be more than $\frac{1}{4}$ inch in either transverse diameter, for which purpose one of the upper cartilages, which does not synchondrose with its neighbour above or below, would answer the purpose equally well. But sometimes we want two pieces, the second to be grafted into another patient. And, again, we may require a flat quadrilateral piece for nasal support, as in the case mentioned above (p. 146).

For these reasons the junction of the eighth, ninth, and tenth cartilages is the most suitable. And a better exposure of a wide expanse of cartilage is obtained by a nearly vertical incision than by one nearly horizontal; the line of skin incision should make an angle of not more than 30° with the vertical. The dissection down to the cartilages is simple, and there is no special point requiring emphasis. Here the question arises as to whether the cartilage should be removed with perichondrium or subperichondrially. In this connection we have to consider, firstly, the graft, and, secondly, the thoracic wall. I used to think that the grafted rib-cartilage would have a better chance of remaining viable if the perichondrium were left on it; but this is, apparently, not material. To this point reference will be made again. As regards the thoracic wall, if the resection be subperichondrial there is a chance that some new cartilage may be formed, and the weak point in the wall to some extent strengthened thereby; also, the cut ends of cartilage will be covered in.

So that, on the whole, it seems that subperichondrial resection is preferable. The cartilage should preferably be taken from the right side, because the dissection is more convenient to a right-handed operator; also because, although it should never happen, there is a possibility of the manipulations near to the pleura initiating a small patch of pleurisy

(this occurred only once in my experience); and in this unlikely event pericarditis might conceivably follow, and the operator will feel happier the farther his resection is removed from the pericardium.

As soon as the surgeon has removed the cartilage he carries it to a sterilized side-table, to shape and whittle it, while his assistant sutures the thoracic wound.

The instruments which have so far been used should now be discarded, and a fresh set used for the forehead. In shaping the rib cartilage, what is to be the lower end in the forehead and the upper end in the subsequent flap may be pointed if it is to fit into the angle between the nasal bones.

The size and shape of nasal bridge required will suggest the dimensions to which the graft should be whittled. If it is intended, when later bringing down the flap, to stiffen the columella with cartilage, this must be grafted of a sufficient length.

Before the operation a piece of stiff wire should have been cut according to measurements taken from the nose; the wire, which is the same length as the cartilage required, may be boiled with the instruments, and is used as a measure in shaping the cartilage before introducing it into the forehead. When the flap is brought down the cartilage, now firmly encapsuled and living, should be fractured at the point which is to form the nasal tip, if it has been originally cut of a length sufficient to extend into the columella.

Inserting the Cartilage into the Forehead.—Previous to this simple operation the hair will have been shaved as far back as may be required.

The exact position in which the cartilage is to be placed, so that later when the flap is turned down the graft may occupy exactly the position desired, is determined by measurements beforehand. These measurements may be taken with compasses or calipers, or by cutting patterns in rubber sheeting or tinfoil, as will be described later in reference to the shaping of the forehead flap.

The precise direction in which the graft is inserted into the forehead—that is, the angle it makes with the vertical—

must also be decided on. The height of the forehead—that is, the level of the hair-line—will affect this.

If the hair-line is very low it may be unavoidably encroached on in performing a total or subtotal rhinoplasty. In this event depilation by X rays will be required after the flap has been brought down.

But if the forehead is amply high for the size of flap required, there is a wide range of choice of angle at which



FIG. 45.—Almost complete loss of nose. An oiled plate of vulcanite has been inserted one each side of septum to prevent its adhesion to turbinals.

the cartilage is inserted. At one extreme it may be placed quite vertically; at the other extreme it may be nearly horizontal, and almost parallel to the eyebrow.

It will be remembered that the nearer to the horizontal the rib lies the less will be the torsion of the pedicle when the flap is brought down, but the more prominent will be the forehead scar. Also, a flap taken from low down above one eyebrow results in a subsequent elevation of that eyebrow by contraction of scar tissue. However, to counteract this elevation of the eyebrow measures are available, to which

allusion will be made later. Fig. 47 shows the elevation of the eyebrow after taking a flap from low down.

In practice, an angle of, roughly, 45° with the vertical will be found suitable in a majority of cases. The technique of inserting the graft into the forehead is extremely simple. A straight incision is made, $\frac{1}{2}$ inch long, at right angles to the line to be occupied by the cartilage, and $\frac{1}{2}$ inch distal to its upper or outer end—that is to say, $\frac{1}{2}$ inch distal to that end of the cartilage which in its final position will be lowest in



FIG. 46.—The flap turned down. Note that its lower margin was separated by less than an inch from the right eyebrow.

the newly formed nose. The cut is made down to the periosteum, and a smooth, small periosteal elevator (or nasal submucous resection elevator) inserted; this instrument is pushed through the tissues in the direction of the glabella, forming a passage for the graft. The graft is now inserted with the pointed end downwards and inwards towards the glabella, and the opposite end, which will eventually be lowest in the nose, is pushed gently $\frac{1}{2}$ inch beyond the incision. The latter is then closed with one, or at most two, stitches, and firm pressure applied by a dressing.

The tying of vessels in this small scalp incision should be avoided if possible, because every ligature or suture introduces another possible source of sepsis. If a vein or artery of some size be cut in the scalp a ligature may be essential; or it may be advisable to underrun the vessel with a small stitch (see Fig. 62, p. 188).

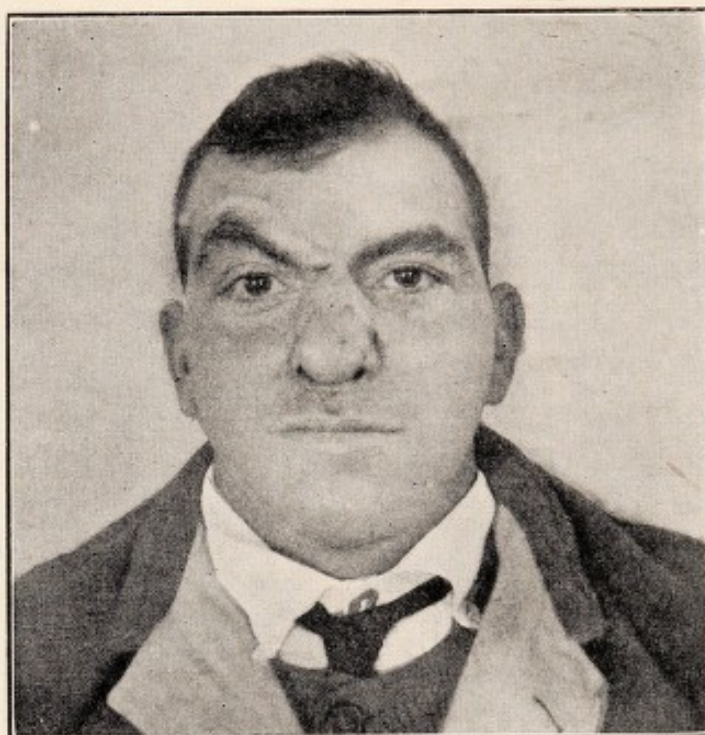


FIG. 47.—The flap was taken from too low on the forehead. The scarring has accordingly exerted the full force of its pull on the adjacent eyebrow, which is elevated. This requires correction by either (1) Excision and a free skin-graft; (2) excision and a pedicled graft from the temporal region; or (3) elevating the scalp by an incision above the hair-line, and sliding the scalp downwards. The patient also requires a cartilaginous graft for the nasal bridge, since none is there as yet. At the stage depicted in this picture he passed out of the author's care.

The forehead wound should, of course, heal by primary union.

Relation of Cartilage to Pericranium.—When a free graft is moved from one part of the body to another, it seems clearly desirable to transfer it into an environment resembling as far as possible its own. And since perichondrium is the natural envelope for cartilage, and periosteum and bone are allied tissues, I disposed the cartilage in the fore-

head tissues in the following way in the first case which occurred to me in this war:

A narrow strip of the whole thickness of costal cartilage was taken, and shaved down on its two raw surfaces only.

The forehead incision was made right through pericranium, and down to bone; the periosteum (pericranium) was then forcibly rugined off the frontal bone along the narrow area on which the cartilage was to lie.

The cartilage was inserted between bone and pericranium, with its two raw surfaces in contact with these two tissues respectively. The cut cartilaginous surfaces thus faced anteriorly and posteriorly, and were in contact with bone and periosteum, leaving the two lateral surfaces covered with perichondrium.

The graft took quite well (Figs. 48 to 50, p. 168), but the bare area left on the forehead after turning down the flap gave a lot of trouble. The return of the pedicle only filled in the lower part of the bare area. Above this the part covered by pericranium soon became covered with granulations in the usual way. But in turning the flap down with its contained cartilage, a strip of pericranium had been, of course, included (since this lay between cartilage and the soft tissues of the scalp); leaving a corresponding space on the frontal bone denuded of pericranium.

This bare area would not granulate; before this could happen the outer table had to desquamate. This occurred very slowly, in tiny flakes, over a period occupying nearly two months. As soon as desquamation was complete, the diploë threw out granulations, and the whole area was Krause-grafted.

As the result of this experience, I grafted the cartilage superficial to the pericranium in my next case; this made no difference to the result.

In subsequent cases I have not even troubled to retain the perichondrium on the two sides of the graft; this, again, makes no difference. Indeed, since cartilage is nowadays constantly being grafted into the pedicle after it has been brought down, and also into the cheek, or wherever it

may be subsequently wanted, it is clear that this tissue is not very exacting as regards the histological nature of its environment when transplanted.

This being so, it seems much better for the sake of the chest wall to remove the cartilage subperichondrially at the outset.

Turning down the Flap.—The period which must necessarily elapse before the flap is dissected from the forehead in order to be sure the graft will live is uncertain, and probably varies with the local state of nutrition of the parts and the general condition of the patient. In one case I elevated two cartilage-bearing cheek flaps in eight weeks, and one of the two grafts died. But this man was notoriously a "bad healer." In my other cases the graft had been left alone for from ten to sixteen weeks, and they all lived.

Twelve weeks is probably a safe period.

Before proceeding to the flap operation the surgeon will have satisfied himself that there is no furunculosis, acne, eczema, or other infective dermatitis about the face. He will also have studied the face and photographs long and often to decide exactly what size and shape of flap he desires.

In this connection it is important to remember that the actual loss of tissue is greater than after cicatrization it appears to be.

The edges of the nasal gap (and the same applies to facial wounds generally) draw in a great deal during healing. When they are freshened by excising the glossy, often bluish, epithelium covering them, and when they have been undercut to allow them to yield and evert for the reception of the flap, the gap will be much larger.

This important factor, which is, of course, merely an ordinary pathological occurrence after a wound in any part of the body, is well shown by serial photographs.

When the earlier writers quoted an additional one-sixth to be added to the size of flap eventually required, and when I quote one-third (below), this does not, of course, allow for the deceptive size of the cicatrized wound just referred to. It is after the cicatricial edges have been freshened and

everted that this one-third should be added to the desired size of flap.

In cases where a scaffolding or lining is required, this will sometimes have been made some weeks previously, while in other cases it will be a part of the same operation.

In this, as in many other respects, each case differs from others, and it is not possible here to give rules. Also, in the matter of the size and shape of flaps, experience is the best teacher, and textbooks on plastic surgery should be consulted for guidance. Here I shall merely make a few observations.

As regards the size of the flap, some older textbooks advise that this should be one-sixth greater than is required, to allow for shrinkage. I should say one-third greater.

If the newly made nose is too big it is easy to remove tissue from it; but it is difficult to add to it if it be too small. The amount of shrinkage is in some cases greater than in others, and is difficult to forecast.

When there is a scaffolding consisting of a large raw area on to which the flap fits, less allowance need be made for shrinkage, partly because the added blood-supply of the underlying raw area makes sloughing of the edges and end of the flap less likely, and partly because the skin of the flap is kept stretched.

The size and shape of the flap as determined on should be recorded in a pattern; this may be made at the time, but is better prepared beforehand. Tinfoil may be used. Personally, the writer has always used the "rubber dam" of dentists. A pattern cut from this may be put in the sterilizer with the instruments.

In planning a forehead flap its blood-supply must always be considered. The angular vessels will usually be included in the pedicle; often the frontal and supra-orbital, and sometimes part of the superficial temporal.

A fuller blood-supply may be directed into the flap by dissecting it up two or three weeks before it is required; during the interval it is prevented from readhering to the forehead by tinfoil or rubber placed beneath it.

As the result of this the flap will shrink slightly, but not very much; and the whole blood-supply of all vessels in the pedicle are now devoted to the nourishment of the flap, since this is isolated.

This plan is particularly useful for improving the nourishment of the distal end of the flap—that is, the end remote from the pedicle. For example, it is a good plan to dissect up here the piece destined to become the columella; and further to increase the vascularity of this small strip, it should be cut of double width, and folded on itself lengthways, raw surfaces apposed, skin outwards (see Fig. 51, p. 171).

Such methods may avoid the later disappointment of seeing the newly made columella slough, or become gangrenous in part, or shrink to nothingness.

The flap is outlined with a scalpel by a faint incision skirting the margins of the pattern, which is then discarded. The incision is rapidly deepened down to the pericranium; the incision should be sloped, so that the tissues are cut in such a direction that if anything the area of skin in the flap is rather greater than the area of deeper tissues. This insures that when the flap is sutured the suture line will tend to be everted. This desirable tendency is also encouraged, in freshening the nasal gap, by cutting its edges with a similar slight slope. The trifling eversion thus obtained co-apts the raw surfaces more thoroughly, and thus makes for better healing; moreover, it leaves a less obvious scar than that left by inverted edges.

In dissecting up the flap the knife-blade may be slightly lateralized; the loose cellular tissue between epicranial aponeurosis and pericranium is thus divided rapidly and cleanly.

The flap is sewn in place by a few silkworm-gut sutures, and between these horsehair wherever necessary. Wherever the edges tend to invert (and this applies to facial plastics no less) a mattress suture should be inserted. The operator must be absolutely satisfied that the pedicle of the flap is not under any tension.

It is a good routine plan, particularly if the flap be large

or its pedicle narrow, or the skin looks blue, to hold the former in gauze wrung out of hot saline: the hot gauze is constantly renewed. This same precaution against death of the flap from temporary malnutrition should be taken whenever there is, for any reason, a pause or hitch in the proceedings—if, for instance, the surgeon has to return to the forehead wound to stop hæmorrhage from the scalp, or to further dissect up the pedicle; or if the anæsthetist for any reason interrupts the operation. At all such times hot gauze or clothes should be handy.

Before finally sewing the flap in place the length of cartilage may require reduction. It is to be hoped it will have been originally cut full long, so that there is no question of it being too short. A piece may be removed, or the cartilage split or altered in shape. As long as this alteration is carried out within reasonable limits no harm results. The cartilage is by now enclosed in a capsule of fibrous tissue; by opening this and removing a piece, and so probably admitting infection, it might be expected that necrosis would be invited. But this does not occur. This fact, taken in conjunction with what was said above as to the unimportance of the perichondrium and the viability of the graft in most unaccustomed surroundings, indicate that it is a long-suffering and hardy tissue; indeed, in contrast with bone, great liberties may be taken with cartilage.

As regards the dressing to apply to the nose, this will be referred to later; I do not regard it as important so long as it is warm, and kept constantly warm for at least one week.

Finally, the surgeon returns to the forehead. Here bleeding-points require attention, either by ligature or by under-running the edge with a temporary continuous suture. The dressing on the raw pericranium should be dry for the first day until oozing ceases; after that it may be replaced with a wet dressing.

CHAPTER IX

RHINOPLASTY: DIFFICULTIES—SHAPING THE NOSE— /AFTER-TREATMENT

Difficulties in the Earlier Stages.

THE several stages in making a new nose, total or partial, in so far as we have already considered them, are attended by the possibility of certain complications which, temporarily at any rate, invalidate the success of the result.

As regards the thoracic wound, there is only one probable complication, and that is sepsis. This has occurred in my practice three times, and I find that others have experienced it much less. One of my three cases occurred in England in a very unhealthy subject. The other two occurred in France, where the conditions under which such work is done are at times more difficult. In a rush of cases it is, as a fact, more difficult overseas than at home to prevent infection of clean incisions from neighbouring very septic cases.

This complication when it occurs is not grave, but it is tedious of cure. The wound suppurates for any part of its length. Later, its margins cicatrize and contract, and the upshot is a sinus, at the bottom of which bare cartilage may be felt. The treatment consists in laying open the sinus so as to convert it into a wide gutter, removing any necrosed cartilage, and packing the wound so that it is kept open and granulates from its depth outwards.

As already mentioned, in one of my cases (p. 153) a small evanescent patch of pleuritic friction appeared beneath the area of removed cartilage; this subsided without the formation of any fluid. It is not certain that operation and pleurisy were related as cause and effect, but highly probable.

I have not heard of another instance of this; it must be quite rare, but should be borne in mind.

Following the insertion of the graft into the forehead, a hæmatoma may form around the cartilage. This is not uncommon, and to prevent it a pad of gauze may be laid horizontally on each side of the graft under the bandage, so as to exert pressure for about twelve hours.

The graft may necrose, exfoliate, or absorb. These accidents, presumably due to sepsis, have not occurred to me. But I know of a case where the graft suppurated, and the source of infection was considered by the surgeon, an accurate observer, to be a suppurating mucocoele of the anterior ethmoidal cells. This emphasizes the importance of previous attention to the nasal accessory sinuses.

The nasal flap may become gangrenous or slough to any extent. The causes of this are—insufficient blood-supply at the outset, sepsis, tension, and cold.

By insufficient blood-supply at the outset, I mean that when the flap is first designed or outlined enough regard has not been paid to the arterial supply. There is little excuse for this, for, as outlined above (p. 159), the arteries of supply may easily be taken into account beforehand, and their out-flow completely diverted to the flap by dissecting it up two or three weeks in advance.

Sepsis is either due to previous inattention to the nasal cavities or sinuses. With regard to this source enough has been said to show that its prevention is possible and imperative. Or it is due to infection of the suture line where the flap joins the face, and this, though not always preventable, is discovered at once, and may be treated and cured by removal of an occasional stitch and alterations in the manner or frequency of dressing.

Tension of the flap is a fruitful cause of gangrene or sloughing, and is generally attributable to the incision which marks the upper margin of the flap not being carried far enough into the scalp, or to the tissues here not being sufficiently undercut.

This statement may require a little amplification, as follows: In practice, the position of the graft in the forehead

is never absolutely in the vertical mid-line, so that we do not speak of the flap as having a right and a left margin. The graft is more or less inclined to one or other eyebrow, and its enclosing flap, when dissected up, has, therefore, an upper and a lower margin. The question of tension is not affected by the lower margin at all.

Let us suppose the graft lies obliquely over the right supra-orbital region. The lower margin of the incision passes more or less close to the inner end of the right eyebrow. Rarely it ends here; almost invariably it must be carried on just below the nasion; and often it will be continued across the left side of the nasal bridge $\frac{3}{4}$ inch beneath the left inner canthus (see Figs. 48-56 and 61-66, pp. 168 and 187). As long as the left angular artery is included in the pedicle the nutrition of the flap is unaffected by the length to which this incision is carried.

If it is found that the flap cannot be brought down far enough because this lower incision is too short, this shortness of incision does not involve *tension* on the flap. Quite the reverse is the case, for the more it is attempted to bring down the flap the more the lower margin bulges and kinks; the impediment depends simply on the position of the lower part of the hinge of the flap, which is not far enough out on to the left cheek.

Now consider for a moment the upper margin of the flap incision. Here it is quite otherwise. If shortness of incision limits the bringing down of the flap, attempts so to lower it put this upper edge under great tension.

Tension of the flap pedicle means, then, that the upper margin has not been carried far enough into the scalp, or that the tissues have not been freely undercut in the layer of cellular tissue which separates scalp from pericranium.

Accordingly, the upper margin of the incision must be either snicked transversely, as in Fig. 43 (p. 151), or prolonged. A transverse snick is undesirable, since it interferes with blood-supply. If the pedicle is wide enough, and its arterial supply assured, the incision may best be prolonged by curving it downwards towards the left external angular

frontal process. The flap may now be brought down by rotating it through the curve of the incision (see p. 249). But if there be any doubt as to adequate blood-supply the incision must be prolonged horizontally to the left, or even curved slightly upwards. This prolongation gives a less neat effect than the former curved one, because it leaves a redundancy of tissue on the scalp margin above the incision. The result is that the scalp here puckers, and this requires correction at the time or later.

Cold.—In a hospital at home, in a sheltered situation, and equipped with every modern convenience as regards heating of wards and water, cold is probably unknown as a factor in causing gangrene of plastic flaps.

Overseas the surroundings are less propitious, and two cases, which I can only call frost-bite of flaps, occurred in my own experience: one in the winter of 1916-17, and one a year later. At the time the cold was intense. The main water-pipes were frozen, and for a few days we were dependent for hot water on melted snow heated up.

The first case was not a forehead flap at all, but was my solitary attempt at making a nose from a flap taken from the forearm.

All possible pains had been taken to eliminate failure. The patient had been gradually accustomed to keeping his arm up in its unnatural position for increasing periods, and without the use of sedative drugs, until he could without inconvenience keep his forearm bandaged to his nose for twenty-four hours. The flap, half as large again as it would eventually be required, was dissected up from the forearm, and allowed to shrink for two weeks; by the end of this time it was thick, well nourished, and only slightly larger than required. During this two weeks the patient was daily practised in keeping his arm up, and Major Valadier devised a most efficient and comfortable cage to support the arm and maintain its position.

The morning following that on which the flap was attached to the nose the frost set in suddenly. The bed was tented with blankets, and a petrol stove placed on either side of it.

The main stove of the ward was less than ten yards away. The patient's head was surrounded with hot-water bottles, one of which was slung so as to be an inch from the bridge of his nose. But the flap sloughed off.

In the second case, a forehead flap was turned down. On the second day the lobule, alæ, and columella sloughed away. The circumstances as regards temperature and precautions taken against cold were the same as in the first case.

Fortunately, the pedicle had not been divided, and so it was possible to provide fresh tissues at the nasal tip by lowering the nose first on one side and then on the other, according to the method which will be mentioned later. Cold was in this case certainly the only cause of gangrene. The local and general nutrition was excellent. As evidence of this it may be mentioned that the tissue of the nose (not yet finished) is soft, free of scar tissue, and of perfect colour; and that not only was the strip of the costal cartilage inserted into the bridge *after* the flap had been brought down, but this cartilage was not even his own—it was a homologous graft taken from another patient. This cartilage graft took well, and the man's condition must have been good.

I have mentioned these two cases to illustrate that cold may be a factor to be reckoned with.

Among minor complications of these earlier stages of rhinoplasty may be mentioned stitch abscesses, which are especially likely to occur if a mattress suture has been tied too tightly; and suppuration, where the pedicle is slightly twisted on itself. At this point, on a level with the nasion, the lower edge of the flap is slightly buckled or kinked. Pus may form here and collect on the deep surface of the pedicle.

Division of the Pedicle.—The pedicle curves slightly from above the eyebrow to the root of the nose, where it merges into the flap at the region where this is sewn to the nasal gap. This is seen in Figs. 48-56 and 61-66 (pp. 168, 187); and, if a large part of the bridge has to be made, the arrangement is similar, whether the case be one of partial or total rhinoplasty. The upper part of the flap completely conceals from view the upper part of the nasal bridge. And it re-

quires careful thought to decide on a point above which the nose will finally consist of the remains of the old bridge, and below which it will consist of the flap. At the stage when the flap has firmly joined on to the margins of the gap, and before the pedicle has been divided, the surgeon may be struck with the idea that the bridge, in profile, has such a desirable line that it would be better to divide the pedicle high up between the eyebrows, and leave the true nasal bridge covered by the flap.

Practically, such a plan is not sound, because it would leave the raw under-surface of the flap in contact with skin. But I mention it to emphasize a particular point, which is, that the pedicle should be divided at a point higher up on the face than seems necessary.

In the first place, a much more shapely nose may often be obtained by dissecting up for $\frac{1}{2}$ inch or more the soft tissues of the nasal bridge, and sinking the upper angle of the flap into this area; this plan tends to avoid the hump at the junction of flap and nose which often results if the pedicle be divided exactly at the end of the nasal tissues. In the second place, if, owing to shrinkage in later stages, more tissue is required at the tip, this can be obtained if spare tissue has been left up above, by lowering the nose one side at a time, in stages.

The dividing incision will be made in the pedicle according to the shape and size of the piece of tissue required to fill the nasal gap. In the case of a total rhinoplasty the incision should be made so that the upper end of the flap is bluntly pointed. This is done by sloping the cut from above the inner canthus on the side from which the flap is taken to below the inner canthus on the opposite side.

The tissues over the bridge are now elevated and the apex of the flap sewn down. Before doing this the operator should take the opportunity of seeing that the upper end of the rib cartilage lies snugly in the angle between the nasal bones, and, if necessary, of shaving down the anterior surface of the cartilage.

The pedicle is now returned to the forehead. Before sew-

ing it into its original place the edges require freshening. So also do the edges of the forehead gap; and if these have shrunk apart, they require undercutting and drawing together in order that the pedicle may fill the space. If the granulations over the raw forehead area are very exuberant they must be partly scraped away before stitching the pedicle back in place (Figs. 48-56).

Subsequent Stages.—These concern the greater part of the raw area on the forehead—which has been only partly



FIG. 48.—Private W. Complete loss of nose. Oiled vulcanite plates have been inserted to discourage adhesions between turbinates and remains of septum.

reduced in size by the return of the pedicle—and the newly formed nose, or part of a nose, which requires final manipulations for æsthetic reasons. The forehead may be dealt with by rotated flaps (p. 249), or by skin-grafting, or by a combination of the two.

If rotated flaps are to be adopted, it must be remembered that to cover in the raw area by this method involves an alteration in the hair-line; this will be not only depressed,

but—what is more noticeable—may perhaps be made asymmetrical. The plan is only suitable for patients with a very high forehead. Moreover, it may leave a bare area of varying size to granulate at the top or posterior limit of the flap which is slid. To conceal this patch reliance is placed on the hair, so that this plan is not suitable to patients with bald heads.

The technique is as follows: The scalp is shaved as far as



FIG. 49.—Private W. Profile, after healing.

necessary, and from a point at the summit of the raw area a vertical incision is carried backwards towards the vertex.

This straight incision is from 2 to 5 inches long, and is then continued as a curve around the parietal region; the flap is then slid forwards to cover the gap on the forehead. The raw area left is partly covered by drawing together its margins; the rest is, as above stated, left to granulate, or skin grafted.

If desired, the vertical incision may terminate in two outward parietal incisions in the form of a **T**. The two flaps

are then moved forwards; this variation leaves the hair line more level on the two sides of the forehead.

Skin Grafting.—If the forehead area is to be grafted, either a Thiersch or Krause graft may be used. The difference in colour and consistence between the graft and the original surrounding skin disappears with the passage of time. But the junction line between the two may remain visible as a scar, which later requires excision.

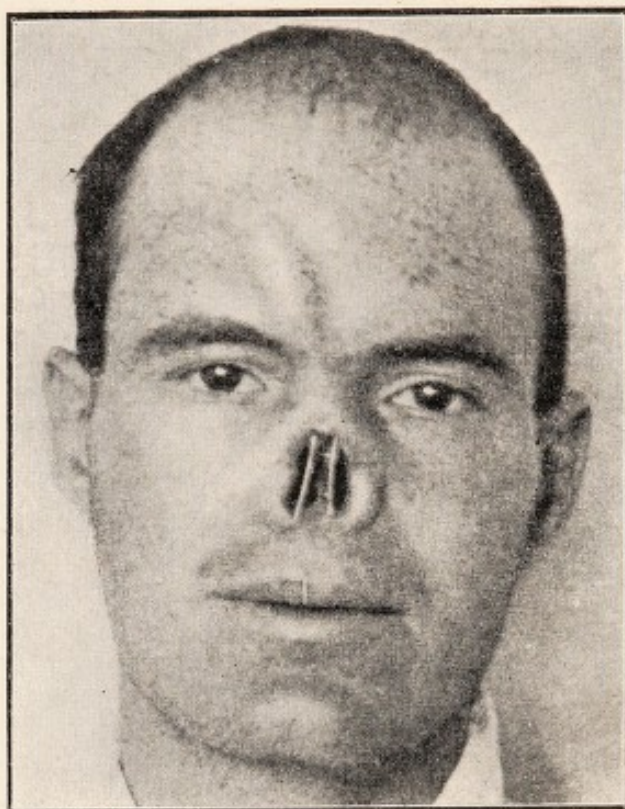


FIG. 50.—Private W. The costal cartilage, destined to form the nasal bridge, was grafted under the frontal pericranium two weeks before the photograph was taken. The graft lies obliquely over the right eyebrow, making an angle of about 30° with the mid-sagittal plane. The vulcanite plates are still in position.

If to cover in the raw forehead area the rotated flap method be adopted, or even if the space be grafted, there may be subsequent elevation of the eyebrow from contraction of scar tissue.

This may be corrected by excising the narrow strip of scar tissue, and then either placing therein a pedicled flap from the facio-malar region, or skin grafting.

The subsequent stages as regards the nose may involve repeated minor operations.

Shaping and Finishing the Nose.

It is to be presumed that the patient has now reached a stage in which what he and his friends regarded as the most glaring and revolting results of his war injury have been corrected. The gap in his nose is closed in with healthy



FIG. 51.—Private W. The cartilage-bearing flap has been turned down, having a pedicle over the left eyebrow. In shape the flap was a trefoil. The raw area left by the middle lobe of the trefoil was at once obliterated by drawing together its margins, as shown by the suture line. The columella, hanging free, has been formed by folding on itself the middle lobe of the trefoil (see p. 160). In the centre of the raw forehead area pericranium has been dissected up with flap. Consequently the bone here is bare, and will not granulate. It was many weeks before the outer table desquamated (see p. 157); thereafter this white central patch granulated from the diploë.

skin; the nasal lobule, alæ, and columella (if any remained after the gunshot wound), are no longer twisted sideways or flattened on to his face, but approximate to their normal position. In the case of a total rhinoplasty, in which alæ and columella have been made from the frontal flap, these parts differ from those of a natural nose by reason of their

clumsy thickness and entire lack of movement; but the patient has reached a stage when he obviously possesses a nose.

Up to this moment the most important goal to strive and hope for has been to make a nose which, although rough and unshapely, shall live, shall not collapse on to the face, and shall admit of ordinary physiological functions—normal respiration, purification and regulation of temperature, and moisture of inspired air, and the sense of smell.



FIG. 52.—Private W. The columella has been attached to the philtrum, and the pedicle divided high up. It is obvious that the size of the new nose has been deliberately exaggerated (see p. 159).

This much has been done. It remains to give the nose a more pleasing appearance.

To pronounce dogmatic rules of guidance for the various modern means adopted to give contour to a newly made nose is impossible for two reasons. Firstly, every surgeon engaged in this branch of work is constantly trying new manoeuvres; these are to a certain extent experimental, as is inevitable in any pioneer undertaking. And it is impos-

sible to predict the degree of success of any new variation; so that it may be discarded after one attempt, or perpetuated as a stereotyped method, or altered repeatedly. The methods are, therefore, in a constant state of flux, and it is best for each operator to record his own experience.

Secondly, we are handicapped in rhinoplasty by the impossibility of replacing certain lost tissues, notably muscle. The small muscles which control the movements of the skin



FIG. 53.—Private W. Various minor operations have been performed to shape the nose (see p. 176). The patient is wearing a prosthesis, designed for the author by Major Valadier; this serves the double purpose of maintaining compression on the nasal bridge, and checking stenosis of the nostrils.

over the nasal bridge and of the nostrils are lacking, and the nose is to this extent a wooden and lifeless organ for all time.

The same applies to a less extent to the alar cartilages. Attempts are constantly being made to graft cartilage into the newly formed alæ; but in so far as the reproduction of the delicate curve of the nostril is concerned I have not heard of any signal success.

The more gross departures from a natural nasal contour

may and should be corrected. And in a majority of cases the first points to strike the eye as unsightly are a bulge at or below the level of the nasion, and a too great width of the nasal bridge; so that the nose above the alar level, instead of being in horizontal section roughly triangular, has a surface approximating to a continuous curve from one cheek to the other (see Fig. 52, p. 172). The prominence between the eyes is caused by the remaining distal end of the pedicle

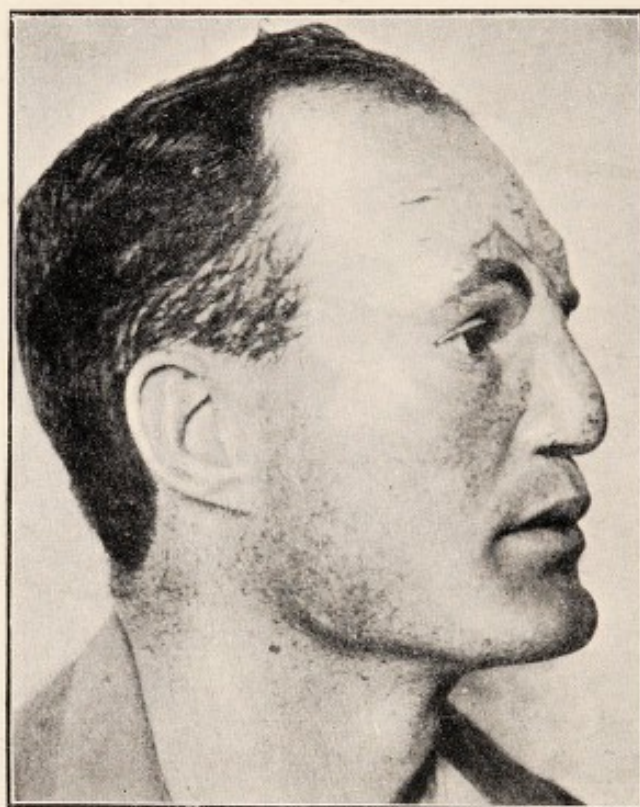


FIG. 54.—Private W. The patient on discharge. The forehead has been Krause-grafted. At this stage the only prosthesis used consisted of two small oval vulcanite rings, worn in the nostrils at night (see p. 179).

(or proximal end of the flap). To have divided the pedicle at precisely the right point when returning it to the forehead would be a counsel of perfection, but withal risky. In all plastic work it is a maxim that it is easier to remove a redundancy than supplement a scanty flap; and, accordingly, the pedicle was, or should rightly have been, divided a trifle too high between the eyes. This is the only safe course.

Now it is a simple matter to correct this by merely remov-

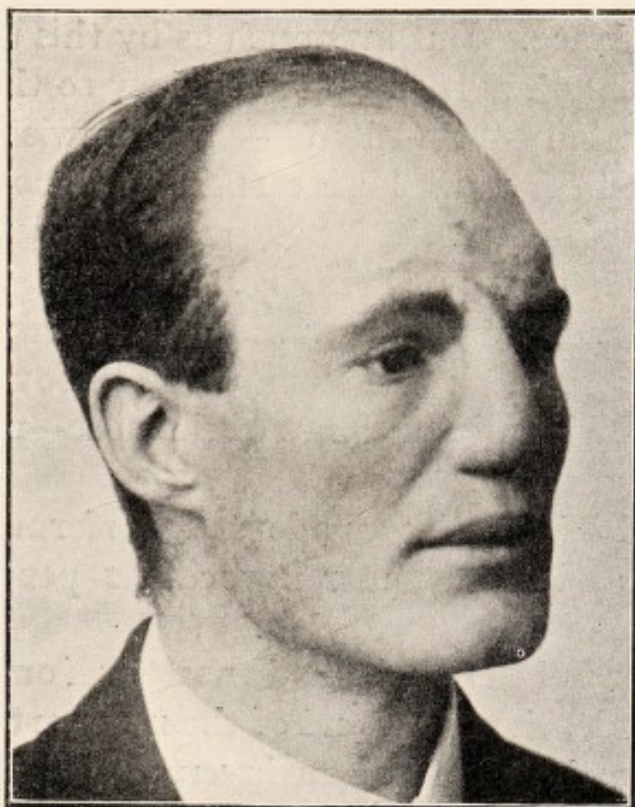


Fig. 55.

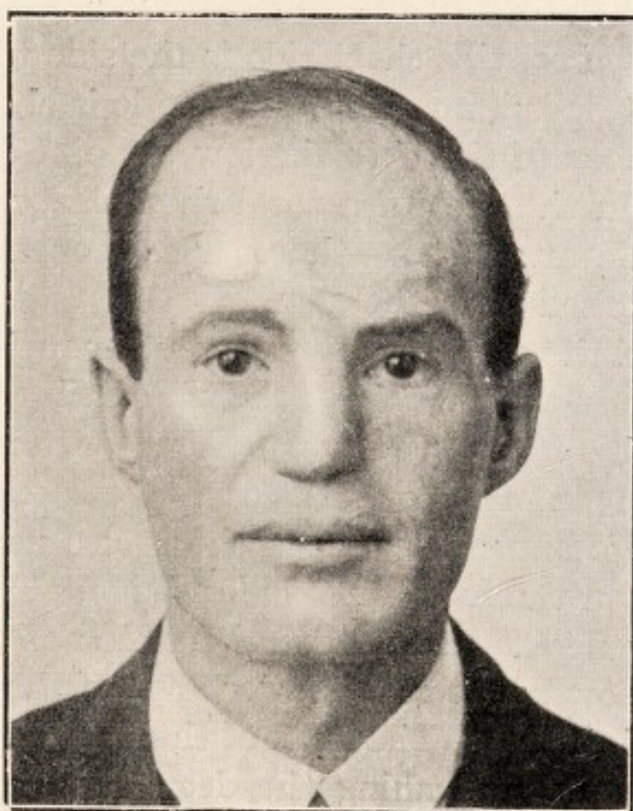


Fig. 56.

FIGS. 55 AND 56.—Private W. Twenty months after the last operation, and twenty-nine months after the wound. The patient now writes that he dispenses with the rings in his nostrils; that he is in very good health, and never feels anything the matter with his nose; and that sometimes he forgets there has been anything the matter with him.

ing the redundancy. But inasmuch as by this time the flap will very possibly have contracted slightly so that the nasal lobule is elevated—"tip-tilted"—it is unwise to remove the redundancy above until it is certain it will not be wanted. If the nose is tip-tilted the lobule may be lowered and the upper bulge removed coincidentally. And since this method, about to be described, involves also reopening the sulci between nose and cheek, the second defect above mentioned—too great width and roundness of the nose—may be dealt with at the same time.

The method I have always adopted, performed in two or three stages, and often under novocain 2 per cent. anæsthesia, is as follows:

The upper end of the newly made nose (or if only the bridge has been remade, the upper end of the new part of the nose) is, roughly, in the shape of an inverted **V**. The limbs of this may form a narrow or a wide angle, and may be symmetrical or not. If asymmetrical, one side of the nose will be longer than the other; and on the shorter side the ala may be too high. If so, this short side is the side to be first reopened; if not, it is immaterial which side is chosen.

From the apex of the **V** to the lowest point of the flap—which point, in the case of a total rhinoplasty, will be the junction of ala and cheek—the scar is reopened, and the scar tissue excised from the skin.

This side of the nose is now undercut enough to allow it to be lifted from the cheek. If the rib cartilage happens to be cut into this is not, in my experience, attended by any bad result; but in most cases the cartilage is easily avoided. The dense fibrous tissue between cheek and nasal bridge is now resected in the form of a wide wedge. The sides and apex of the wedge lie lengthways along the nose, and extend above and below between the lower level of the eye and the upper level of the ala. The apex of the wedge lies along the length of the nose, touching the deep surface of the skin midway between the bridge and the line where nose joins cheek. From this apex the sides of the wedge slope away from the skin deeply, towards the deep surface of rib carti-

lage on the one hand, and deep surface of cheek on the other.

The result of thus resecting the scar tissue is that, when the nose is resutured to the face, there is a gap or gutter beneath the skin of this side of the nose. This gap is triangular in section, and its long axis lies lateral and parallel to the nasal bridge. And by applying and maintaining pressure to the side of the nose until healing is complete, the result obtained is the natural wide shallow sulcus on this surface, instead of a convexity.

In resuturing nose to cheek the former is reattached lower than it was placed before. This change of position simultaneously lowers this side of the nose, and partly removes the redundancy above.

A month or so later a similar manœuvre is executed on the other side of the nose. And, alternately on one and the other side, this may require to be repeated several times.

Depilation.—In cases where the nasal alæ and tip remain, and only the bridge requires to be remade, the flap will not encroach on the hair line unless the latter be exceptionally low on the forehead. I have never seen a case where the hair line was so extremely low. But in a total rhinoplasty the width of the flap at its distal end—that is, the part which is destined to form the columella and margins of the nostrils—is often necessarily great enough to invade the hairy scalp.

The hair-bearing part of the flap will, accordingly, require depilation; this should be done by the use of X rays by an experienced radiographer.

Depilation may be undertaken on the measured area of scalp before the flap is dissected up; or later, when it has been transformed into a nose.

There is one good argument for not depilating until the flap has been fixed to the face and the nose nearly finished, and this is, that over a certain small space the presence of a few hairs is immaterial, for the following reason:

As will be mentioned shortly, one method of forming the alæ consists in making the flap sufficiently long and wide to

allow of inversion of the edges where these form the margins of the nostrils; so that these margins have a nicely rounded edge, and also a lining of skin. If this method is followed, the inverted skin consists of those parts which were at the extreme upper and lower edges of the distal end of the flap when it was dissected up from the forehead.

Now, however wide the flap, its lower edge will be kept well clear of the eyebrow; and if the forehead is too low for the necessary width of flap, this will encroach on the hairy scalp above. This piece is just the part which will form one nostril; and its extreme upper edge, the patch most likely to contain hair follicles, will be the part inverted to line the nostril.

This lining may contain short hairs (comparable to the natural vibrissæ of the nares) without disadvantage. If hair extends on to the flap so low down that it appears on the outer surface of the nostril it will require depilation. But the probability that hair will be limited to the inverted skin which lines the nostril is the reason for depilating after, and not before, the flap has been raised from the forehead and fixed to the face.

Points of Especial Difficulty in Final Stages.—These concern chiefly the nares and columella in the case of a total rhinoplasty. The nares tend to shrink and their orifices to contract; and the more efficiently the nose has been lined the less will this tendency be manifest. An ideal case would have nasal cavities of approximately normal capacity, and these would be lined throughout by skin; and whether this skin had been obtained by inverting flaps from the margins of the healed wound or by Thiersch-grafting the flap while it was yet on the forehead, it would be hoped that the lining would in the course of time come to resemble that of a normal nose. That is to say, the upper and deeper parts would undergo metaplastic change into mucosa; while the vestibular part would remain skin, and not shrink.

As to the metaplasia in the upper regions, I have never seen a case which affords any evidence on this question.

As to the lower vestibular part, the lumen of the nostril

does sometimes tend to shrink and become stenosed even although carefully lined.

I have formed the margins of the nostrils, in my cases of total rhinoplasty, by outlining a trefoil flap from the forehead. When the flap is turned down (or as a separate stage, before the flap is turned down) each lobe of the trefoil is folded on itself, so that both sides are covered by skin. The middle lobe forms the columella, and each lateral lobe one ala.

Nostrils so made do shrink if allowed; and for a long time, quite a year, a small hollow prosthesis should be worn for twelve hours out of every twenty-four (say at night) to counteract this tendency (see Figs. 55 and 56, p. 175, and accompanying quotations from the patient's letter).

Apart from the alæ contracting, they are often too thick. This fault should not be corrected by dissecting through the free edge of the nostril; for if this be done it leaves a contracting scar, and, moreover, the inverted lining skin will probably die. The proper time to correct this undue thickness is when the nose is dissected up from the face; this (see p. 176) should have been undertaken earlier, one side at a time, with the double object of lowering it bodily on the face and shaping its sides. During this operation, when one side of the nose has been separated from the cheek, the thickness of the ala may be reduced by elevating its lining for half an inch from its margin, where ala joins cheek, and excising a thin slip of fibrous tissue between the outer and inner alar surfaces. A "mattress" stitch, as will be described under Dressings, may now be passed through the ala, and the nose stitched in its new and lowered position (see p. 177) to the cheek.

The Columella.—As regards the columella, the difficulties of making a shapely part which will retain its size and form are similar to the difficulties in the case of the alæ—but they are even greater.

To minimize subsequent shrinkage of the columella it is a good plan to form it on the forehead before the flap is lowered; this is done by dissecting up the middle lobe of the

trefoil (referred to above, p. 160), and folding it lengthwise on itself. The two folds of skin are sutured together, raw surface to raw surface, and a dressing placed between this embryo columella and the bared periosteal area from which it has been lifted.

If the cartilage graft has been made extra long, with the idea that the distal end shall subsequently be fractured at right angles to the remainder and used as columellar support (see p. 153), this distal end will be raised from the forehead with the middle lobe of the trefoil, and the raw surfaces of the two folds sutured around this small strip of cartilage.

The result of this plan is that a large proportion of the inevitable contraction in length of the columella occurs before the main flap is raised, and subsequent disappointment is less likely. Moreover, if the columella has shrunk more than was allowed for, this fault may more easily be corrected before the flap is lowered than after.

This plan of arranging a flap so that both of its surfaces are skin covered before it is transplanted can be, and often is, adopted, not only for the columella, but for any part of the nose or face. But even although this method has been followed, the columella will usually shrink a certain amount in length; this occurrence is commonly aggravated by the retraction of scar tissue at the point where the columella is sewn to the top of the philtrum of the lip. In addition to the actual diminution in length of the columella, it often sags; the nasal lobule sinks backwards towards the face, and the line of the columella becomes convex downwards.

The best prophylaxis against eventual deformity of the columella lies in the careful preliminary preparation of nasal support; if the septal cartilage can be brought out (see Fig. 37, p. 145) to meet the columella so much the better.

A small sliver of rib cartilage may be grafted into the columella when it is in place; but this plan is less likely to succeed than is the method of septal support, plus the fractured end of an extra long piece of rib cartilage as originally placed in the forehead.

If the intermittent wearing of a prosthesis is necessitated to maintain the shape of the nostrils, it will also aid in keeping the columella straight and extended.

The point where the columella is attached to the upper lip is poorly nourished, and likely to slough. And if this does not occur there still remains the possibility that this point of junction may subsequently be drawn too far upwards and backwards into the nose, or, conversely, too low down on to the philtrum. Indeed, at this point of junction it is difficult to obtain a good cosmetic effect,



FIG. 57.—Private N. Part of the right cheek is destroyed, exposing the tongue. The columella is absent.

which is unfortunate, since it is a noticeable point on the human face. There are at least four methods of attaching columella to philtrum:

1. The freshened end of the columella is simply sewn to a freshly rawed surface on the lip. This plan, if it succeeds, is good. But there are certain contingencies. The surgeon must be sure that the columella is over-long, as the junction may slough and require resewing.

Another possibility is that, if it does not slough, the point

of junction may afterwards become thinned transversely, so that this becomes the thinnest part of the columella, and the effect is ugly. The best way to reduce the possibility of disappointment is to split the end of the columella vertically and splay it out on the raw lip surface, and suture accurately with horsehair. The splaying makes the columella thicker at its facial end than in the middle, as it is normally.

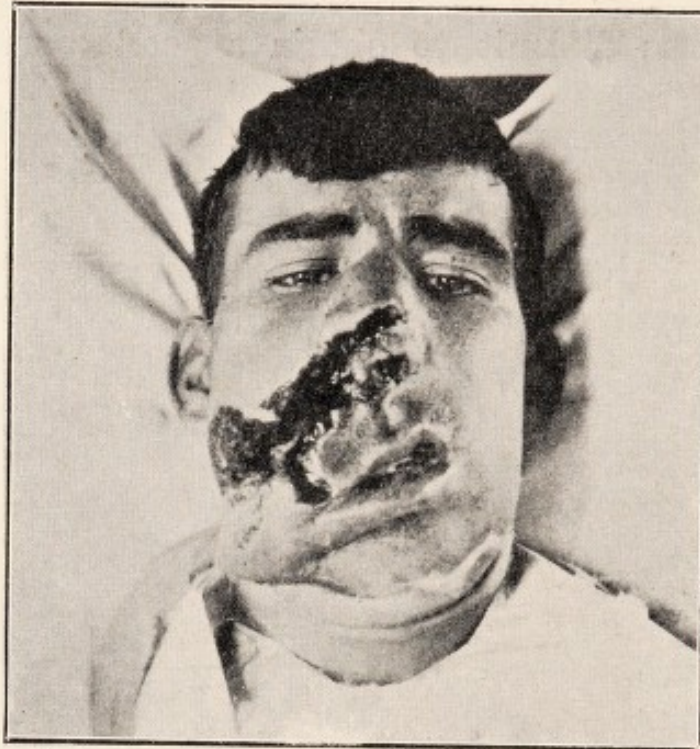


FIG. 58.—Private N. Full-face view. The right ala nasi has been divided transversely, and is hanging from the left ala. There is no columella. This patient also suffered a fracture of the maxilla, which was refractured in a subsequent operation by the sudden force of a gag.

2. A small flap, with its pedicle just within the nasal vestibule, is turned up from the uppermost $\frac{1}{4}$ inch of the philtrum, and its end accurately sewn to that of the columella. The possible disadvantage of this method is that, subsequent to healing, the point of junction will appear as if retracted backwards and upwards into the nose.

3. A similar flap is used, but it is turned down from the top of the philtrum, so that its pedicle points downwards instead of upwards. The possible disadvantage of this method is that, subsequent to healing, there will be a too

obtuse angle between columella and philtrum, so that the former appears to curve insensibly into the latter.

4. A small flap may be taken pedicled upwards, as in Method 2 above; but instead of attaching it to the columella end to end, the lower raw surface of the flap is apposed to the freshened upper surface of the columella; while the extreme end of the latter is sutured to the denuded area of the philtrum from which the small flap was taken.

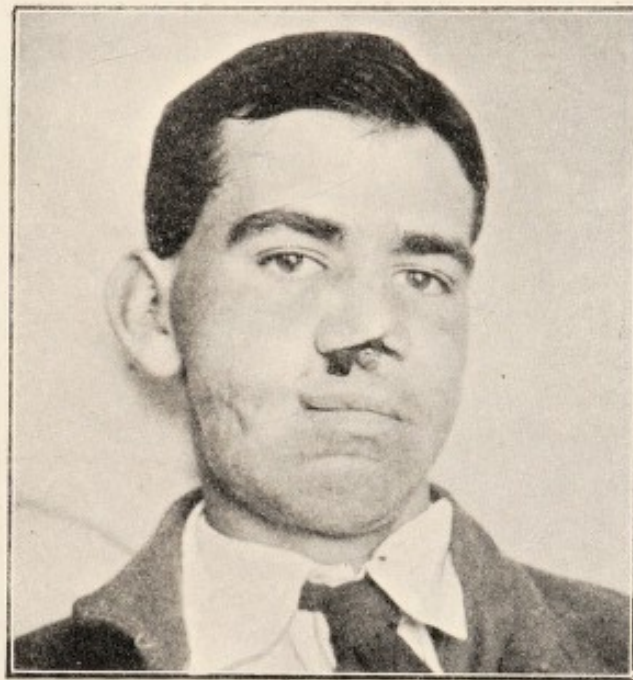


FIG. 59.—Private N. The face has been repaired. A columella has been made from the upper lip. There is a piece of rubber tubing in the right nostril.

By this method a larger raw area is apposed for junction. But it requires a greater length of columella than Methods 2 or 3, because the length of the pedicle in this method is not added to that of the columella, as it is in 2 and 3.

This last plan has seemed to me, on the whole, to be the most satisfactory.

In cases where the columella is the only part of the nose lost, it may be entirely remade from the upper lip. This was done in the case of Private N., Figs. 57-60.

The technique is simple. A strip, much wider than the columella is intended eventually to be, say about $\frac{1}{2}$ inch, is dissected from the median line. The strip includes the whole

thickness of the lip. Its lower end is lifted and attached to the deep surface of the nasal lobule. The cut edges of the lip are sewn together for their lower two-thirds, tension buttons (see p. 212) being used if necessary. The upper part of the gap in the lip must be left widely open, as any pressure here would kill the new columella. When the junction of columella and nasal tip is firm—that is, after two months at least—the basal end of the columella at its junction with the upper extremity of the lip may be adjusted.

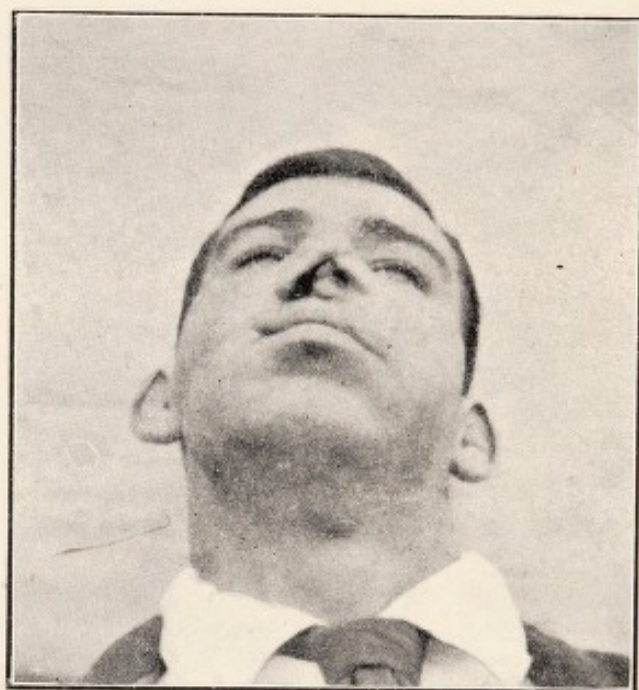


FIG. 60.—Private N. The new columella made from the philtrum of the upper lip.

This plan is not, from an æsthetic viewpoint, a counsel of perfection, for it destroys the two vertical lines which in nature mark the philtrum. But it is sometimes very useful.

It will be clear that the under surface of a columella so formed is covered with mucosa, which formerly lined the upper lip. By metaplasia this gradually changes to skin. But this change is slow, and for six months this surface has a very angry red colour.

After-treatment.

Dressings.—It is inevitable in the case of any new branch of surgery that the manœuvres and the variations of technique should be endless in number. And, naturally, every operator who has practised rhinoplasty in this war is prejudiced in favour of some particular solutions, ointments, methods of applying dressings, tubing, and prostheses. Since the after-treatment is of signal importance, it is well to record the forms of dressing which have best stood the test of repeated trial.

Warmth is a paramount necessity. This may seem too obvious to merit emphasis, especially to such as have carried on similar work entirely in this country. But, personally, having been engaged in this type of work not only in England, but also in France for two years—which included two severe winters in hospital huts at the top of an unsheltered bleak hill in France—I have a most lively respect for the effects of cold on skin flaps. I have already (p. 165) referred to two cases in which a nose flap froze off; but the same insistence on this point is, of course, equally necessary when other parts of the face are concerned. If (as has occurred in my experience) the warming of an operating-theatre is unsatisfactory, unremitting attention to temperature begins from the moment a flap is first raised, and does not cease day or night until this flap has firmly grafted on to its new site.

During the operation all flaps of soft tissue are covered with constantly changed gauze wrung out of saline solution at about 140° to 150° F. A flap which is being manipulated should be held wrapped in similar gauze. Rib cartilage is resistant, and need never be separated from its host for more than a few minutes; during this time it may be kept in warm saline (115° F.), or be wrapped in dry, warm gauze.

The patient's bed in cold weather should be tented by means of two screens and a blanket thrown over them. His head is pillowed between two hot-water bottles. Even then his nose is likely to be cold, and the best simple way I know of counteracting this is to sling a hot-water bottle from each

of its ends to the screens at the side of the bed or the rafters of the hut ceiling, so that the bottle hangs horizontally an inch from the nose. This was, as far as I know, devised by the nursing staff in Hospital No. — in France, and it answers the purpose quite well.

When the rib-cartilage is inserted, firm pressure has already been insisted on as necessary to prevent the possible formation of a hæmatoma; beyond this precaution, no remarks are necessary. When the forehead flap is made, the eventual size of the raw area on the forehead will be minimized if at the same operation its margins are approximated by means of "tension buttons" (see *Injuries of the Face*, p. 212).

The denuded part of the forehead, when the flap is turned down, should have a dry dressing for twenty-four hours, until oozing has ceased. After that, various applications may be used. Normal saline, changed two to four times daily, is most usual.

There are only two probable reasons for wishing to depart from this—either because the forehead wound becomes septic, or because it granulates sluggishly.

In the former case, eusol 1 in 3, or what is chemically similar, liq. sodæ chlorinatæ 1 in 8; or mercuric chloride 1 in 4,000, are useful.

The latter case, too slow granulation of the wound, seldom arises; usually the reverse occurs, and exuberant friable granulations bulge out above the level of the surrounding surface. But if it is wished to stimulate granulations, the aniline preparations are helpful—ointment of scarlet red 4 per cent., or aqueous solution of brilliant green 1 per cent. I have never seen any special advantage or disadvantage from the use of amberine.

As regards dressing the suture-line on the face, this may be regarded as a wound which passes through three stages, at each of which the dressing may require changing.

Firstly, immediately after the operation. The surgeon may, if he likes, dispense with any dressing at all. The blood which oozes out forms a thin layer of clot which may for one or two days form a most efficient dressing if the

patient's surroundings are quite clean. But there are obvious disadvantages to this plan. The clot cracks in places, and so does not remain air-tight for more than a few hours. Tears or serum trickling down from beneath the dressing on the forehead wound may infect the suture-line. And as he lies recumbent or semi-recumbent, any post-anæsthetic vomiting is nearly certain to soil the wound.

It is better to paint the suture-line with something that will dry rapidly and form an air-tight covering. Any spiritu-



FIG. 61.—Sergeant R. Subtotal loss of nose. The tubing in each nostril serves for drainage and to prevent adhesions. To insure retention of the tubes, the upper end of each is attached to a piece of silk which is strapped to the forehead. The dappled spotty appearance is due to imperfections in the photographic plate.

ous mildly antiseptic solution answers this purpose, such as Whitehead's varnish, or tinct. benzoini co. as used at the Queen's Hospital.

If a dressing be used, it should be dry until the oozing has ceased.

This stage lasts one day if a dry dressing has been applied; the dressing and clot are then gently soaked off with any bland warm solution. If an antiseptic spirituous paint has been used, this stage lasts from two to five days, during which time the wound may be repainted once or twice.

Secondly, the stage between the removal of the first dry dressing (or the separation of protective blood-clot or paint) and the removal of stitches. As long as the suture-line remains absolutely clean a daily dry dressing may be adopted. But it rarely remains clean. Serum trickles down from the forehead wound; pus appears here and there, perhaps as a stitch abscess, often beneath the kink in the pedicle. A saline or any mildly antiseptic wet dressing is required,



FIG. 62.—Sergeant R. Cartilage-bearing flap turned down. The dotted line encircling the raw forehead area is due to the marks of a continuous stitch with which the skin was underrun to control obstinate bleeding.

which is changed more or less often according to the cleanliness of the suture-line. The stitches are taken out between the sixth and tenth days, and at the end of ten to fourteen days the second stage is ended.

Thirdly, when union is complete a light dry dressing may be used; two thicknesses of gauze, held to the cheeks by a piece of strapping, is often sufficient.

It is important in the early days after lowering the flap to keep its sides closely opposed to the underlying supporting structures, so that the sides of the nose are not allowed to be convex, but are kept flat, or, still better, slightly concave

in transverse section. Any scheme which will effect this will minimize the amount of undercutting subsequently necessary (see p. 176). Of course, a prosthetic appliance which grips the nasal bridge from side to side would preserve this shape. But in the early days, when dressings may require fairly frequent changing, a prosthesis is not very desirable.

In the first seven to fourteen days there are two methods I have used with satisfaction.



FIG. 63.—Sergeant R. A faint ridge, passing from a point between the eyebrows towards the left inner canthus, marks the direction of the incision which divided the pedicle. Subsequently some minor operations have been effected, and the forehead has been Krause-grafted. The bridge is too thick and clumsy.

Pressure may be made by sewing together three bandages. Two finger bandages rolled are sewn to a 3-inch bandage unrolled. The two small rolls lie across the width of the larger bandage, and at a distance of 1 inch from each other.

The dressing is applied, and then the larger bandage wound round the face across the nasal bridge. The two small bandages lie between the large one and the dressing; they are fixed to the former, and therefore cannot slip outwards on to the cheeks. They maintain gentle pressure on the sides of the nose; and when the bandage is tightened they

keep it lifted away from the face, and entirely prevent pressure on the nasal bridge from in front—an important point.

The other method is by inserting a large mattress suture through the nose from side to side at the conclusion of the operation. The needle traverses the nose just above its centre from side to side, deep to the rib-graft (bridge), and is then threaded through a piece of fine tubing $\frac{3}{4}$ inch in length. The needle then makes a return journey in a similar position, parallel to its first course, but $\frac{5}{8}$ inch lower



FIG. 64.—Sergeant R. A good straight bridge. The lateral scar was deliberately left, to be excised if necessary a year later. Such scars often gradually disappear with time.

down on the nose. At its emergence, $\frac{5}{8}$ inch below its original entry, and on the same side of the nose, it is passed through another piece of tubing similar to the first. The ends are then tied, creating a slight concavity on each side of the nose. The pieces of tubing, being slightly longer than the vertical superficial parts of this mattress suture, prevent it from cutting into the skin. Instead of tubing, "tension buttons" (see p. 212) may be used. The dressing by three bandages and that by a mattress suture may be combined if desired.

After healing is complete, and while the tissues deep to the flap are undergoing fibrosis, a prosthesis is usually required to maintain the slight concavity; such an apparatus is seen in Fig. 53, p. 173.

A columella fashioned by plastic surgery, whether it is made from the forehead or lip, has an inveterate tendency to shrink upwards into the nose. This applies to all cases except those in which the septal support extends down as far as the normal columella. When healing is complete,



FIG. 65.—Sergeant R. Fifteen months later. The lateral scar has nearly disappeared.

this tendency may be combated by a prosthesis. But for the first two or three weeks I have found a piece of rubber tubing, suitably bent, answers well.

The tube has a diameter of about $\frac{3}{8}$ inch, and a length of 3 to 4 inches. It is cut half through, exactly in its centre. It is now passed up one nostril and through to the other, above the columella and any scar or granulation tissue to which the columella has been sewn. The tube now emerges from the other nostril. Its ends are pulled down as far as necessary, and kept exactly level, and are sewn to the upper lip. The tube forms an inverted V. The cut in its centre

lies in the upper aspect of the angle of the **V**, and insures that the tube kinks at the right point. Moreover, the nasal cavities may be irrigated through the tube, the solution passing through the cut in the rubber, which naturally gapes because the ends have been approximated below. This plan was used in Case Private N., Fig. 59, p. 183).

Alæ nasi which have been made by plastic surgery tend to grow very thick, for the same reason that the bridge and sides of the nose tend to grow rounded and convex—that is



FIG. 66.—Sergeant R. Taken at the same time as Fig. 65. The bridge is still slightly too wide and convex. The patient now writes that breathing is good and unobstructed; sense of smell is quite natural; and that as the result of catching cold he sneezed fairly frequently last winter, but felt no inconvenience.

to say, the potential space between covering and lining fills up with fibrous tissue.

In the alæ this is particularly noticeable in cases in which the alar lining has been made by doubling on itself the skin of the two lateral lobes of the trefoil (see p. 160).

Now it has been said above that in the case of the nasal bridge this tendency to roundness may be partly prevented, partly cured. Prevented by lateral pressure, the means being either folded bandages or a mattress stitch (p. 189); cured by

reopening the sides of the nose, one side at a time, and excising part of the fibrous tissue (p. 176).

The same principles of prevention and cure guide us as regards undue thickness of the alæ, but with this difference: that cure, by opening up the edge of the nostril and excising the intermediate fibrous tissue, is hazardous. There is a risk of death of the thin unsupported remaining skin. So that, cure being less practicable, prevention is more important.

The means for prevention are similar to those for the bridge of the nose (p. 190). At the same time as the flap is turned down, a mattress suture is passed through each ala horizontally, and tied through a short piece of narrow tubing. This keeps the two surfaces closely apposed during healing.

The patient should be warned against cold and trauma to his new nose. For the first subsequent winter he should cover his nose with a scarf when out on cold days. And he should permanently avoid any means of either livelihood or athletic recreation (such as boxing) which involves risk of a blow on the face.

CHAPTER X

THE FACE : EARLY TREATMENT

The Face.

PLASTIC surgery of the face is a branch of work whose field has until now been limited.

The number of cases in which the ravages of syphilis, lupus, or rodent ulcer are sufficiently extensive to produce hideous deformity is relatively small; and when they present themselves such cases are rarely, if ever, suitable subjects for extensive plastic correction. The prospect of obtaining good and permanent healing in patients with a tertiary specific history, or a long (even if remote) record of recurrent lupus ulcerations, is at best debatable. I have no experiences of plastic work performed on patients who had previously received curative injections of 606 or 914.

As regards traumatic cases, here again extensive injuries to the face are not often met with; they occur chiefly as the result of explosions, burns, and machinery accidents, in which the victim has, as a rule, no time to shield his face.

It will be admitted that a man who is suddenly exposed to danger to life or limb, and has not time to extricate himself, but just sufficient time to protect some parts of his body at the expense of others, instinctively guards his face. Probably the momentary delay enables him to think of his eyes; as the blow or other injury assails him, these close by reflex action; he bows his head and, if possible, covers his face with his hands.

As the type of accident from which a man may not be able to extricate himself, but which, nevertheless, is so slow in its development that he has the opportunity to make some

sort of preparation, an earthquake may be taken as a fair example.

I remember in the great Indian earthquake in 1906 the disturbance of the main shock took the form of three alternating waves. The earth, and with it the buildings, rocked first one way, then back again; and with the third wave, which was in the same direction as the first, roofs and rafters fell.

Everyone had time to realize what was happening; many people had time to get out of their bungalows before these, or any part of them, collapsed.

I happened to be sent to Dharmasala twelve hours sooner than any other medical officer, and, therefore, I naturally saw and treated many of the worst cases; they were of the most varied nature. And since the people caught by the earthquake comprised the officers and men of one complete Gurkha regiment, and the reserve depot of another, as well as the entire civilian population of the small cantonment of Dharmasala, there was of course a large number of injured. Yet, speaking from memory, I can remember only one case of facial injury—a Gurkha whose ear had been torn off by falling masonry.

This instinct to defend the face may account for the comparative rarity with which massive face wounds are met with as the result of, for example, street accidents, crushes, or attacks by hooligans or savage dogs.

When the soft tissues of the face have undergone extensive destruction by burns, the patient in many cases dies of shock. This still further reduces the frequency with which surgeons are called upon to undertake large plastic corrections. In cases which survive after burns by explosions, scalding liquids, or burning oil, the face has often suffered because the injury was almost or quite instantaneous. But if injured by being caught in a burning building, a man has time to think and act with deliberation, and here again he does his utmost to protect his face.

Now in war nearly all the injuries received are instantaneous, for they are practically all ultimately due to

explosions—either directly or indirectly through a blow from falling masonry, rafters, or earth—and the victim has no time to act.

So that facial injuries may be regarded as, to a large extent, inherent to warfare. During the long intervals of peace the art of plastic facial surgery sinks into the background; it receives but scant attention, and is not taught at medical schools in Great Britain. The writers of standard textbooks on general surgery have not treated the subject at any length. And when we turn to the older special books on this branch of work, the instruction provided gives an unsatisfying impression of being theoretical rather than practical. This impression is largely due to the fact that the illustrations are more often diagrams than pictures of actual cases, but also to the omission of a most important stage of the work. For the older literature rarely mentioned the *early* treatment of facial injuries. Whether the illustrations were purely diagrammatic, or sketches, or photographs, the writer usually took up his task at the stage when the wound had healed, or was at any rate clean. He described the existing methods of shaping flaps to fill in various gaps and deficiencies in the face, without illuminating the various vital points in the early treatment of the wound or its sequelæ, or in the conservation of tissue after such a wound. This common tendency to limit instruction to the artifices for making good a clean, healed hole in the face was no doubt partly due to the fact that the methods described had largely been carried out on cases in which there never had existed any early stage of a dirty wound—such cases, for instance, as gaps produced by the generous removal of an epitheliomatous lip, as the clean severance of the nose in a Pathan woman mutilated by a jealous husband.

Now in traumatic cases there are not only hurdles to be jumped in the shape of complications (as mentioned in the first three chapters) before the actual dovetailing flap work can be thought of, but apart from these dangerous complications there is the early treatment of the facial wound itself, and the conservation of tissue, to be ensured. From

this point of view modern facial surgery, as compared with what we read in the older books, opens up a new field.

Lastly, the earlier authors devoted hardly any of their writings to technique—to the many effective operative refinements which the surgeon daily learns, partly from others, and partly from his own (not always fortunate) experience.

During a war facial injuries and their treatment occupy a more important place. And this is true of the present war more than ever before, not only because, owing to the vastly greater number of combatants engaged, the incidence of every kind of war injury is augmented, but also because the enormous advance in the use of high explosive greatly discounts, by its instantaneous action, the self-preserving instinct which prompts a man to shield his face when he has sufficient time to do so.

Thus it is true that plastic facial surgery, as we interpret it to-day, is the modern outcome of this war. But now that (at the moment of going to press) the Armistice has been signed, it is well to emphasize that the usefulness of the work will not cease as the demand for it decreases. The fact that the war has come to an end will reduce this branch of surgery in quantity; but the fact that the war has ever occurred must exalt it in quality. The comparatively rare cases of traumatic facial deformity seen in peace time—explosions in mines; lacerations of face, scalp, or nose, caught in the driving-belt of an engine; dog-bites; and lift accidents—were, when seen after “cure,” a reproach rather than a testimonial to surgery. The vast experience accumulated since 1914 should change all this; and a plastic repair may yet be an integral branch of surgical work in industrial districts.

When a patient is admitted to hospital with a gunshot wound of the face, a superficial examination will not enable the medical officer to form any true estimate of the gravity of the wound. In the case of an abdominal or thoracic lesion, the first factor to be considered, as affecting the treatment or prognosis, is, of course, whether the wound is pene-

trating or not. The gravity depends entirely on the injury suffered by deeper structures.

And the same applies to face injuries. Their seriousness as affecting life depends primarily upon the amount of harm done below the surface; on concomitant injuries to the brain and to deep structures in the head or neck; on the presence or absence or accessibility of foreign bodies in these deep regions.

The mere closure of a large gap in the face produces a deep impression on the mind of a layman. It is something which he can see, and thus strikes him as a more clever performance than, for instance, a difficult abdominal operation, of which he can neither see nor understand the technique or results. If the quack appears, he will trade on this. Those who are engaged in plastic work should accordingly be careful to put on record by serial photographs precisely what they have done, which will show that they have achieved many things beyond the skill of the pseudo-plastic surgeon if he appears.

No photographs should be retouched, either in the negative or the positive. In this book there are only three illustrations (Figs. 55, 56, and 80) for which I cannot vouch as certainly not retouched. These were taken from picture postcards of patients whom I have not seen since they left France. They were sent to me by the patients themselves a long time before their discharge from hospital. In fact, Figs. 55 and 56 were taken more than a year after the patient's return to civil employment. Quite possibly the photographers had retouched these three.

The earliest photograph should be taken with the patient's face just as it was on removing the dressings with which he was admitted—except, perhaps, that blood-clot and dirt may be removed from the skin.

The margins of the wound often gape and evert so much as to give an exaggerated idea of its gravity and extent. This is repeatedly illustrated by the result obtained when the edges have merely been drawn together, with or without undercutting of their margins (Figs. 67-70, pp. 200, 201).

As a fact, when once the patient has escaped death from shock, the seriousness of any damage to the soft tissues of the face is measured, not by the area damaged, but by the amount of tissue lost. If the wound be simply left to itself to heal by unaided nature, it is astonishing to see how much the raw area shrinks in size.

When arranging a scheme of photographic records of facial wounds, any other available methods of registering the progress of these cases should be considered.

As a refinement of ordinary photography, stereoscopic pictures must be mentioned. These afford a lifelike impression of the depth of the wound, which is most valuable as a subsequent tribute to what surgery has achieved in any given case. If two photographs of the wound be carefully studied—first an ordinary, and then a stereoscopic picture—the observer will at once realize that the former has given him a quite inadequate appreciation of the depth of the cavity.

Such appreciation is essential, because, although the gap will subsequently fill up with granulation tissue to a great extent, there may still remain a sensible hollow which requires filling with grafts of fascia, fat, or cartilage before a skin flap is grafted to cover it in. Moreover, as the cavity granulates up from its base, the cicatrizing skin edges become drawn in deeply to meet it. So that, when the cicatricial margins are excised and the skin undercut for plastic repair, it is seen that the hollow was deeper than was evident.

Such points as these, which an ordinary photograph fails to show, are well brought out by stereoscopic methods. Photographs in colour, taken by the Lumière or the Paget process, are very beautiful, and bring out many points which may be missed in an ordinary photographic print. And stereoscopic coloured pictures, such as those in the beautiful collection of Major Valadier, are the zenith of all that has been attained in the way of photographic surgical records.

Diagrams have been referred to above; they are very useful as an adjunct to photographs, but not as a substitute for them. Occasionally it is not easy from a photograph to have an exact idea of the size, shape,



FIG. 67.—Private F.



FIG. 68.—Private F.

Figs. 67 and 68 show the same patient on admission and after one operation, which consisted in merely cutting away dead tissue, undercutting the skin, and performing primary suture in two layers. Thereby an extensive wound has been reduced to a small buccal fistula.



FIG. 69.—Rifleman C.



FIG. 70.—Rifleman C., after one operation.

Fig. 69 shows the same patient on admission. These two figures exemplify the same point as Figs. 67 and 68, which is that a seemingly large loss of the soft tissues of the face can often be made good by merely undercutting and approximating the wound margins.

and nature of a flap. The pedicle may be kinked, and the kink may hide an important part of the photograph. The suture-line may have healed at an unequal rate, so that in places the scar is already imperceptible on a photograph. In a photograph, again, mucous membrane is not always easy to distinguish from skin, and especially from granulation tissue, whereas in a diagram the difference is readily indicated by shading.

For various reasons of this kind diagrams supplement photographs very helpfully. And diagrams are useful to illustrate *types* of plastic operations. But they can never take the place of photographs. Sketches in black and white or colour, taken from life, are more helpful than diagrams, but less so in most cases than photographs.

Plaster casts are inexpensive, and not difficult to make. They form an excellent record of cases, and in particular should not be omitted in the earliest stage; a cast may always, unless the patient be acutely ill, be taken within forty-eight hours of his wound.

Wax models, taken from plaster casts, are also valuable as records, but their merit is artistic rather than scientific; for purely scientific purposes the simple plaster casts are as good. Wax models are more realistic, and admirably suitable for museum purposes.

When a missile has wounded the face and then traversed or lodged in some part of the head or neck, the importance of the deeper lesion of course momentarily outshadows that of the facial wound. The signs and symptoms of the deep injury are apt to be deceptively trivial.

As a generalization, it may be said that in any such case the facial lesion is less serious and the deeper lesion more serious than appears at first sight.

A few of the worst cases of facial injuries are fatal, either immediately from shock or within a few days from septic pneumonia. Many of these more ghastly injuries involve destruction of both eyes, so that mercifully the wounded man dies without ever knowing the extent to which he has been maimed.

Early Treatment.

The accidents and complications to which the patient is liable soon after admission have already been mentioned in earlier sections on hæmorrhage, laryngeal œdema, cellulitis, lung infections, and dysphagia. And in these sections the indications for treatment of such sequelæ, and the lines on which it should be carried out, have been described.

Apart from the treatment of such complications, the immediate necessities of the patient are rest, food, and cleanliness.

Rest must be local as well as general.

When there is a large gash, with or without extensive loss of tissue, in the face, and especially if there is also comminution of the mandible, the whole weight of the parts below the wound naturally tends to sag downwards or to one side. The resultant dragging pain interferes gravely with the patient's sleep.

This must be combated by supporting the drooping parts with a suitable arrangement of bandages and dressings.

Feeding.—In reference to injuries of the mandible (p. 255) I shall call attention to a striking feature in my experience of extensive wounds of this region—namely, that, contrary to all expectations, these patients can be fed, or even feed themselves, very easily.

It is not difficult to understand the popular idea which suggests a surgeon armed with an œsophageal tube, and in anxious consultation with his colleagues as to the probable necessity for a gastrostomy.

But this conception is wrong; the necessity for an œsophageal tube is rare. And as regards gastrostomy, I have only once seen a case (in which the pharynx was involved in the lesion) for whom this operation was seriously debated; I have never known it to be actually performed.

Cleanliness involves, first of all, the removal of all tissue that is dead beyond doubt, and leaving any that has a chance of living. After this, frequent lavage of the wound is instituted at once. The choice of medicament to be employed

is not a matter of great importance. The remarks made on the risks attending the use of hydrogen peroxide in the earliest days in wounds of the neck (p. 29) apply here also. Irritating or corrosive solutions are also to be avoided, as being prone to damage the oral mucosa. An alkaline solution (similar to an ordinary stock collunarium) has the merit of being a solvent of mucus, and in this way assisting in the separation of sloughs. Any of the various solutions containing free chlorine (liquor calcis or sodæ chlorinata, Dakin's or Carrel's solution, Chloramine-T) are excellent for cleaning up the foul surface. Pure water acts nearly as well as any chemical solution; but its efficacy depends largely on the use of a forcible stream, which mechanically separates sloughs and debris. Whatever fluid is used must be used often: two-hourly in the daytime is about the correct frequency. As regards lavage at night, this should be carried out at intervals, provided the patient is awake. Regular and frequent nightly washings involve disturbing the patient's rest, and it is, to say the least, doubtful whether the advantage reaped from the washings compensates for the fatigue consequent on this disturbance.

Among cleansing agents, sunshine must not go unmentioned, although its rôle is, of course, to heal as well as to cleanse. In warm weather these patients, even in the earliest days, may be placed in a sheltered spot in the open air; the eyes may, if necessary, be shielded from the sun, and its rays allowed to fall directly on the wound. The latter requires no covering at all unless to protect it from dust or insects, in which case two thicknesses of muslin gauze are sufficient.

Sunshine, when available, is, of course, beneficial not only to the local, but also to the general condition of the wounded man. It cheers him up, makes him more anxious to live, and is, in fact, invaluable for his morale.

At this stage nothing that can possibly contribute to encouraging the patient should be omitted or considered too trivial for serious effort. It must always be remembered that to the average lay mind of a self-respecting citizen facial

disfigurement is the most calamitous of disasters. Anything which can help him momentarily to forget his ugliness—still better, anything which can, without making him forget it, give him faith that he will recover and prosper—must be deemed an important factor in the mental therapy which should be an integral part of our practice. Flowers by the bedside, cheerful tunes on the gramophone, visits from friends—no such item is too small to merit attention.

In this connection the question arises whether or not the patient should be allowed to realize his deformity—whether he should be in possession of a looking-glass. The curious jumble of articles which make up the soldier's kit usually includes a shaving-mirror, and if permitted he will, unless grievously ill, use it as soon as the dressings are removed.

My own practice has been to have the looking-glass removed for a few days. When the patient is well enough to sit up and observe he is introduced to others in various stages of facial repair. His neighbour—whose gaping wound has been partly closed, or who has an amorphous flap (representing an embryo nose) hanging from his forehead—has, in his turn, been encouraged by seeing others in a more advanced stage, and is only too ready to hover round the newest arrival, dilating upon the wonderful improvement which the hospital promises.

After a few days the mirror may be handed to its owner—preferably soon after any operation which happens to diminish the *size* of his wound, for the size is to his lay mind the one and only criterion of progress.

Primary Suture.—Before the patient has been for long an inmate of the hospital the advisability of partially closing the wound by drawing together its edges will come under review.

During this war there is no surgical question that I have heard more keenly argued than the most desirable period at which to suture a facial wound.

In most surgical controversies the views of extremists become gradually toned down. The pendulum of argument swings through a steadily diminishing arc until either it comes to rest or its oscillations are small and slow. Diverse

opinions become approximately reconciled to a happy medium. The participators attain this satisfactory issue by finding a common ground on which to argue, and this common ground is simply an improved understanding of the factors contributory to the morbid condition under discussion.

It is, then, at last recognized that while the extremists were in any case wrong, their more moderate disciples are right (whether they have a mild leaning on one or the other extreme), according to which of the several contributory factors is most active in a given case.

Thus, in arguing as to primary suture of wounds of the trunk or limbs we consider the general and local condition, the size and depth of the wound, the infectivity as estimated by bacteriological counts.

But in facial wounds there are additional considerations which greatly confuse the issue. To quote a few of these: the wound communicates with the pharynx and air-passages; it is constantly reinfected by saliva; the wounded parts, owing to feeding requirements, cannot be kept at absolute rest; and the region wounded is apparent to every beholder, which may bias the surgeon and make him hurry unduly so as to minimize the scar.

For such reasons the argument at issue is complex; and the factors which influence our treatment of a facial wound are so manifold that there is no such thing as a typical case. Consequently, there can be no common ground on which to debate.

This may be the reason why two careful and experienced observers may persist in holding diametrically opposite views; each is making honest deductions from his own experience; but neither can base his deductions on any logical sequence of cause and effect; he can merely say that this case did well or that one badly, and that he accordingly intends to follow one course or the other.

Against primary suture of facial wounds it is argued that the wound unaided will heal to a great extent; that through the open wound it is easier to deal with the fracture of the

jaw which so often exists; and that free drainage of a cavity communicating with the septic mouth is in the earliest days highly desirable.

In favour of primary suture the chief arguments are that it minimizes loss of tissue from sloughing, and that certain parts of the face which are very difficult to imitate by plastic methods (lips, alæ, and columella nasi) may thereby be saved.

This question of the correct moment to suture facial wounds has interested men who have not specialized in plastic work, who see such cases only occasionally, and who, feeling nonplussed by the hot arguments which they hear or read, and being anxious to do the best for their patients, seek enlightenment from those who should know.

Personally, I have often been asked by others working at a field ambulance or casualty clearing station what is the best they can do or leave undone in such cases. Should they sew up, or not? In attempting to answer such questions unequivocally I have tried to arrive at a formula, and failed. But it is at least possible to define a reasoned compromise.

If no attempt be made to close the wound in the early days the tissues shrink; there is an actual avoidable loss of substance. The significance of this loss depends not only on the diminishing area of skin and subcutaneous tissue, but also on the vital importance of certain special parts; the loss is, in fact, not only quantitative, but qualitative. By this I mean to say that, for instance, the sacrifice of a piece of cheek occupying two square inches is a small matter, whereas the loss of an ala meaning half a square inch is nearly a tragedy. My own view is quite clear, that entirely to abstain from sewing up soon after the wound is wrong.

On the other hand, it is impossible within a few days of the injury to reproduce the deformed facial contour with any degree of faithfulness; the parts will shrink and become distorted with the subsequent gradual contraction of scar tissue. And in this respect a surgeon who attempts the impossible will be very crestfallen three months later if confronted with his handiwork. The correct course is to

bring the parts together without too great a regard to their shapeliness, but with a healthy respect for drainage; to make every effort to preserve as much tissue as possible by augmenting blood-supply, without endangering its vitality by shutting in septic areas; to regard as sufficient to the day the evil of pendulous flaps which threaten to become gangrenous, and leave the morrow of cosmetic effect to the near future.

The improvement in appearance and prospects of the wound which is attainable by merely approximating its



FIG. 71.—Private T. The left cheek and part of the nose hang down as a free flap. The wound is very dirty. But there is, as a fact, only a very small loss of tissue.

margins a few days after injury is often striking. Figs. 67-70 are two typical examples. In both these cases the change depicted was obtained by a single operation, which reduced a considerable wound to a small buccal fistula.

Figs. 71-73 lend force to the same argument. They show the first, second, and final condition of the patient, who underwent several operations. But the operations performed between Figs. 72 and 73 were of a minor character. They included the excision of scar tissue, but were chiefly

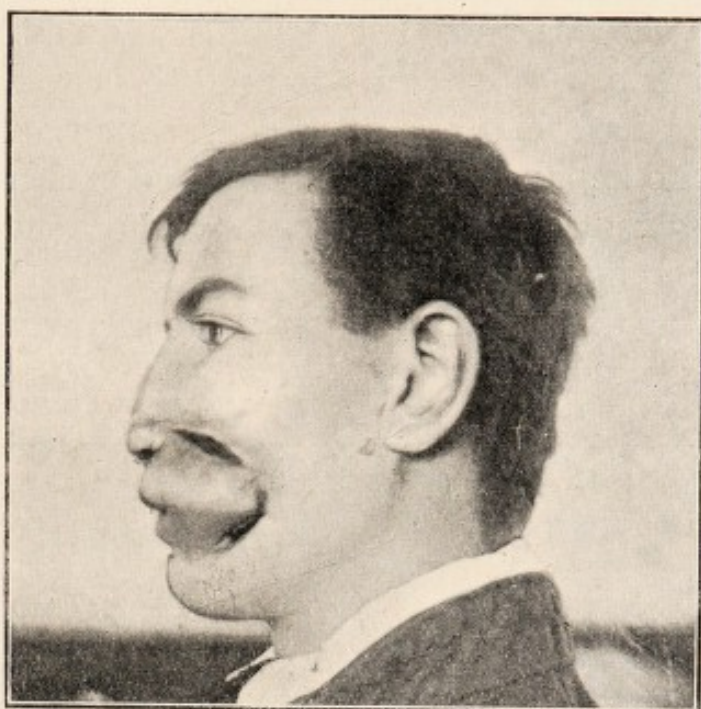


FIG. 72.—Private T. The parts have, after an interval of a few days, been replaced, and primary suture performed in two layers.

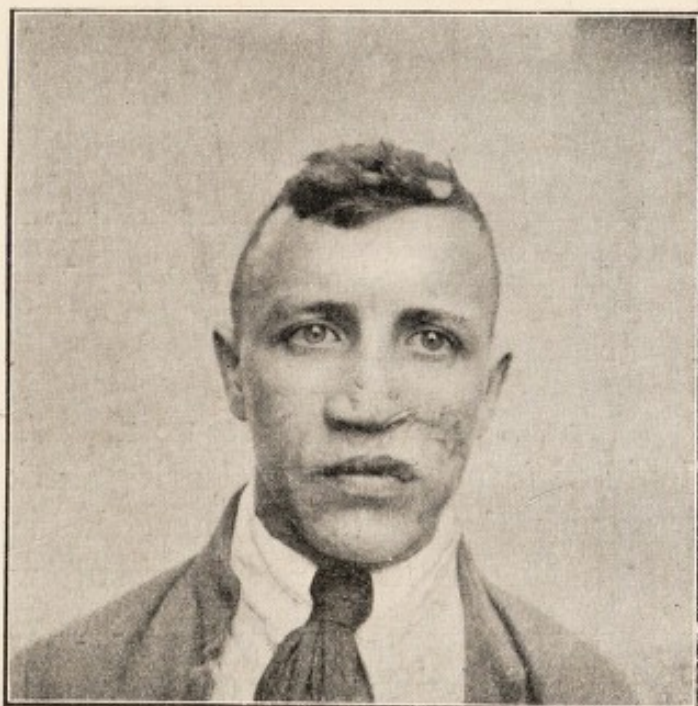


FIG. 73.—Private T. Minor operations, aided by prostheses, have been necessary to improve the nasal lobule and alæ.

directed to enlarging the nasal lobule and alæ by a combination of surgery and prosthesis. The chief importance attaches to the difference between Fig. 71 on admission and Fig. 72, after one operation. By merely sewing the parts together the face was to a great degree restored, and from first to last no flaps were slid or transposed in this case. The effect was produced very simply by the replacement of parts before they had time to shrink; but to the lay mind of the patient this transformation would seem extraordinary and most encouraging.

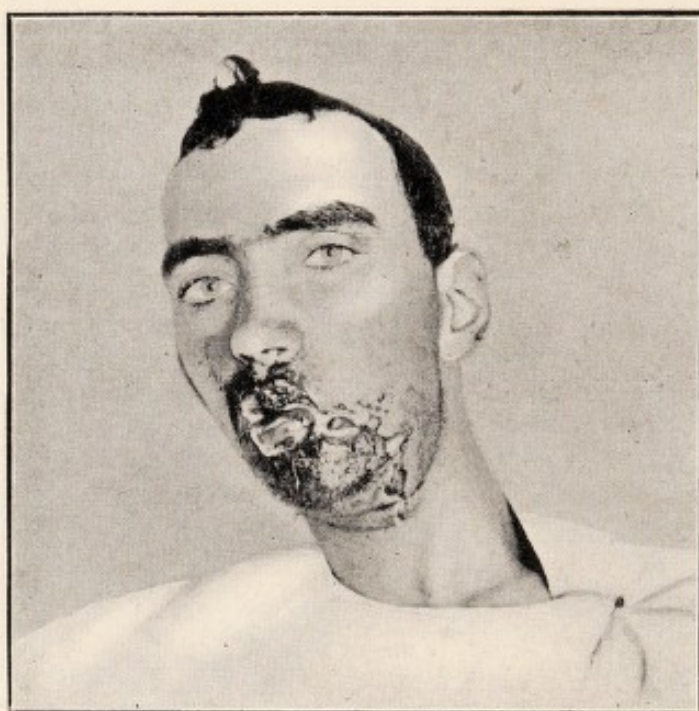


FIG. 74.—Private D. as he arrived at a Base hospital overseas from a casualty clearing station. Too much has been attempted, resulting in an obvious condition of microstoma. (See text.)

Fig. 74 illustrates the converse point. The patient arrived as depicted from a casualty clearing station. Instead of merely drawing the parts together, the surgeon had attempted to reform the mouth. The result was an early stage of microstoma, which became more obvious after a few days as the parts healed.

Owing to a rush of cases in France I was unable to keep this patient for long. I do not know who treated him on his arrival, but it is reasonably certain that the operator was

compelled to reopen the angles of his mouth and evert mucosal flaps to enlarge it. This patient would have been better if the soft parts of cheek and chin had only been sewn together without attempting to make a shapely mouth.

Technique.—The technique of the early closure of facial wounds is not complicated. Naturally it is useless to be satisfied with drawing the skin edges together; to do this burdens poorly nourished tissues with the added evil of putting them under tension, and the upshot will be that, instead of minimizing sloughing, this is aggravated.

Tension must be excluded by first approximating the deeper fascial structures so as to take the pull off the skin. The deep sutures may be of heavy catgut, its knots preferably tied within the mouth. The superficial sutures are of salmon-gut. The latter give way, and the cutaneous suture-line breaks down to a greater or less extent; but, beneath, transverse bands of rich granulation tissue will have formed. The skin margins are drawn together a second, and maybe a third time; and eventually, the deep tissues having mostly granulated across the gap, this is reduced to a small sinus.

After a massive face wound even the method of sewing up in two layers may not succeed in keeping the raw edges together, either because the margins could only be co-apted under tension, or else because, although there was no tension, the mere weight of the chin and jowl (with, perhaps, the added weight of a fractured mandible) drag on the stitches. There are various simple expedients to diminish this dragging.

A "butterfly" dressing, originally used by American surgeons for relieving stitch tension after harelip operations, is one. Two pieces of adhesive strapping are taken; each is 7 to 8 inches long. The width of each is 2 inches at one end, and tapers down to 1 inch at the other end. On the non-adhesive side of each piece, 3 inches from the wide end, a row of three ordinary sempstress's hooks is sewn in a transverse line across the strapping; the open ends of the hooks point towards its wide end.

The narrow end is now rolled on itself, adhesive side outwards, as far as the bases of the hooks.

These strips are applied to the skin on each side of the wound, in the line along which it is wished to relieve tension. For example, after a harelip operation the wide ends lie horizontally on the cheeks, level with the lobule of the pinna, and about 2 inches from it. The narrow rolled ends pass along the outer parts of the two upper lips, and the rolls and rows of hooks are situated in a vertical line drawn from the point where ala joins cheek. This leaves the operation area uncovered and flanked on either side by the rolls of strapping. The dressing is placed over the wound, and then the suture-line is relieved of all tension by twisting thick floss silk in figure-of-eight fashion backwards and forwards between the hooks of either side.

The silk may be cut, the wound dressed, and silk retwined between the hooks as often as desired. The strapping is changed daily or less often. This "butterfly" dressing may be used with success on any suture-line about the face.

Another means of relieving tension is to pass a few additional sutures widely from side to side of the wound. These cannot be left in for long, as they become very septic. But after five or six days the incision line is more resistant, and the tension stitches, having fulfilled their function, may be removed.

To make these long tension stitches less liable to cut through the tissues, each end of the gut or silk may be attached to a perforated vulcanite button instead of tying the two ends together. Or, with the same object of preventing cutting through, the stitches may be tied in the ordinary way, but first threaded through a piece of rubber tubing which has a length slightly greater than the distance between the stitch-holes. The tubing (diameter about $\frac{1}{8}$ inch) bends slightly, but if it buckles up entirely it fails to keep the stitch away from the skin surface. Too much buckling occurs either because the piece of tubing is too long or because it is too flexible. The latter fault is easily corrected by threading a finer piece of tubing through it, and so using a tube of double thickness.

Tension stitches may be required not only to prevent two

surfaces dragging apart; they are also sometimes invaluable in preventing the edge of a flap from sliding laterally on the edge of the skin to which it is sewn. Figs. 94-96, pp. 241-243, exemplify my meaning.

In performing primary suture of facial wounds there are a few other points to be attended to besides the minimizing of stitch tension.

Inasmuch as the wound is expected after primary suture to break down in part, it should be encouraged to heal where healing is most essential, and to break down where this can do the least harm. And since drainage of the sutured wound is usually necessary, this should be provided at the point where it is preferred that the wound should break down.

As an example, consider a linear gash which extends from the parotid nearly as far as the angle of the mouth, and which for its whole length opens the oral cavity. It is highly improbable that primary suture by two layers of stitches will close this wound entirely. And the whole thickness of the cheek is more likely to close through the greater part of its extent if drainage is provided somewhere. A failure to close at the posterior end might eventuate in a fistula of the parotid gland, and be much more obstinate to close than a buccal fistula at the anterior end. Consequently, it is best to drain at this anterior end—by a fine tube or narrow strip of thin rubber sheeting, or a plait of three or four strands of silkworm-gut, which passes into the midst of the tissues to be between superficial and deep layers of stitches—and encourage this end of the wound to break down. In many wounds which open into the mouth counter-drainage is advisable; this is easily obtained by a short median piercing incision from beneath the symphysis, between the geniohyoid muscles, to a point in front of or to either side of the *frænum linguæ*—just as would be made for an ordinary case of median symmetrical Ludwig's Angina.

After primary suture the mouth requires frequent washing by some alkaline solution which can loosen mucus. The external wound should be treated with wet dressings from the outset until healing is complete.

The Intermediate Period.—After primary suture has been completed (whether this is attained by one, two, or more operations) a long period must elapse before any further surgical interference is advisable or, indeed, justifiable. This interim should be profitably utilized by taking all possible steps to promote the resolution of scar tissue.

By scar tissue is meant deep as well as superficial. It is inviting disappointment to move flaps of skin as soon as this has softened if the immediately underlying cellular tissue is still as hard as cartilage, for the thin dermis is unlikely to take well to its poorly nourished bed, and, in consequence, the distal parts of such flaps often necrose.

Massage should be instituted as soon as the scar has ceased to be tender—usually in from two to three weeks. Simple manual massage is good; some experts in this art hold that vibro-massage is better. In any case, if the apparatus is available, vibro-massage may be combined with the ordinary manual sort.

In France, if the massage department was over-busy, or if for any other reason there was difficulty in obtaining the services of a skilled masseur, I always instructed the patients to massage their own faces. The directions given were of the simplest: I told them to pinch, pummel, and rub the parts until they were red, warm, and slightly uncomfortable. This auto-massage was carried out for five minutes two or three times daily.

Active movements, or, if these are impossible, passive movements, constitute another item in the treatment of the intermediate stage. Thus, if the primary suture of a wound in a man's cheek renders his jaw movements cramped and limited, he should practise opening his mouth widely. If the wound included his sterno-mastoid region, the result is naturally a unilateral stiffness of the neck, and he should accordingly practice the movements necessary to overcome this.

Radiotherapy should, where possible, be instituted. The beneficial action of the sun's rays on the original wound has already been referred to; and when a plastic closure has been

made, light is an agent of great value in softening scar tissue. In order to be independent of weather, the ideal arrangement is to possess an electric plant to give radiant heat. Whether or not such an apparatus be available, no opportunity should be lost of utilizing sunlight.

Before leaving the subject of the intermediate period it is well to observe that the remarks made apply not only to the time elapsing after primary suture, but that massage, movements, and radiotherapy are highly desirable between any two stages in the remodelling of a face. Limited massage and radiotherapy are also useful in rhinoplasty.

CHAPTER XI

THE FACE : LATE TREATMENT

THE extent of the facial deformity which calls for correction varies, in the first place, with the amount of tissue lost. If primary suture has been carried out it is possible, or even probable, that the area of skin and mucous membrane requiring replacement will have been reduced thereby. The converse is hardly true; it is difficult to imagine a case (unless afflicted with grave septic complications) in which the net result of primary suture is to give the plastic surgeon a greater area to fill in than if such suture had been omitted.

On this controversial point, however, enough has been said above, and I refer to it again only to introduce the point that plastic facial surgery by no means necessarily involves the shifting of extensive flaps. In an extremely favourable case there is practically no loss of tissue—the tissue is simply badly distributed. The most obvious instances of this are some of the faces in which the angle of the mouth is raised or depressed. Fig. 83, p. 229, is an example of such a position of affairs, in which there is plenty of tissue, but it requires rearrangement.

General Principles.

To such as practise plastic facial surgery the only points which are not controversial may seem too obvious to deserve mention; but for others there are certain general principles which may be briefly outlined.

When to Operate.—As a broad but important generality, the best advice on this matter is to wait. Enough has been said as to the softening of scar tissue in what I have called the “intermediate period” to make it clear what there is to

wait for. The nutrition of the parts must be beyond all criticism, their suppleness beyond reproach. If the tissues are not sufficiently supple, wait again. Different patients vary greatly, not only in the extent to which flaps soften in a given space of time, but also in their softness when they have ultimately reached their best. So that, if any area is after many weeks not as supple as it should be, it is impossible to predict whether the condition will improve or not. Still, there is no harm in waiting a little longer. I have several times regretted operating too early, but never thought that I have delayed too long.

When to cease Operating.—The question as to when a man's face is passable-looking is, after all, purely relative. A patient who has had half his face shot away and restored by a series of painstaking operations would doubtless prefer to be as he is depicted in a photograph taken before his injury.

And we see in this branch of work some results which scientific critics regard as brilliant, but which would horrify a woman who was debating whether she should entrust to whatever surgeon is responsible the correction of a too Grecian nose or the removal of a large mole.

On seeing the photographs of some of the facial wounds in this war the first impression is that the patient was unlucky in remaining alive; the second thought is that, since he did live, he is lucky to come through with a face which is not actually revolting.

The correction of these deformities invariably involves several operations; and if the operator sets out to make the patient's face absolutely normal he may haply continue for ever.

The social position, future occupation, and environment of the patient are, of course, factors in deciding when to leave well alone. But as long as the war continued, the possibility of skrimshanking had also to be reckoned with. The necessity for another operation meant delay in returning to the army. It has several times occurred that a soldier has solemnly declared that he would like another operation,

because he is dissatisfied that a small scar should remain; while, as a fact, a scar twice as large, if resulting from the removal of breaking-down tuberculous glands from his neck, in peace time would not have interested him at all.

Undoubtedly judgment is necessary as to when to cease operating.

The Blood-Supply of Flaps.

In planning a pedicled skin-flap, the arterial supply will be the first consideration. The pedicle should, if possible, include a greater part of the distribution of some vessel of considerable size. The arteries of which the surgeon most often avails himself will be:—

From the external carotid : The facial; its termination, the angular artery; and its labial and coronary branches; also the superficial temporal.

The infra-orbital branches of the internal maxillary are usually sacrificed, because it is hardly possible to make a flap parallel to their length without cutting off the supply of the facial, which is more important.

From the internal carotid by the ophthalmic : The supra-orbital and frontal branches.

It is often advantageous to outline and raise a flap from ten to twenty days before it is moved to its new position. By this procedure the whole of the blood-supply in the pedicle is diverted to the flap, which becomes gradually independent of vascular supply from surrounding anastomoses.

Exaggerating the Size of Flaps.

The importance of allowing for subsequent shrinkage of a flap when outlining its form has already been mentioned under Rhinoplasty. The amount of necessary excess in the superficial area of the flap is, however, not so great in the case of the face as it is for the nose.

And this for several reasons. Firstly, if a slight miscalculation occurs, resulting in too small a flap, this error is more detrimental to the ultimate appearance of a nose

than of the cheeks, chin, neck, or cutaneous part of upper or lower lip. It is much more important that the nose should have a smooth homogeneous surface. Unnatural rugæ and faint suture lines testify to the error when an extra piece has afterwards to be added because the original flap was scant. And these rugæ and scars map out a sort of mosaic which is much more noticeable on the nose than on the soft parts of the face.

Secondly, the skin of the face is freely movable over subcutaneous tissue, and therefore any deficiencies can often be made good in the final plastic operations by undercutting and sliding. By this means quite large areas may be filled in and earlier mistakes corrected. But the nose, once its pedicle has been divided, does not permit of this. It is a relatively rigid structure, and its covering allows no licence for liberties to be taken with impunity. The famous man with the elastic skin at Barnum's Show could do many things with his neck and cheeks, but performed no tricks with his nose.

Thirdly, partial sloughing, in the case of the nose, is more serious when it occurs, and rather more likely to occur. The greater seriousness of sloughing, when it happens, depends on the two other factors just mentioned—namely, that scars of added flaps are more unsightly, and that the nasal covering itself permits of no sliding flaps being taken. The greater liability (in my experience) to slough probably depends on the difficulty of avoiding contamination from tears and nasal secretions.

If it be granted, then, that facial surgery demands less excessive care than rhinoplasty in overdoing the size of flaps, nevertheless a certain exaggeration of their size is necessary.

In reference to this question for the nose, I quoted for the size of a flap one-third larger than it is eventually required to be. For the face it may be a little less—about one-fourth.

Flaps taken from the neck suffer not only the ordinary shrinkage by subsequent contraction of scar tissue, but it must also be remembered that if the platysma be included they shrink instantly when they are raised. If the flap is

simply swung round to another spot where its margins will abut on areas which also contain platysma, this momentary shrinkage is corrected by a counter-pull. But if a platysma-containing flap is translated to the skin of the cheek, the edges of the platysma have nothing to pull against except subcutaneous tissue and fat, and within a day or two the flap may shrink and tear away from its stitches. It might be argued that it were better to take a flap of skin only, not including platysma. This is done in pedicled bone-grafts of the mandible (see p. 298), but then the flap is merely raised and replaced. When it has to be rotated or twisted to move it to another place the blood-supply is handicapped, and its nutrition will suffer if the flap consist of skin only; it is safer for neck flaps of any size to dissect down to the deep fascia. It was remarked above (p. 216) that in an extremely favourable case a candidate for plastic facial repair has suffered no loss of tissue; there is merely a redundancy at one place and a scarcity at another, and a redistribution meets the occasion. And this condition of things should always be aimed at when mapping out the flap for an operation; so that in subsequent manœuvres nothing beyond a redistribution can possibly be required. In fact, there should be, after the principal flap operation, rather more than a normal amount of tissue in the face. For, despite massage and radiotherapy, all later minor operations and finishing touches are to be carried out, not on a perfectly normal substance, but on parts permeated with scar tissue (howbeit little), which may slough here and there; and it is best to be on the safe side.

The Importance of Mucous Membrane.

The farther a case has progressed towards restoration, the less accessible is the mucous membrane of the oral lining. In a normal subject, operations on the buccal mucosa are sufficiently difficult of execution through the mouth. And any of the common results of gross injury—such as partial false trismus, thickening of the cheek, adhesion or narrowing

of the gingivo-labial sulcus—increase the difficulty enormously. It therefore behoves the surgeon to attend to any defects of the mucous lining before he completes the æsthetic work on the covering. Epithelial inlays to deepen the gingivo-labial sulcus, flaps of mucosa to take the place of tight fibrous bands on the inside of the mouth which limit jaw movement—all such corrections should occupy an early place in the calendar of plastic manœuvres. In particular,



FIG. 75.—Lance-Corporal L. The injury involves destruction of nearly one-half of the "red line"—*i.e.*, the mucosa of the upper and lower lips on the left side; the skin below the mouth is also damaged.

great attention must be paid to making a full red line to the lips, because this will during the patient's life be a noticeable feature.

This restoration of a red margin to the lips involves repeated and patient minor operations—eversion of mucosal flaps from within the mouth, operations of the harelip type, and rectification of the muco-cutaneous line of the lip. Figs. 75-80 are taken from a case of this type; and Figs. 92-98 (pp. 240-244) exemplify strongly the necessity for

restoring a red line before the shape of the mouth is corrected. In this patient the repair of the left cheek involved a big dissection laying open the mouth from ala nasi to angle of jaw. The resulting fibrosis was extensive; and although this softened to a gratifying extent it remained intractable, at any rate, to such an extent that eversion of flaps of mucosa to form the red line would have been impossible afterwards. Fortunately, this was done at an early stage; and a



FIG. 76.—Lance-Corporal L. Ten days later, after partial healing.

margin of mucous membrane had been given to the mouth before any attempt was made to give it a normal shape and size.

Certain Tissues are Irreplaceable.

The fact that many histological types of tissue, when once lost, cannot be replaced, unfortunately imposes limitations on the extent of cosmetic and functional repair achievable by plastic facial surgery. We can graft pieces of skin,

mucous membrane, and bone, and to a certain extent cartilage ; but bloodvessels, muscle, and nerve, are beyond our control.

Cartilage is, of course, daily grafted in rhinoplastic work ; but when we come to the cartilages of the alæ or of the columella we are, as yet, in the infancy of this science (see p. 173). As regards bloodvessels, arteriorrhaphy of



FIG. 77.—Lance-Corporal L. The red line has been restored by eversion of flaps of mucosa from within the mouth. The notches on left side of both upper and lower lips, but especially the lower, call for minor operations of the harelip type.

medium-sized and small trunks is, of course, impossible ; but nature supplies the deficiency by the formation of new vessels, usually in time to avert death of a flap.

Muscle can be, and often is, transplanted as part of the thickness of a pedicled graft for the face ; but it is not feasible to give it the same origin and insertion as the original muscle for which it is the substitute. From this disability certain functional and cosmetic disadvantages inevitably result.

As an example, a gap in the cheek may be filled by a flap

from the soft tissues overlying the sterno-mastoid muscle; the flap may be cut parallel to the muscle-belly and include a certain thickness of its substance. If the innervation of this transplanted muscular slip has been partly preserved, it is reasonable to suppose that after healing in its new position it will retain some contractile power. But its action cannot, either in force or direction, compensate for that of the destroyed buccinator. The result is that a mouthful of food is on that side insufficiently churned up in



FIG. 78.—Lance-Corporal L. After minor operations under novocain.

mastication, and after any meal a lot of debris collects under the cheek. In such cases there is usually a fracture of upper or lower jaw, or both. And I have seen a case in which, for various good reasons, the ultimate functional restoration of the broken mandible was better on the side of the wounded cheek; on the opposite side mastication was very laborious. So that this patient was permanently faced with a choice of evils. On one side his jaw, and on the other side his cheek muscles were unable to carry out their function in preparing a bolus of food for swallowing.



FIG. 79.—Lance-Corporal L. After final minor corrections.



FIG. 80.—Lance-Corporal L. Photograph sent by patient six months after his last operation.

Another example of the manner in which a patient is handicapped by the impossibility of replacing the origin, insertion, and action of muscle occurs in the upper and lower lips.

Owing to the absence of an orbicularis oris, a man whose mouth has been well restored as regards appearance sometimes suffers from the drooling of saliva. It is characteristic of such a patient that as he talks to you he occasionally checks the flow with a handkerchief, or by drawing in his saliva with a sucking inspiration.

The destruction of the orbicularis oris has also a cosmetic result, which, however, is fortunately not at all obvious to the passer-by. When, to complete the red line, a flap of mucosa has been swung out from any part of the lining of the mouth, the lip so formed lacks its normal rugæ; this is easily seen on close examination.

Fig. 83, p. 229, shows this.

This latter patient I saw a few days ago. And at the time of writing, fourteen months after the last operation on his lip, the distinction between the smooth piece, devoid of rugæ, and normal lip is visible on everting his lower lip. In addition to the absence of normal creases, the new part of such a lip is slightly paler in colour—corresponding to the lighter salmon-tint of the oral mucosa from which the flap was taken. This point is admirably brought out by colour-photography.

Nerves are also quite irreplaceable. The only important trunk with which we are concerned is the facial. For a nerve of this size grafting is, of course, not under consideration. The question is whether anastomosis with the spinal accessory or hypoglossal is practicable.

The cases of gunshot facial injury in which a nerve anastomosis is feasible must be very rare. I have only seen one in which it was proposed, and have never had a suitable case under my care. A case which held out any reasonable hope of success would have to be of an uncommon type. It would have to be a clean punctured wound which had cut the nerve before its primary division into main branches,

and a wound which had involved other surrounding tissues hardly at all, so that there was practically no scar tissue in the neighbourhood.

The extracranial course of the facial nerve before it branches is so short that, as a rule, a wound which severs it leaves no remaining distal end for anastomosis. Moreover, there is, as a rule, a mass of scar tissue extending from the skin through the parotid gland almost into the digastric



FIG. 81.—Private K. This photograph of the patient's condition on admission is reproduced to illustrate the impossibility of nerve anastomosis of the facial nerve for most cases of gunshot injury of the face. The wound is not very large, and (as may be imagined by comparison with Figs. 67-70, pp. 200, 201) may be closed by undercutting and sliding. But in such cases obviously a subsequent nerve anastomosis will not be feasible.

fossa. Anastomosis of the facial nerve to one of its neighbours under such circumstances is not a practical suggestion. (see Fig. 81).

It remains to do what we can to conceal or minimize the facial deformity consequent on the paralysis. As a minor point it should be noticed that occasionally the same injury which destroys the facial nerve on one side also carries away

a large part of the nose, rendering a forehead flap rhinoplasty necessary later. In such a case, if there is no other cogent reason for taking the forehead flap from one side rather than from the other, it is better to select that side on which the facial nerve has not been injured.

For, owing to the paralysis of the occipito-frontalis and corrugator supercilii, the forehead on the side of the injured nerve is destitute of deep creases, and expressionless. Since



FIG. 82.—Private H. Destruction of soft parts around the angle of the mouth. The greater part of the damaged area lies at a higher level than the angle of the mouth; consequently, the contraction of scar tissue will later tend to draw the angle upwards. The considerable oedema of the lower lip masks the fact that the mucosa of its outer third has been destroyed.

we cannot replace these creases, it is best to obliterate them on the other side by taking the graft from the latter side. Later, when the raw forehead area is closed, either by free grafts or sliding scalp flaps, the whole forehead will be more or less uniformly smooth.

The most noticeable blemish following facial paralysis is a drooping of the angle of the mouth. There is a simple and extremely efficacious plan for plastic correc-

tion of this asymmetry, first shown to me by Major Valadier, C.M.G.

This plan can be adopted not only when facial paralysis is the underlying lesion, but also when for any other cause whatever—for instance, the contraction of scar tissue—one angle of the mouth is depressed. Moreover, by simply reversing the incisions above and below the angle, and taking

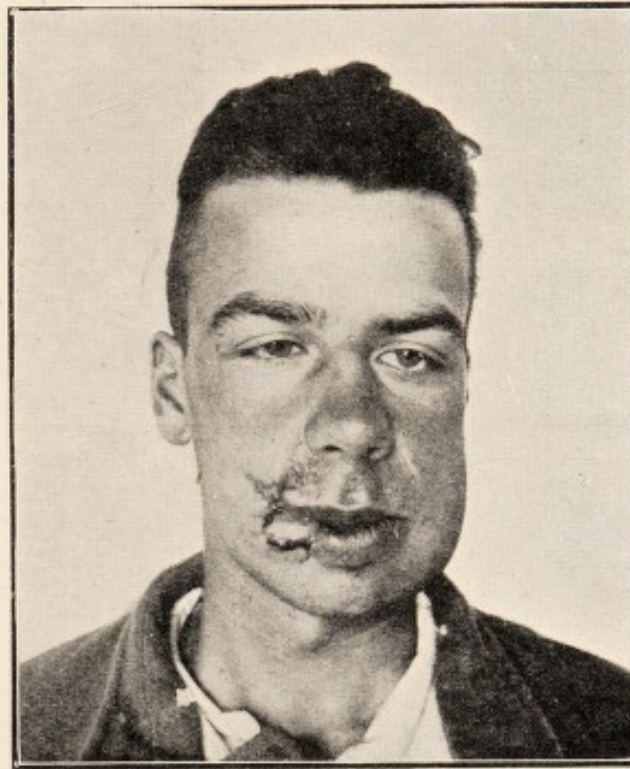


FIG. 83.—Private H. A flap of mucous membrane has been rotated from the lining of the cheek, and swung out to complete the "red line" in the lateral third of the lower lip on the right side. The extent of injury was greater above the angle than below. And, accordingly, the maximum cicatricial pull, being above the angle, is already tilting the latter slightly upwards.

the flap from below instead of above (and then implanting it above instead of below), this operation may be used to lower just as easily as to raise the angle.

Figs. 82-85, pp. 228-231, illustrate this method very well. On admission (Fig. 82, p. 228) there was destruction of the tissues around the angle of the mouth on the right side. But when the wound was primarily sutured it became evident that, as far as the red line was concerned, the upper lip was

complete and the outer third of the lower lip destroyed. A flap from inside the mouth was therefore taken, and swung out to fill in the gap in the lip. This flap is seen in Fig. 83, p. 229, which shows the surrounding tissues still in the stage of cicatrization. In this figure it is clear that, as regards the cheek, the bulk of the damage has occurred above rather than below the angle of the mouth. And the cicatrization is already drawing the mouth angle slightly upwards.

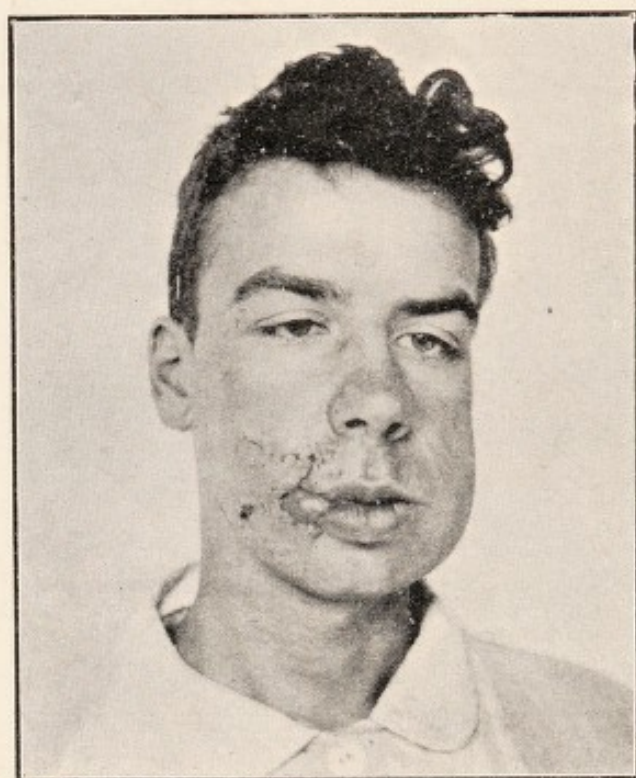


FIG. 84.—Private H. A translated flap from below the angle of the mouth has been placed above the angle, thus correcting its level. For technique see p. 231.

When cicatrization was complete this elevation of the angle tended, of course, to become greater.

The operation was performed thus:

An angular incision was made to enclose the outer third of upper and lower lips as follows: One incision was made from just beyond the mouth angle towards the right ala nasi, but stopped short of the latter by $\frac{1}{2}$ inch. A second incision passed from the starting-point of the first along the lower lip for its outer third and at a distance of $\frac{1}{4}$ inch from the

muco-cutaneous junction. From the median extremity of the second incision a third was made downwards and to the right, ending at a point just about overlying the mental foramen.

These three cuts formed a Σ . The upper and middle limbs of the Σ enclosed the elevated mouth angle, and the middle and lower limbs bounded a flap of skin below the mouth.

All three incisions were now deepened into the mouth cavity. Thus the mouth angle was left intact, but freely



FIG. 85.—Private H. Final condition.

mobilized, while the lower flap, covered on its two surfaces by skin and mucous membrane respectively, was free to be moved where required. This lower flap was now simply transferred from its position below the right side of the mouth to lie above the mouth on the same side. In doing this the lowest incision was made to gape widely, and the gap was closed by resuturing the mouth angle therein. Similarly, in depressing the angle of the mouth the uppermost of the three incisions was made to gape widely, and this gap was

filled by the flap translated from below. Sutures of catgut, tied in the mouth, are used for the mucosa, and fine salmon-gut or horsehair for the skin. Fig. 84 shows the straight mouth and the outline of the three-cornered flap after it has been moved; the stitches have been taken out, but the suture-line is visible.

This method may be used with great success for elevating or depressing an asymmetrical mouth angle.

A word of caution as to technique is advisable. It is important to carry the incisions freely into the mouth cavity. If they fall short of this depth, the upshot will be a redundancy of mucosa under the original site of the flap, and a paucity of mucosa under the site to which the flap is transferred. The former results in a clumsy eversion of the lip, and the latter in a troublesome deep band of scar tissue.

In choosing a site from which to elevate flaps, allow for possible failure. There is always a possibility that a flap may not "take," in which case a second flap will have to be made from another region. And when a great part of a face and nose requires reconstruction, this possibility greatly increases the surgeon's responsibility. For clearly he may at any moment find that there is no supple tissue not heretofore used as a flap of which he can avail himself.

The following supposititious examples will illustrate my meaning:

In rhinoplasty from the forehead there are various reasons why the flap is practically never taken from the vertical median line, such as encroachment of the hair line and excessive torsion of the pedicle in lowering the flap. But, apart from such reasons, suppose a median flap has been used, and that later it sloughs and another flap is required. The operator will find it difficult to obtain sufficient skin on one or other side of the original median flap. If he had originally raised a flap from above one eyebrow, he would be left with a large area of supple, unused tissue on the opposite side for his second attempt.

Or let us suppose that a patient has a chasm in his face

3 inches wide, extending from below the nasal bones into the mouth. For his nose a forehead flap will be wanted. And he also requires an upper lip.

If the rhinoplasty is undertaken before the cheiloplasty it is quite likely that the surgeon may cover in the raw forehead area by sliding flaps from the scalp.

Later, he finds that for the upper lip he cannot obtain sufficient tissue from the cheeks. Accordingly he raises one or more flaps from the neck and upper pectoral region for this purpose. But these slough to a greater or less extent, and the patient still lacks an upper lip.

There is now only one situation about the head and neck from which he can obtain a flap—that is, the scalp. He will wish to swing down a transverse flap of scalp, having a double pedicle in the temporal regions—an operation such as has been performed by Major Gillies, and by Professor Sebileau of Paris. But he is handicapped, if not prevented, by scar tissue in this region, created by his previous manœuvres in closing the forehead area.

The wiser course would have been to skin-graft the forehead, leaving the remainder of the scalp undisturbed in case it should be required.

In planning the reconstruction of large facial deficiencies the scheme should be such as to use up available skin areas as sparingly as possible in case of the necessity for repeated operation.

Types of Grafts.

A classification that at once suggests itself is that of free flaps and pedicled flaps.

Free Grafts.—These belong to either the Thiersch or the Krause type of the textbooks. Formerly it was usual to place such grafts gingerly on the raw surface, avoiding any pressure on the new skin; and to stretch the graft was regarded as detrimental to its vitality. As often as not the grafts sloughed or were partly digested by the tryptic action of pus from the underlying granulating surface.

There is, however, good reason to believe that a free skin graft, whether of epidermis (Thiersch) or whole dermis (Krause), thrives under moderate pressure and tension. A graft, on the whole, prospers more with its edges drawn fairly tightly to the surrounding skin by horsehair sutures and with moderate pressure over it, than if it is simply spread on the raw surface and protected from the slightest

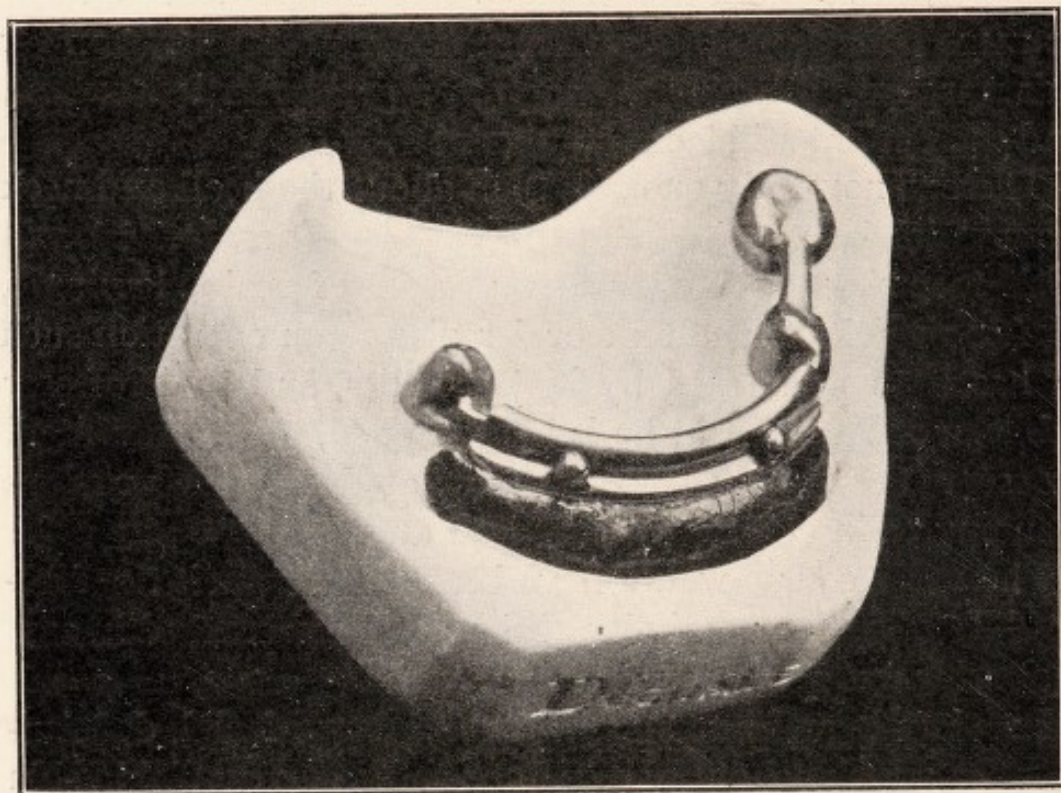


FIG. 86.—Appliance for holding in position an "onlay" Thiersch graft, inserted to deepen a shallow gingivo-labial sulcus. The caps are cemented on to remaining teeth. Below the metal arch is attached a bar of vulcanite, of which the corners and angles have been rounded off. The graft is kept pressed in its place by this bar. (As used at the Queen's Hospital, Sidcup.)

pressure by a metal cage. And in the modern technique of "inlay" grafts (see p. 46) pressure and tension are an important factor. For the epithelial strip in these grafts is stretched fairly taut around a supporting core of composition, and the tension maintained by suturing its edges together with horsehair; so it is certainly under tension. And as regards pressure, this is considerable; for when the inlay on its core has been buried in the depths of an incision, the

edges of the latter are drawn closely together over the buried graft.

Moreover, if the graft be an "onlay" as distinguished from an "inlay"—that is to say, if, instead of being buried in the tissues, it is merely maintained in close contact with the raw surface by a plaque of composition—the probability of



FIG. 87.—Private T. To improve the nutrition of the flap by diverting to it as much blood as possible, the flap was raised twelve days before it was transferred to the face. With the same object, the distal end was folded on itself. The flap is seen held up in dissecting forceps to show the skin on its deep surface. The marks near each margin of the triangular raw surface show where, until recently, tension buttons threaded on silk have been used to prevent too great gaping of the wound. A prosthesis in the premaxillary chasm is ready to receive the flap.

the graft "taking" seems to vary largely with the firmness with which pressure is maintained. Fig. 86 shows an appliance for ensuring firm pressure on an "onlay" graft.

Pedicled Grafts.—As usually made, this sort of flap has a pedicle at one end only; the other end forms the graft, and is attached in the desired position. But in very large flaps the nutrition of the blood-supply of the distal end may be

endangered; to avoid this risk, the flap may be dissected up in the centre of its extent, leaving a pedicle at either end.

The centre part is then swung into its position over the space of raw surface to be covered. Whether a single or double pedicle is used, the pedicle is divided and replaced from ten to thirty days after the fixing of the graft.

Besides the method of using double pedicles, there are other schemes for ensuring a good blood-supply. One such



FIG. 88.—Private T. The flap has been translated to its new position. The doubled part covers the premaxillary gap. If this flap had lived right up to its distal extremity, the new upper lip would have been covered on superficial and deep surfaces by skin. (See text.)

consists in raising the flap some time before it is moved into place (see pp. 159, 179). Another plan is to raise the skin flap and fold it on itself, raw surfaces in contact, and leave it thus for one or two weeks; this improves the blood-supply, and minimizes the likelihood of shrinkage by sloughing.

If a double-pedicked flap is used it can only be folded on itself longitudinally; it is known as a "rolled" or "tubed" flap. But with a single pedicle a flap may be either thus rolled on its long axis or folded on a transverse axis.

Figs. 87, 88, pp. 235, 236, illustrate a case in which I folded a flap transversely.

The flap was raised from the pectoral region, and its pedicle sprang from the side of the neck. In Fig. 87 the flap is being held up in a pair of dissecting forceps to show the manner in which it has been folded on itself. After twelve days the folded distal end was attached to the raw cheek margins on either side of the premaxillary gap; the photograph shows a premaxillary prosthesis destined to prevent the flap from falling backwards into the mouth. Fig. 88 shows the flap in place.

Unfortunately, the most distal doubled part of the flap sloughed to a great extent. And at the moment of writing this case is far from completion.

The three methods of establishing a good blood-supply to a pedicled flap already mentioned—raising the flap some days in advance, giving it a double pedicle, and folding it on itself—may be combined in any way that seems desirable.

Types of Pedicled Flaps.

A flap may be reversed, raw surface outwards, as is done in lining a nose with the inverted skin of the cheeks or of the nasal bridge. But as regards flaps which are used skin outwards (whether their raw surface is lined with a free skin graft or by folding the flap on itself, or not lined at all), they conform broadly to one of the following types:

1. Sliding Flaps.—This is the simplest type. It entails mobilizing the piece of tissue which is required to cover in a gap. The tissue may consist of skin, fat, and cellular tissue, muscle, or mucous membrane—or a combination of any or all of these. The mobilization is effected by first making a lateral incision on each side of the flap and then undercutting.

The lateral incisions allow the flap to slide; the undercutting permits it also to stretch.

It should be remembered that if a thin flap (skin and subcutaneous tissue only) be extensively undercut its nutrition is endangered. To minimize this risk it is advisable, as the



FIG. 89.—Private W. A piece of rubber tubing has been inserted into each nostril. The remaining mucosa of the upper lip was mobilized and everted on itself to re-form a "red line." The new "red line" so formed was supported by a vulcanite trough, as seen in the next figure.



FIG. 90.—Private W. The patient still wears the trough which supports the mucosal edge of lip. But a further stage of restoration has been effected also. The skin of the lip has been restored by (1) a sliding flap from the right, and (2) a translated flap from the left. On the left, the site from which the flap was translated has been closed by sutures.

knife proceeds towards the base of the flap, to undercut at a progressively deeper level; so that the attached pedicled end of the flap is much thicker than the free end, and includes, for instance, a stratum of muscle fibres.

The sliding flap is represented in its simplest form by the mere drawing together of the edges of a wound; these edges have to be undercut to a greater or less extent, and if the surface to be covered in is very narrow the marginal mobilizing cuts are entirely omitted, or they consist merely of two small snicks. But every time a wound is sutured, if there



FIG. 91.—Private W. Condition on discharge.

be any loss of skin, however small, this simple operation is really an elementary form of the sliding flap.

A further development of the sliding flap is well exemplified by some cases of reconstruction of the upper lip. Fig. 89, p. 238, shows such a case.

On admission the only vestige of an upper lip was the mucosa of the lip edge (Fig. 89) and a thin muscular layer between the red line and the nose. The mucosa was carefully freed from the deep surface of the cheeks at each angle of the mouth and stitched across the middle line. The strip of mucosa was folded outwards on itself, and

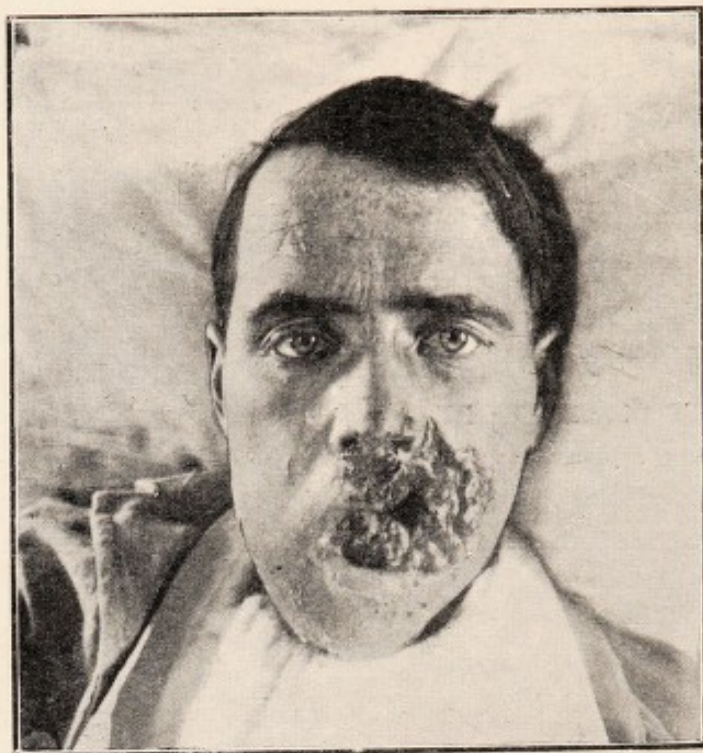


FIG. 92.—Lance-Corporal B. The area of destroyed tissue extends to well above left nostril, and also involves the entire left angle of mouth and left half of upper lip.



FIG. 93.—Lance-Corporal B. When the wound was sufficiently clean, a flap of mucosa was swung out from inside the mouth to line its irregular left margin. The edge of the wound still appears rough and granulating.

stitched to the remains of muscle and granulation tissue, and supported in a vulcanite trough attached to the upper molar teeth on either side (Fig. 90).

The new red line so formed lived and thrived.

To obtain a solid skin-covered upper lip two flaps were taken, one from each side. On the right a sliding flap was made by two parallel horizontal incisions extending into the

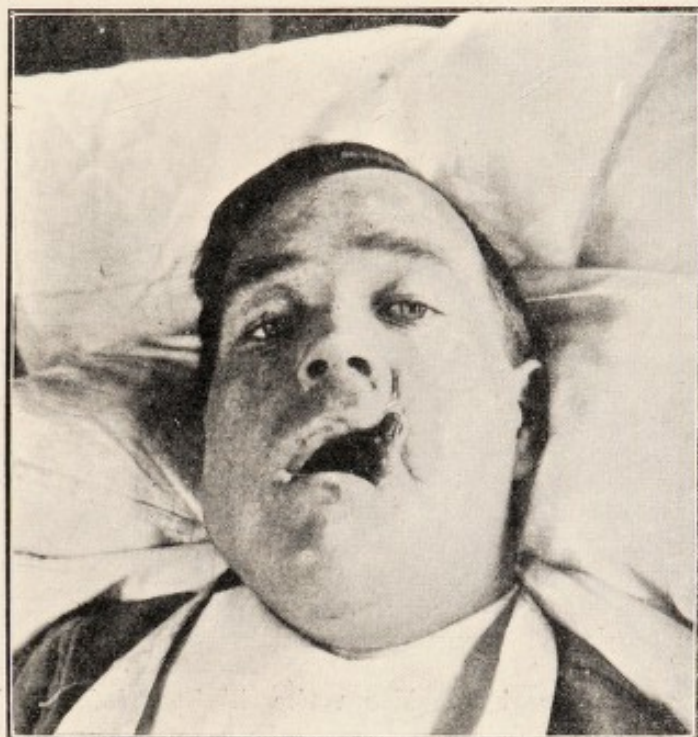


FIG. 94.—Lance-Corporal B. The mucous membrane which has been sewn along the border shows more distinctly as a "red line." This has been provided before restoring the shape of the mouth. The left side of the latter is as yet shapeless.

right cheek. The upper incision passed outwards from beneath the right ala nasi, the lower from the angle of the mouth.

This flap was undercut and slid across towards the left. This is a typical example of a sliding flap.

The left side of the lip was completed by a translated flap; this type will be presently described (see p. 249). In this case the flap was a vertical strip from the left cheek, pedicled above, and separated by 1 inch from the left angle of the mouth.

This flap was swung up to meet the sliding flap from the left.

In subsequent minor operations the red line was adjusted to the lip and the median vertical suture line excised from the new philtrum. The columella nasi was partly intact,



FIG. 95.—Lance-Corporal B. From the highest left-hand angle of the mouth a curved incision was carried up to the malar bone and then down to the angle of the jaw. This incision extended into the mouth, avoiding only the proximal end of Stenson's duct. The whole cheek below the incision was then rotated downwards and forwards. What had been the vertical left border now became horizontal, continuing the line of the left upper lip where this had been shot away. The tendency of this flap to drag back was very great, and was overcome by tension sutures. Two of these were tied through buttons, of which only the left button is visible. The other sutures, passed obliquely so as to counteract the backward pull of the flap, were threaded through short sections of rubber tubing. At the posterior extremity of the incision, over the angle of jaw, is seen the projecting end of a plaited salmon-gut wick for drainage.

but had become drawn up into the nose by scar tissue. It was freed, drawn down, and reattached to the philtrum, and maintained in its proper position by a **V**-shaped rubber tube, whose two ends emerged from the nostrils to be attached to the upper lip (see p. 191).

The final condition of this patient is seen in Fig. 91, p. 236.

It should be noted that when mucous membrane instead of skin is to be transplanted the sliding type of flap is not likely to be successful, possibly because it is less elastic than skin.

Suppose, for example, that it is wished to replace a part of the red line of the lips which has been destroyed. If from the margins of the piece lost two incisions are carried along



FIG. 96.—Lance-Corporal B. The cheek flap in its new position; at present it is an amorphous mass. The moustache will not grow from the new part of the lip, since this was made from a previously hairless region.

the deep surface of the lip at right angles to its surface, and the intervening strip of mucosa, after being undercut, is pulled out and everted to cover the patch, the result will be failure. The strip of mucosa will drag back towards its original site, the lip will invert, and little or nothing will have been added to its red margin. A flap of mucous membrane should always be rotated out, or swung out on a pedicle, as in types 2 and 3 described below; this was carried out in the case illustrated in Fig. 83, p. 229.



FIG. 97.—Lance-Corporal B. The patient, after several minor operations on the lip, has improved so much that he is keenly interested in his own looks, and, incidentally, has taken to parting his hair in the middle. This entirely alters his appearance, but he is recognizable as the same man. In addition to massage and radiotherapy, he was provided with this prosthesis, working on a spring, to stretch and make supple the left angle of the mouth.



FIG 98.—Lance-Corporal B. On discharge.

2. **Rotated Flaps.**—This type of flap is used if, instead of sliding a strip of skin or mucosa along a straight line to fill a gap, it is desired to move forwards only one corner of the tissue.

This might be effected by merely making a straight incision and undercutting, which would suffice to provide a freed corner of skin to be moved as required. But if such an



FIG. 99.—Private P. A black gangrenous chasm occupies the greater part of the right anterior triangle. The right horizontal mandibular ramus has been shattered. The desperate condition of this man when wounded is indicated by the evident haste in which someone had inserted a tracheotomy tube; for this presents not from the front, but the right side of the trachea.

incision be made and the skin on one side of it slid forwards, the skin on the opposite side of the incision will be redundant and will buckle. The pucker so produced will require excision either at the time or later; and this excision of healthy tissue from a face which already has but little to spare is undesirable.

To avoid any necessity of thus excising and discarding a

pucker from one side of the incision it will suffice if this be made in a curve instead of a straight line. The skin to be moved is then freely undercut, and by dragging on its corner is rotated into its new position.

An example will make this quite clear. In Fig. 13, p. 43, the patient had entirely lost his upper lip. From just below each ala nasi a curved incision was made up towards the malar bone, and then done again in the direction of the

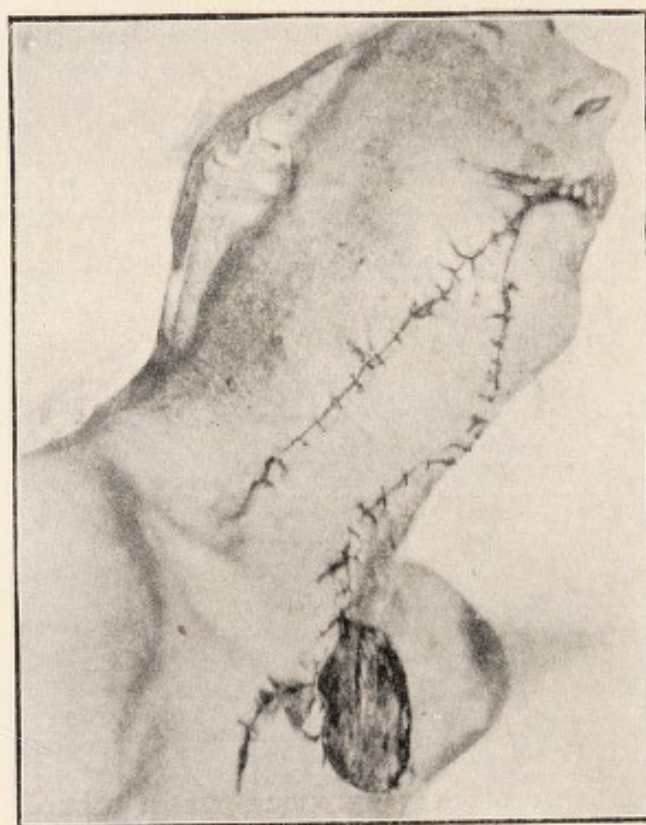


FIG. 100.—Private P. A flap of skin and fascia has been translated from the infraclavicular regions and manubrium sterni.

angle of the jaw. On each side of the face this bilateral incision described part of the arc of a circle, concavity downwards.

The margins of the wound immediately below the incisions were now rotated downwards, so as to cover in the premaxillary region, and the two opposed surfaces sutured together.

Figs. 92-98, pp. 240-244, illustrate another case. The

condition on admission is seen in Fig. 92. First of all the raw granulating edge on the left was covered by everting a flap of mucous membrane; as a result, the mouth, while remaining as unshapely as before, was everywhere surrounded by a red line of mucosa.

From the highest point of the gap on the left side a curved cut, as above described, was made into the left cheek. This

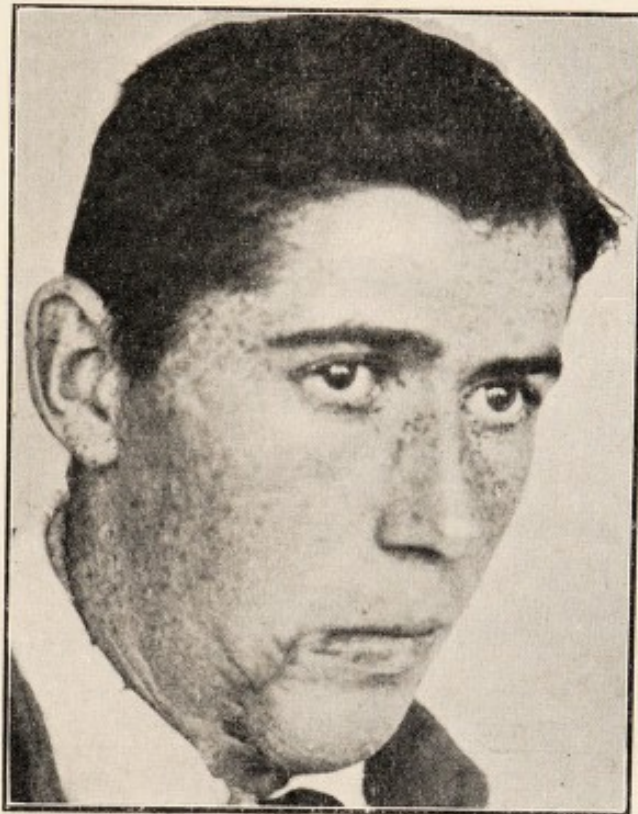


FIG. 101.—Private P. The distal apical part of the flap, which closed the wide septic buccal opening and the gap in the mandible, has sloughed. Subsequently the deeper parts were mobilized and sewn together to close the buccal fistula; a tough cicatrix of the false keloid type resulted. The resulting head flexion and torticollis was, during the ensuing three months, patiently combated by massage and by passive and active movements.

incision was carried deeply right into the mouth, through everything except Stenson's duct, which was deliberately isolated and left alone. The cheek flap was then rotated downwards and forwards, so as to complete the lip line; it was, in fact, swung down rather lower than required, so as to allow for shrinkage.

There is naturally in all such cases a strong tendency for the flap to rotate back again to its former position. Fig. 95, p. 242, shows the simple means adopted to combat this tendency. The stitches have been tied through short pieces of rubber tubing to prevent them cutting out. Moreover, the stitches have been passed, not at right angles to the



FIG. 102.—Private P. The mouth is being held open by retractors to show a denture prosthesis, designed by Major Valadier, which fulfils a double purpose. It not only substitutes false teeth for those missing, but also maintains divergence of the mandibular fragments. It takes its purchase from teeth remaining in the left lower jaw, and from one existing right lower molar. For cleansing purposes, not only is the prosthesis as a whole removable from the mouth, but the false teeth are also removable from the framework of the prosthesis.

suture line, but obliquely, in such a manner as to oppose a counter-pull, checking the tendency of the rotated flap to return to its former position. Figs. 96-98, pp. 243, 244, show this case in its subsequent stages.

Another application of the method of rotating a flap is constantly seen in the closure of the raw forehead area in rhinoplasty (see p. 168).

3. **Translated Flaps.**—I use the word translated to signify that the flap, instead of being simply drawn out on its long axis, or rotated as on a pivot, is moved bodily. The flap is swung to occupy an entirely new position, often remote from its place of origin; it is swung on its attached end, which forms a pedicle. If the flap, in passing from its

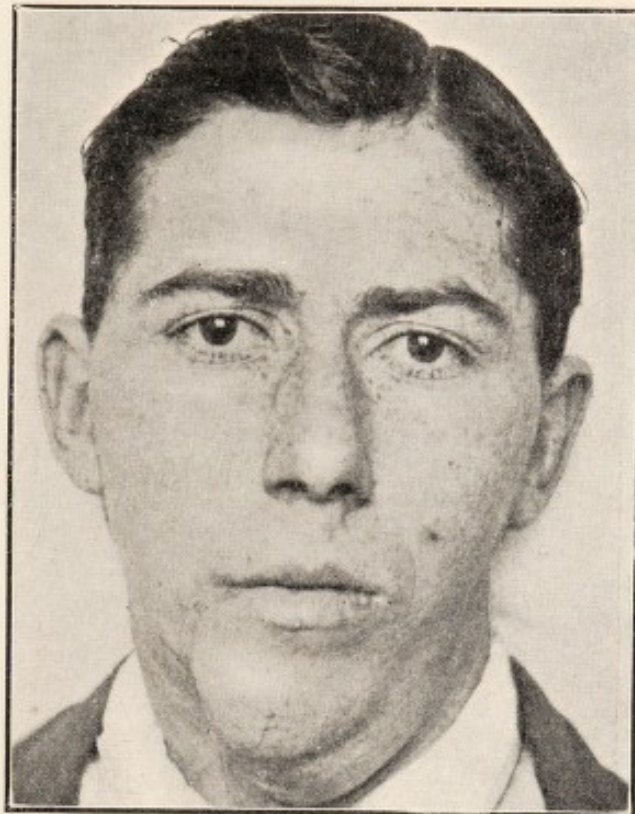


FIG. 103.—Private P. After the maximum possible improvement had been derived from massage and movements, the scar tissue was excised. Partly as a result of this operation, and partly because the prosthesis has restored the contour of the jaw, the deformity is much less marked than before. But asymmetry is still obvious, caused by cicatricial depression on the right and a suggestion of double-chin on the left.

pedicled end to the free end (which is grafted into a gap), crosses an intervening patch of sound skin, the pedicle has subsequently to be divided and returned to its old position. In other cases the whole flap, from attached to free end, is used to cover in the raw surface; and in this case no division of pedicle is necessary. In Fig. 89, p. 238, the left half of the upper lip was made from a flap translated from the left

cheek, with its pedicle upwards. The right half was made from a sliding flap from the right cheek. Another illustrative case is shown in Figs. 99-105, pp. 245-251. On admission this patient was thought to be moribund. A deep gangrenous chasm, black as a coal-pit, occupied the right anterior triangle of the neck. No landmarks could be identified. His right mandible was comminuted. He was put



FIG. 104.—Private P. Final operation. For the second time the scar tissue in the right mandibular and submaxillary regions has been excised in a thin wide sliver. The raw area so created has been covered by a sliding flap taken from the redundancy of skin on the left. Thus, this proceeding simultaneously removed scar (right) and double-chin (left).

in a corner bed to keep him undisturbed and quiet. In this corner of the ward the light was too poor for photography; and three weeks elapsed before he was considered well enough to have his bed carried out into the better light of the ward. Tracheotomy had been performed up the line; and when wounded he was probably in imminent danger of suffoca-

tion, for the tracheotomy tube seen in the figure had evidently been inserted in haste, since it is in the side instead of the front of his trachea.

When the wound had cleaned and granulated, I swung up a large flap, taken transversely from his chest (Fig. 100). The uppermost part of this flap sloughed (Fig. 101). When this fistula had been closed a tough keloid scar resulted.



FIG. 105.—Private P. Final result. During his last few weeks in hospital the patient was occupied as a ward orderly, and was eating ordinary food.

Massage and passive movements were patiently and continuously instituted. Fig. 102 shows the false denture, attached by a cap-splint to the remaining sound teeth on the left side. In Fig. 103 it is seen that the keloidal contraction on the right has produced an appearance of unilateral double-chin on the left. This redundant skin and fat on the left was elevated as a flap, pedicled in the left submaxillary

region, and drawn over to the right to cover a raw area created by the excision of the keloid. By this manœuvre the keloid on the right and the double-chin on the left were disposed of simultaneously. Fig. 104 shows the suture-line after this final operation, and Fig. 105 his condition on discharge.

CHAPTER XII

THE JAWS : THE MANDIBLE

Injuries of the Jaws.

THE science of treatment of injuries of the jaw has received a lively stimulus during the last few years. These injuries have always concerned the dentist as well as the surgeon; and in the vast majority of cases there was nothing very complex in the lesion or its treatment.

The ministrations of the dentist comprised the extraction of teeth and the fitting of dentures or of splints to maintain alignment of the alveolus: those of the surgeon were usually limited to the wiring of a mandible. Compound fractures were rare, and comminution so seldom seen, that to be called upon to remove several large sequestra was almost sensational.

The war has changed all this. The field of both dentist and surgeon is vastly enlarged. That of the dentist is most variegated. He is called upon to supply dovetailing appliances to fill gaps in jaws, and to devise ingenious appliances which shall coax fragments into place against unbalanced muscular action. The dental profession has risen nobly to the occasion; and the help of the prosthesis has become an integral part of the treatment of these injuries, quite as important as the surgical.

The surgeon's work is less unconventional; in the early days he has to prevent or treat complications, while nature does the rest. In the later stages the advance in the surgical side may be summed up as bone grafting.

The Mandible.

When a patient is admitted to hospital with a gunshot injury to the mandible the surgeon should ask himself three

questions: Can he breathe easily? Can he swallow? Is he likely to bleed?

Dyspnœa.—Purely mechanical interference with breathing—that is, interference due to the fractured jaw apart from any secondary infective angina—is rare after unilateral fractures. After bilateral fractures it is common, especially so when the fractures lie between the premolar region and the angle.

If in front of the premolar region, the fractures result in a downward displacement (both gravity and muscular pull acting in the same direction, and unopposed) of the anterior arch and symphysis; but there is no reason why this should produce marked dyspnœa; nor does it, as a fact, do so. If the double fracture lies behind the angle, the displacement is in the earliest stages not very great. Often on one or both sides the lower fragment is pulled firmly against the upper, and there may be actual impaction, so that displacement is limited.

But when the mandible is broken between the premolars and the angle on both sides, the anterior part swings downwards on a transverse axis through the fracture. The patient's appearance is characteristic. His chin has dropped, and saliva drools from his mouth. The tip of his tongue is drawn down behind the symphysis, and its dorsal surface bulges forwards so as to be vertical; or the tongue may protrude from the mouth.

This patient is very likely to have difficulty in breathing; for the posterior ends of the anterior fragment are tilted upwards, carrying with them the base of the tongue and floor of the mouth.

The treatment of this condition is simple, consisting in dragging the tongue and jaw forwards. The patient may require the constant attention of a nurse or orderly; but if the cause of his trouble is recognized as being simply a misplaced jaw, without any œdema of soft parts, tracheotomy may usually be avoided. In the course of the next twenty-four hours his jaw will be partly lifted into position by the dental surgeon, who will attach the lower to the upper teeth

by interdental ligatures or an interdental splint, and the man will thereafter breathe easily.

When the dyspnoea is due to oedema the problem is quite different. Often the oedema affects only the tongue and ranular region; the former is swollen, tense, shiny, and purple, and the latter semi-translucent, suggesting a sublingual retention-cyst. The sucking of ice should at once be instituted, and under this treatment the swelling will often subside. If it does not, or if after its subsidence dyspnoea persists, it is evident the larynx is involved; sometimes, but not often, this may be seen in the laryngeal mirror, or an anginal condition in the neck proclaims it. In this case the air-passages will probably require opening; the indications and procedure have already been described under the section on the larynx.

Feeding.—When first I saw a series of these cases brought in from a hospital-train in France I should have said it was quite impossible to feed the majority without passing an oesophageal tube. But this is not so. To have to pass an oesophageal tube after gunshot jaw injuries is the rarest occurrence—far below 1 per cent. of cases. A rubber tube, about 10 inches long, attached to an ordinary feeder can be used in practically every case.

In the first three months of the war railway arrangements in France did not work as smoothly as later, and delay was common. This was inevitable under circumstances then existing. And I remember a man who had spent thirty hours on a railway-train and fed himself with a piece of rubber tubing, although shrapnel had carried away his mandible from angle to angle. The problem of feeding remains important throughout the course of the case, but the difficulty later on lies in mastication rather than swallowing. At the end of the treatment of the case the question as to what he can eat is often the deciding factor when discussing the disposal of the patient—to duty, or discharged from the army, as the case may be.

The Probability of Hæmorrhage.—Under the section on hæmorrhage the indications for tying bleeding-points and

main trunks have already been discussed (Chapter I.). Here it is only necessary to emphasize that in gunshot wounds of the mandible bleeding from the base of the tongue and floor of the mouth is likely to be recurrent and intractable, even if not alarming. Often it is difficult to know from which side the bleeding comes (see case described on p. 11). Generally the external carotid of one, and later, perhaps, of the other, side will require ligature.

Within the first forty-eight hours the problem of feeding will have been settled. The risks of dyspnœa and hæmorrhage continue for a longer period than this; secondary œdema of the glottis may supervene any time during the first week, and unexpected hæmorrhage during the first two weeks.

But after the first two days his other wants will also be attended to. And the next question for decision is, how much bone and which teeth may be saved, and what must be removed?

The decision as to teeth of course rests with the dental surgeon. The question of when to extract teeth exercised his speciality greatly in peace time. And although it might seem to the uninitiated a simpler matter after compound fractures, it is evidently quite debatable during war also. The liveliest argument hinges on the question of removing teeth in the line of fracture. Many dental surgeons always remove such; but I have read an entirely opposite view, even to the length of stating that the removal of a tooth in a fracture line is a disadvantage which should be as far as possible compensated for by inserting a metal plug into the socket at the time of extraction.

The surgeon is chiefly concerned in that, if he is, later, required to perform a bone graft, he hopes there will be a sufficient number of firm teeth in upper and lower jaws for the fitting of a double splint which will effectively immobilize the mandibular fragments, both in front of and behind the fracture. This may eventually become a point of the first importance to the surgeon, as will be seen from the bone graft cases quoted below. Apart from this consideration,

the question of immediate extraction of teeth interests chiefly the dental expert; and, of course, the decision, as already said, rests with him.

But as regards what bone to save and what to discard it is different; here the surgeon is interested and responsible no less than the dental specialist.

This question as to the removal of bone has been, to say the least, hotly debated. It has seemed to me obvious that the diametrically opposite views expressed about a given case by conscientious surgeons can only be reconciled by remembering that they have seen the patient, not in consultation, but at different periods after his injury. And criticisms amounting to remonstrance might be avoided if it were remembered that in this, as in all other surgical questions, it is only the man who sees a patient at a given moment who can say what should have been done at that moment. It is easy to be wise after the event, and so, in any such difference of opinion, it is invariably the surgeon at home who is the critic and his colleague overseas the criticized.

In this debatable question as to the removal of bone in cases of gunshot fractures of the jaw the matter stands somewhat as follows:

The surgeon in France is confronted with a patient whose dire condition comprises a catalogue of evils including a fractured jaw. If, as a general surgeon, he is responsible for the whole treatment of all the patient's lesions, which may include wounds of the brain, thorax, or abdomen, he may be excused if he overlooks the removal of a small sequestrum of the mandible. And even if his appointed task is that of a specialist, and he is experienced in this class of wound, circumstances may preclude a rapid decision as to detail. For wounded men arrive in rushes; the nearer the front the greater the rush. The influx of wounded men during a battle finds a fair analogy in the systemic blood-supply of the mammal. The fighting line represents the heart, which sends out its wounded (the arterial pulse) in spurts to the field ambulances (the arteries). In the casualty clearing stations (the arterioles) the systolic pressure

becomes lower, and the diastolic pressure higher—the pulse is disappearing. At the Base hospital overseas (the capillaries) the pulsation ceases, simply because the vessels (hospitals) have such an abundant capacity relative to their contents. Until at last in the veins, represented by the Base hospitals at home, the flow preserves an even tenor.

This being so, it follows that as regards time and convenience for treating the wounded thoroughly the surgeon at the Base overseas is much better equipped than the man in a field ambulance; while the expert at home often enjoys even the luxury of meditation on his patients. This surgeon considers his cases calmly as they arrive. He sees a large wound into the mouth pouring with a mixture of pus and saliva. He sees and feels large loose sequestra, which he rightly decides, maybe without even the aid of a skiagram, require removal. He notes that in the presence of so much sepsis the jaws have in some cases been splinted, or the upper and lower jaws attached by interdental ligatures. And he concludes and announces that there has been incompetence, if not culpable negligence, in the treatment of this patient.

In a case which has not been splinted he thinks that nothing has been done owing to neglect; he forgets that during a rush the surgeon overseas was probably too much occupied with life-saving emergency operations to attend in any detail to a patient whose life was never in danger. In a case which has been splinted but arrives in a filthily septic state, he forgets that it may have been sent out in a clean condition, and that pieces of dead bone which are now rocking as loose sequestra may then have been healthy and firmly attached by periosteum. If he referred to the patient's case-card he might discover that between the man's exit from his last hospital in France and his admission to a hospital or department with facilities for special jaw treatment there was an interval of a week or more, during which time he had been transferred from one hospital to another—a delay which is sometimes unavoidable in the administration of special hospitals.

It is true of any bone in the body that a surgeon respon-

sible for its treatment in the early days following a gunshot injury is often obliged to give certain fragments the benefit of the doubt—that is to say, he leaves some pieces which, if he happens to see the case a fortnight later, he will admit should have been removed. But this does not prove that his treatment was faulty. On the contrary, it is better to leave several fragments which subsequently die than to remove a single useful piece which might have lived.

And what applies to other bones of the body applies, of course, to the jaw. From a pathological point of view compound jaw fractures differ from other fractured bones in only one respect. In the latter it is possible before sending the patient on a journey largely to eradicate old sources of infection, and entirely to shut out new sources. In the mandible this is not feasible, owing to uninterrupted re-infection by oral sepsis. And this fact accounts for the lamentable condition in which fractured mandibles sometimes arrive home.

The surgeon overseas requires some fixed ideas to guide him as to what bone to remove and what to leave. Having removed all the fragments that will obviously die, he ponders over the debatable pieces.

Factors Influencing the Treatment of Jaw Fragments.

The Attachment of Periosteum.—A piece entirely separated from this membrane could only become reattached in the same way as a free bone graft; this, in a virulently septic wound, is impossible. (There are, however, cases of free autogenous grafts which have “taken,” although the operation wound has become slightly infected.) Such pieces are, therefore, removed. But if there is a periosteal attachment over even part of the surface of only one side, that piece may perhaps live.

What is the Importance of this Particular Fragment in Preserving the Dental Arch?—The least important is a fragment which does not involve the whole vertical depth of the horizontal ramus, since the loss in this case need not neces-

sarily impair the arch at all. But if the whole depth of the ramus is involved, such a loss at or quite near the symphysis is less serious than one farther back. Because, in the former case, it is easier to maintain the arch by a prosthesis which keeps the separated ends of bone apart. Also, it is much more likely that this prosthesis will so immobilize the fragments that in its movements the mandible will work as a whole, and so mastication will be reasonably easy. Moreover, in this loss at the symphysis a prosthesis more effectually counteracts muscular displacement of the fragments.

Does the Questionable Fragment contain One or More Teeth?—If so, then, everything else being equal, it should be preserved. Whether or not it has an opponent in the upper jaw is not of decisive importance; for an opponent can be supplied on a denture. Apart from its use in mastication, it must be considered whether perhaps a bone graft may be necessary in the particular case; if so, the tooth on the debatable fragment may be highly useful to take a cap splint used in immobilizing the jaw. When the tooth is the last remaining behind a gap which may require grafting it will probably provide the only means of immobilization; so it is wise to leave the fragment carrying the rearmost existing tooth, in the hope that it may synostose with the posterior fragment.

If the Fragment is allowed to Remain, is its Fixation Feasible?—Is it large and strong enough to be wired to the fragments in front or behind? If it carries one or more teeth, are these firm and healthy enough to hold interdental ligatures against the pull of muscles which tend to displace it? If it cannot be fixed in some way, and so is pulled widely out of alignment, its subsequent value is discounted.

Would the Gap left by its Removal be Easy or Difficult to Graft?—The most promising region for a graft is between the canines and second molar. In front of the canines, where the bone curves, fixation is less easy, as is also the close apposition of diploë of graft to diploë of fragments. The least favourable region is behind the molars. The ascending ramus is always displaced, generally upwards and

inwards. There is no means of fixing it immovably, and closely maintained apposition of the graft is difficult to ensure.

The above are some of the most important factors by which the operator will be influenced in deciding which pieces of a fractured mandible to discard.

The problems which we have so far considered in relation to gunshot injuries of the jaw—the problem of the patient's breathing, feeding, and of his liability to bleed, and the problem of deciding the fate of various bony fragments—by no means exhaust the list of difficulties.

The difficulty of safe anæsthesia affects surgeon and anæsthetist. The mandible, consisting of two or more pieces, tends to fall back and impede respiration dangerously. Its unity and stability being destroyed, the act of pushing the chin forward does not, as a rule, meet the difficulty. In France I attempted to overcome it by passing an intratracheal tube through a Shipway's laryngoscope. But I soon abandoned this plan, because the jaw and hyoid bone in the early stages were often pulled back so strongly that it was impossible without violence to draw the epiglottis forward with the tip of the laryngeal spatula. A mask was always an impediment to the surgeon. And eventually, by a process of exclusion, we adopted a routine of using a Junker or a nasal tube, the anæsthetist having first induced anæsthesia with a mask. We found the Junker or nasal tube to be the best method for these short operations on fractured jaws in the early days following an injury, the tongue being constantly protracted by a stout silk thread.

For the longer anæsthesia required in later stages—for instance, for a bone graft—such a method as oil ether *per rectum* is best.

The points which arise in connection with lung infections are the same as those which have to be considered in connection with wounds of the upper respiratory tract (pp. 13, 39). Septic inhalation pneumonia is one of the bugbears of gunshot injuries of the jaw. And if the patient shows any

tendency to be "chesty," this may, of course, be aggravated by an anæsthetic. So that in these early stages, for short operations such as the removal of shrapnel and dead bone, the anæsthetist often avoids ether entirely, preferring the slight risk of depression or syncope incurred by using pure chloroform.

When the patient arrives in England the earlier problems have for the most part cleared up. There is no longer the same risk of dyspnœa or hæmorrhage; and he has learnt various tricks of head posture and swallowing which make it possible for him to feed himself.

But the question of removing dead or useless bony fragments now recurs again; usually more bone has to be removed. And there are various other problems which occur for the first time in this later stage of the case.

Trismus.—This is, of course, of the false variety. I have not yet seen a case of true trismus from gunshot injury, although it might occur as the remoter result of an injury to the temporo-maxillary joint. The chief causes of the trismus met with are muscular action, contraction of scar tissue in overlying soft parts, and, more rarely, interlocking and impaction of bony fragments. The first two of these, and sometimes the third, may usually be overcome by gradual mechanical stretching—as by a metal dental prop with a jack-screw arrangement for separating the flanges of the prop, or by making the patient bite on to box-wood wedges of gradually increasing sizes. If these means fail, the jaw must be forcibly opened under an anæsthetic; the gag must be only used with care to avoid refracture of any young callus and destruction of early bony union.

Quinsy.—This is mentioned here, not as a specific sequela inherent to the later stages of these jaw injuries, but because it is the type of the pharyngeal infections encountered; because such infections are fairly frequent; and because owing to the difficulty in opening the jaws widely, they are very awkward to deal with.

In the earliest stages, before there is any fibrosis of soft parts, and before any splint has been applied, the mouth is easily opened under a light general anæsthetic to deal with

any septic foci deep in the pharynx; moreover, until he leaves the overseas hospital there is every opportunity for frequent lavage of his mouth.

But when he leaves France his upper and lower jaws may have been immobilized with an inter-alveolar splint, which, even if it keeps the mandible in a partially open-bite position, none the less hampers the nurses in washing out the mouth. And it is not so easy, on the journey, to attend regularly to the washing. Moreover, the journey may aggravate any pre-existing pain, for which he is given morphia. This sends him to sleep perhaps for many hours, during which he is not disturbed for mouth lavage.

For reasons such as these the patient is very likely to develop some such local mouth infection as a peritonsillar abscess.

In passing reference to the subject of jaw splints which are to be worn during the journey home, I would like to say a word in favour of the lattice-work open-bite interdental splint, first shown to me by Major Valadier. This consists of an upper and lower cap splint (moulded, of course, on a plaster cast of the patient's teeth) joined by transverse vertical bars. The advantage of this arrangement over one which keeps his jaws in the closed-bite position, for a patient making a journey, is manifest. His mouth can be washed out through the cross-bars; and—which is of great importance—he can, if he is a bad sailor, vomit.

To return to the question of quinsy. If the patient on or soon after his arrival has pain on swallowing, enlarged cervical glands, and fever, inspection through his partly opened mouth will show a pharyngitis, tonsillitis, or quinsy. And owing to the difficulty of access through the narrow space between his teeth, it is difficult or impossible to reach the palatal region with a scalpel with any safety. On several occasions, under these circumstances, I have been compelled to rely on external fomentations, and allow a ripe abscess of the supratonsillar fossa to burst spontaneously; watching, meanwhile, for laryngeal œdema. This complication, quinsy, is an additional reason why the prosthesis should immobilize such jaws in a widely open position.

Displacement.—The displacement of the mandible consequent upon fractures differs, of course, according to the position of the one or more fractures, whether the break is unilateral or bilateral, and with the amount of bone lost. The deviation of the jaw in various cases, in so far as it depends upon muscular action, is described in the textbooks.

In gunshot injuries there are other adjuvant factors to be reckoned with, resulting from the fact that the injury has destroyed soft tissues as well as part of the jaw. Thus, destruction of muscles leaves their opponents with an unchecked action; while the cicatrization of overlying tissues draws the jaw to one side or the other, or limits elevation or depression (false trismus).

Displacement of the fragments of a fractured mandible concerns both the prosthesis and the surgeon; and the interest of the latter becomes very lively if the case is deemed suitable for a bone graft. Illustrative cases of this will be given at the end of this section.

But suppose the case is not considered suitable for a bone graft, what line of action should be taken by surgeon and prosthesis? Or, again, even if it is intended to graft later, the displacement may be so considerable that the mere restoration of bony continuity by a graft may promise but little towards restoring the jaw to useful function. How can surgeon and prosthesis combine to correct the displacement?

The answer to this problem, which recurs constantly, is that it is the duty of the prosthesis, the dental surgeon, to correct the deformity; but it is for the general surgeon to make correction possible.

The question may be asked, Which of the two is to work on the case first? On this point it is not possible to dogmatize. The final plastic work will generally be completed after the prosthetic correction. But there are certain surgical steps which must precede the rectification of alignment of jaw and opposition of teeth, in order to render these corrections at all possible.

Scar tissue and fibrous bands in the skin need division,

or more often excision, which may or may not involve the interposition of a skin flap to fill the gap.

Similar cicatrices may require removal from the inside of the mouth, which may or may not involve the interposition of a mucosal flap or the grafting of an "inlay."

Instances of skin and mucosal flaps will be found in the section on Injuries of the Face. Epithelial "inlays" or "onlays" have already been mentioned (p. 46) in reference to injuries of the mouth; but it is necessary here to emphasize their importance in enabling the dentist to fit either a good prosthesis which will fill a complete gap in a mandible, or a tooth-bearing denture to close an incomplete gap in the alveolar margin.

For the proper fitting of such appliances it is often necessary that the lower gingivo-labial sulcus should be deepened, which may be effected to a practically unlimited extent by an inlay.

Let us suppose, then, that the surgeon's part of this work has been done. All hampering bands and masses of scar tissue have been excised from outside and inside the mouth, and where necessary replaced by flaps or inlays of soft tissue. The jaw has free passive movement, and, except in so far as any muscles have been destroyed, free active movement also. And the only obstacle to correction of displacement, or to the maintenance of this correction, is unopposed muscular action. It is now time for the prosthesis to act.

This subject is, and should be, written about only by experts. I shall make the briefest reference to this part of the work, with every acknowledgment to it as a distinct speciality.

If the displacement is obstinate, and difficult to overcome without using undue force, the mandible or its displaced part is gradually coaxed back to its normal position. Before he considers what means he will adopt to apply a force of gradual traction or pressure the prosthesis has to find stable points between which this force shall act; to use a simile, it would be useless to provide a muscle without giving it an origin and insertion.

In the cases under consideration the *point d'appui* (corresponding to a muscular origin) is furnished by an appliance fixed, by cement or otherwise, to the teeth of the upper jaw; and the point to be acted on (corresponding to a muscular insertion) by another appliance fixed to the remaining teeth

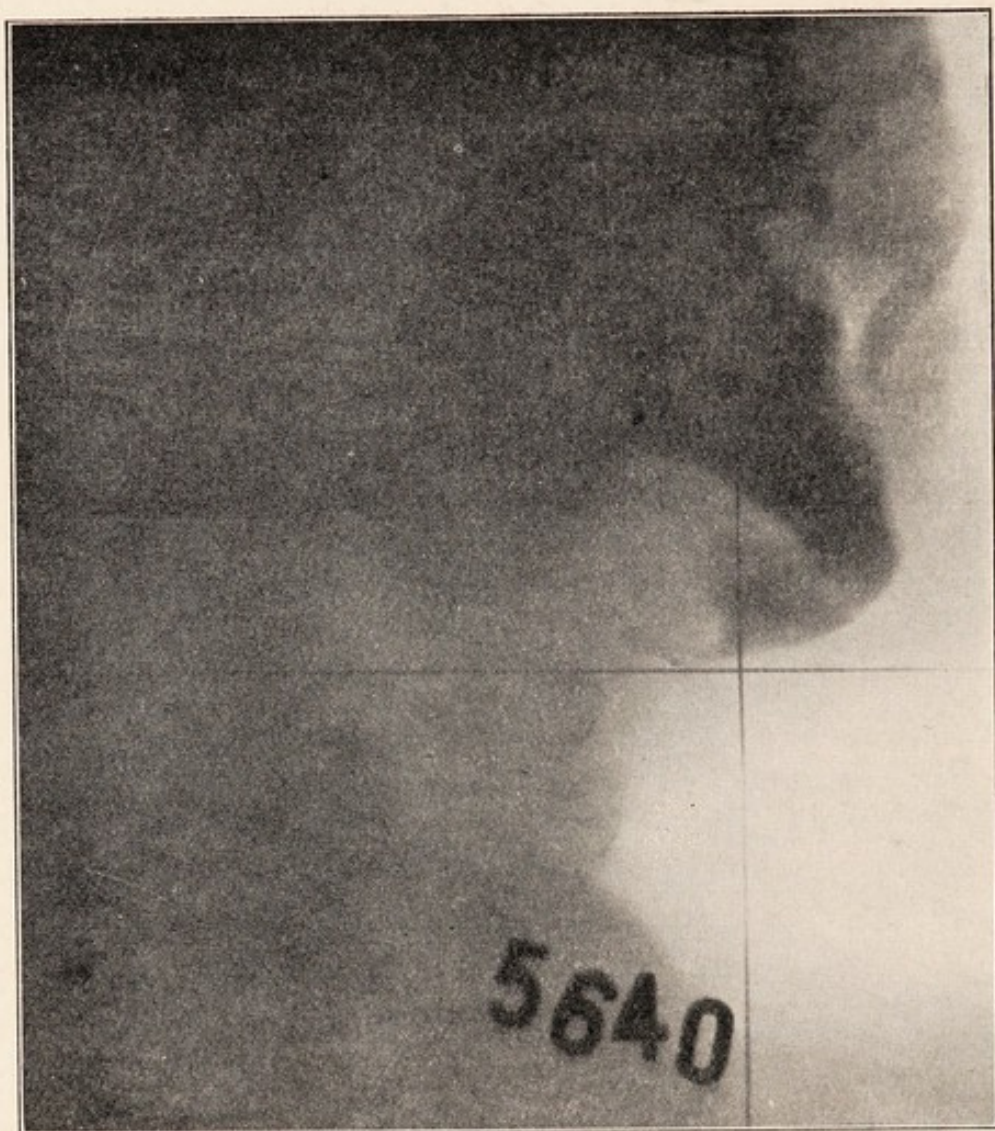


FIG. 106.—Compound fracture of the mandible, with some loss of bone.

of the mandible. Various ingenious refinements are called for and provided; for instance, when teeth remain only on one side of the maxilla and the opposite side of the mandible, the force must needs be applied diagonally.

The force itself is arranged to be capable of regulation; it is supplied by such means as rubber bands, metal springs,

or jack-screws, which coax the mandible in the desired direction.

When by such methods the resistance to replacement has been overcome, a second type of appliance is applied to maintain the good position. Or, in cases where the displace-



FIG. 107.—The lateral view of the same mandible as shown in Fig. 106; this skiagram was taken a little later, after the jaw had been splinted. The unilateral pterygoid pull, overcome by the flange splint on the left, remained corrected. The prosthesis cured the displacement without any surgical aid, and apparently permanently.

ment was not even at the outset obstinate, and could easily be corrected without much force, the first stage, of elastic or coaxing pressure, is dispensed with, and the prosthesis proceeds straightway with the second type.

The second type is an appliance to maintain the mandible or its displaced fragment in correct position. As examples

may be mentioned double-hinged splints cemented on to upper and lower teeth, and vertical flanges, similarly cemented, which slide one on the other. The lower flange slides up and down on the upper, pressing against its inner or outer surface according to whether the original displacement was outwards or inwards. I have seen excellent results in my patients for whom prosthesis have fitted these flanges. Even a high degree of displacement, when once overcome, may remain corrected. *The unilateral pterygoid pull, although unopposed, may cease to deflect the jaw.* Figs. 106 and 107 illustrate this. The statement sounds contrary to the most elementary laws of dynamics; but I can only vouch that I have seen it verified repeatedly.

When there exists in the mandible a gap behind the last existing tooth, the displacement—usually inwards—of the ascending ramus is difficult to deal with, often incorrigible. To this point further reference will be made under Bone Grafts.

CHAPTER XIII

THE JAWS : THE MAXILLA

Injuries of the Maxilla.

AFTER the foregoing remarks on gunshot wounds of the mandible, similar injuries of the maxilla must not be considered without a clear realization of the cardinal differences in the problems presented by fractures of the lower and upper jaw respectively. These differences are, perhaps, obvious without much deep thought; but to have them clearly in view is essential if the patient is to derive the maximum advantage out of every circumstance and factor which affect his prospects.

In some respects injuries of the maxilla are less favourable, less promising as regards the ultimate condition, than those of the mandible; we must decide what underlying causes are responsible for these disadvantages, and as far as possible combat them.

In other respects injuries of the maxilla are more promising as regards the result than those of the mandible; we must realize what factors underlie these advantages, so as to be able to make the most of them.

In relation to injuries, the fundamental differences between the maxilla and the mandible are that the former is fixed, a part of the skull framework, and that it is hollow, containing the antrum.

Its fixity is a favourable factor in dealing with lateral displacements after fracture, and an unfavourable factor in dealing with downward displacements.

The mandible being mobile, supported only by a joint at each end, a fracture which crosses it in a straight, vertical,

or oblique line often results in displacement. The jaw *on both sides of the fracture* is freely movable.

Suppose, for instance, that there is a bilateral fracture in the bicuspid regions, the separated part being edentulous. The chin becomes depressed, and there are no teeth by which to fix the anterior fragment to either the upper jaw or to its neighbours in the lower jaw. Suppose, further, that an apparatus fixed beneath the chin, and taking its *point d'appui* from an upper denture or a head-band, fails to correct the displacement and keep it corrected. Although the anterior fragment cannot be kept in good position with the right and left posterior, the latter can at least be depressed and so brought into proper relation with the former, because all parts are movable; the jaw may, in fact, be set in an open-bite instead of a closed-bite position.

It is evident, then, that the mobility of the mandible makes for ease in reducing fragments. But this same attribute, mobility, may handicap us in maintaining the bone in its reduced position; so that for fixation we are often obliged to take the support from the upper teeth.

The maxilla, by contrast, is a fixed bone. The displacement is nil if a linear fracture crosses the bone vertically; and possibly nil also—or, at any rate, usually only slight—if the line of fracture makes a small angle with the vertical.

For a fissure that is quite, or nearly, vertical leaves to the separated part a considerable attachment to the base of the skull and other neighbouring bones; and there is no joint on which the separated fragment can swing. Thus it occurs that a fracture which happens to produce no displacement of the maxilla is often discovered accidentally by a skiagram or by an inflammation of the antrum.

If the fracture runs in one line it must be horizontal, or nearly so, to produce displacement. The typical injury of this sort is the horizontal fracture of Guérin, in which the lower parts of both maxillæ, separated from their upper parts by a horizontal fissure above the palatine vault, drop downwards.

Except in the case of this Guérin type, a fracture which

causes displacement of an upper alveolus must be angular or curved, so as to isolate the alveolar position not only from the body of the bone, but also from the neighbouring alveolus. The fixity of the upper jaw is taken full advantage of in reducing a laterally displaced upper alveolus, by dentures and supports which take their *point d'appui* from the other maxilla.

But in the Guérin type the immobility of the maxillæ is a disadvantage. In order to restore a normal bite to the patient it is necessary to lift the maxillæ into their normal



FIG. 108.—Private H. Splinting the maxilla to counteract its tendency to fall downwards. Major Valadier kindly undertook the splinting.

positions; and the upper fixed part, being continuous with the basis cranii, will, of course, not yield.

Owing probably to the interposition of blood-clot, periosteum, or the lining mucosa of the antrum, great resistance is often experienced when the fractured bone is lifted up. The moral is to effect this reduction as soon as possible after the injury, and before there has been time for much effusion to occur, or for this effusion to become organized. If there is much swelling of the face to hinder reduction, an ice-pack on the face expedites matters. The splint is pulled up by

rigid or elastic connections to a fixed head-band. Fig. 108 exemplifies this.

So much for the importance of mobility of the lower and immobility of the upper jaw as factors affecting reduction of fractures. The other factor is no less important—that is, the fact that the body of the upper jaw contains a cavity, the antrum, which communicates with the nose.

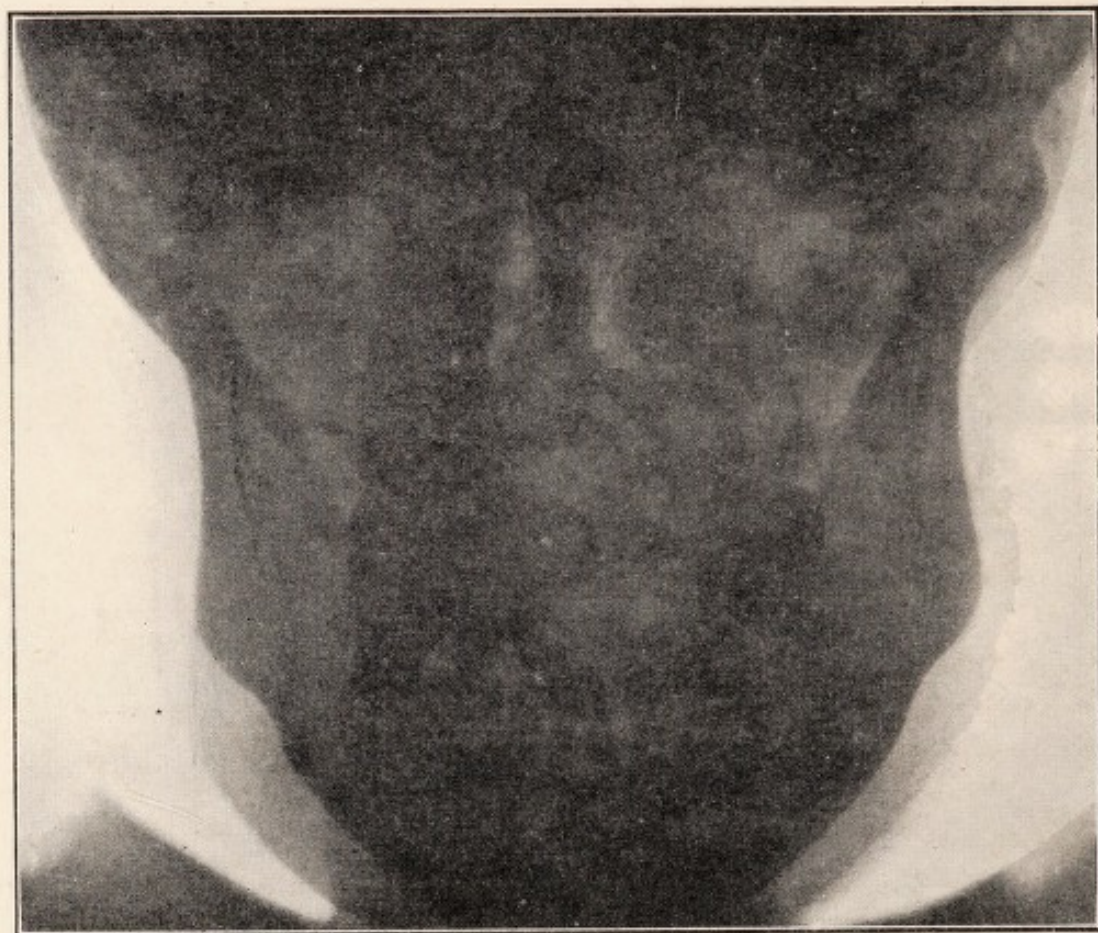


FIG. 109.—Private B. Unsuspected necrosis and comminution of left maxilla (right-hand side of picture). As compared with the sound side, the outlines of the outer antral wall and of the naso-antral wall are vague and shadowy.

The subject of injuries to the antrum has already been dealt with when speaking of the nasal accessory sinuses. Its importance in connection with maxillary fractures is obvious—the neighbouring nasal area is a perpetual source of sepsis.

Until all dead bone has been removed from the walls of the antrum, and its septic cavity given ample drainage, it is

impossible to exclude the spread of necrosis through the body and alveolus of the maxilla.

Figs. 109 and 110 are of a case which forcibly reminds us of this possibility. The first skiagram (unfortunately not available for publication) gave no indication of necrosis of the jaw; the man was up and about and in good general health.



FIG. 110.—Private B. Lateral view of the same condition as shown in Fig. 109. Note the lack of definition in the hard palate.

He was anæsthetized in order that I might simultaneously clear his nasal cavities by cutting out callus and make a fenestra in his left naso-antral wall for drainage.

I found the usual conglomerate mass of inferior turbinate, nasal floor, and nasal spine of maxilla; but it was not hard, as it usually is. On the contrary, it broke away easily.

At the back of the left inferior meatus there was a loose piece of hard palate, leading by a tiny unsuspected sinus into the mouth. When the anæsthetist inserted a gag so as to be able to swab out his mouth, the whole left upper alveolus rocked.

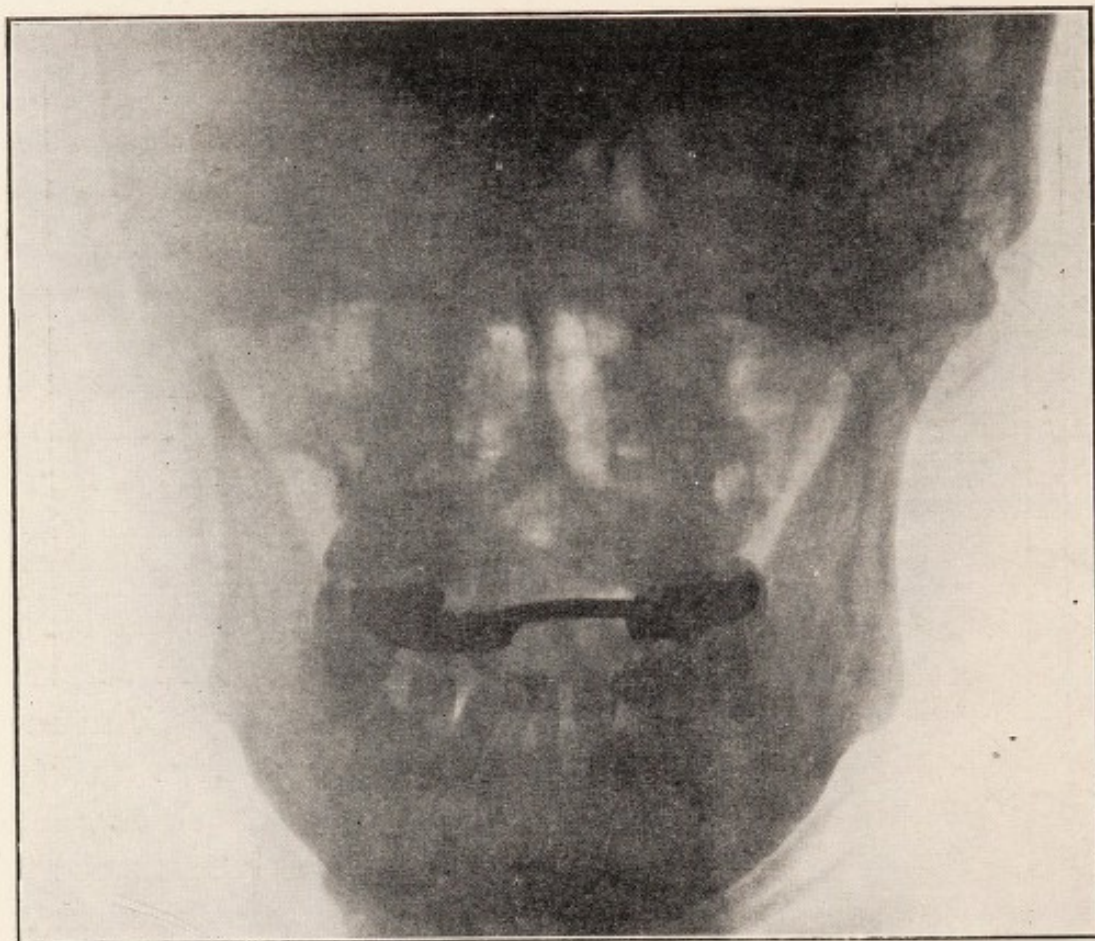


FIG. III.—Private B. After twelve weeks of expectant and prosthetic treatment. On the left side (right-hand side of figure) the maxilla appears symmetrical with the other side as regards palate, inner and outer antral walls. The only evidence of any past lesion is a lack of definition of the lower part of outer antral wall.

In short, the whole left maxilla was falling to pieces, without any suppuration to suggest the fact. I stopped the operation, for to continue would have meant that his left maxilla would be removed piecemeal.

The second skiagrams (Figs. 109 and 110), taken the following day, show the unsuspected necrosis well. I decided to wait for the separation of sequestra, and to try and save the

left alveolus, so that possibly it might later join at least by fibrous union. He was put under the care of the prosthesis. The improvement twelve weeks later was remarkable. Clinically the upper jaw was firm and healthy, except for the small perforation in the hard palate. There was no sign of

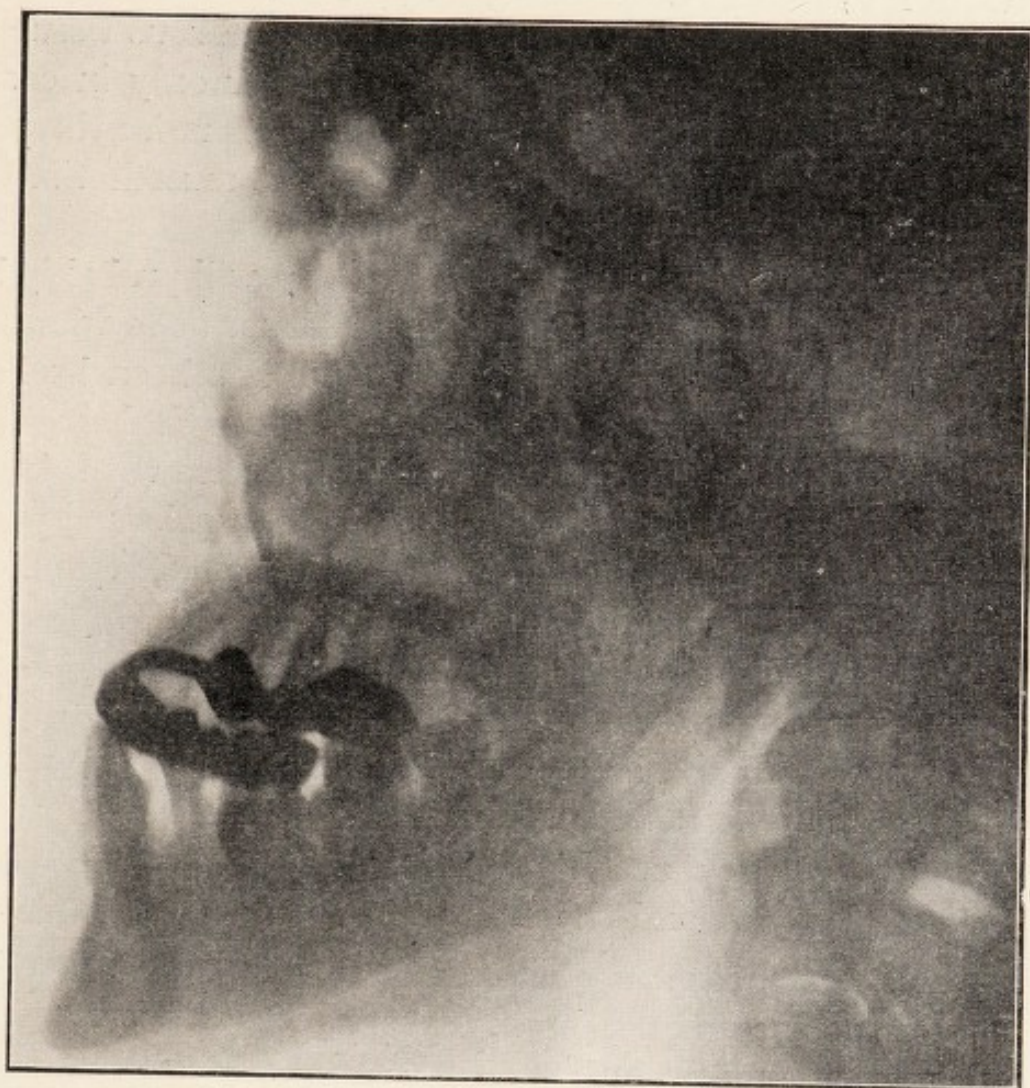


FIG. 112.—Private B. Lateral view taken at the same time as Fig. 111. In comparison with Fig. 110 note the clear-cut appearance of the hard palate.

sepsis anywhere. The skiagrams, taken before the splint was removed, confirmed this impression of a complete cure. The antero-posterior picture (Fig. 111) shows that the removal of the conglomerate callus projecting from the nasal floor has made the left naso-antral wall less bulky, more defined and symmetrical with the same part on the right

side; also that the left outer antral wall is less vague, more discrete; and the palate, as seen in both antero-posterior and lateral views (Fig. 112), is clear, firm, and gives evidence of new bone formation. This case affords a strong testimonial to conservatism in treating fractures of the maxilla.

With reference to a "rocking" upper alveolus, it must be recognized that a union by young callus or fibrous tissue is easily refractured. This will naturally occur only in cases in which no fracture had been suspected; otherwise the jaw would have been properly splinted and the anæsthetist on his guard against the accident.

Since the fracture was unsuspected, there will probably be no recent skiagram available, so that evidence as to whether it is young callus or fibrous tissue which has been broken down is incomplete. We can only make a rough deduction from the length of time which has elapsed since the injury. If the latter was quite recent, the alveolus may have joined by bony union. If many months have elapsed bony union would have become firm, and the tissue which has yielded must be fibrous. This occurred in the case of the patient seen in Fig. 58, p. 182.

When such an accident occurs I have heard the remark made, at the moment of the refracture, that it is not a very serious matter, because it could only have been a fibrous union in any case, and this will form again. This attitude is quite wrong, for the fibrous junction is feebler the second time, probably because the gap between the separated fragments is wider. And whereas the original fibrous union may have provided enough solidarity for a useful masticating jaw (especially if steadied by a small prosthesis), the alveolus after the second fibrous union may be a movable, wobbling, useless bone.

The possibility of refracture applies, of course, to the lower jaw as well as the upper. But there are two points of difference.

Firstly, a fracture in the case of the mandible is less likely to be overlooked in a skiagram, so that the accident is less probable. Secondly, the means available for artificial

repair are far more limited in the case of the maxilla. This brings us to the fundamental influence which the propinquity of the antrum has on maxillary injuries. It provides a septic focus which militates against the success of wiring a fracture; and, above all, the communication of a fracture with the antrum is, in the present state of progress, an absolute bar to bone grafting.

In bone grafting the mandible, whatever the type of graft employed, the bed-rock of the technique is that the operation area must be entirely shut off from the mouth. And the only way to ensure this is to expose the ends of the separated fragments from the side remote from the oral mucosa; that is to say, we expose the mandible by working upwards from its lower edge.

Now the same principle of course applies to the maxilla. To graft its alveolus we should have to approach from above, and work downwards, avoiding the mouth cavity. But it is impossible to conceive any case calling for a graft in which this technique would not involve a communication with the antrum.

Thus, in contrasting the upper with the lower jaw as regards the means at our disposal for treatment of refracture it is evident that, since cure is less easy, prevention must be more assiduous. This involves a more careful study of the early skiagrams and a very light hand in using the gag.

There is one other potent effect exercised by antral sepsis in gunshot fractures of the upper jaw, and that is in its aggravation of sloughing of mucous membrane over the alveolus and hard palate and in the gingivo-labial sulcus.

As has already been mentioned, the prosthesis is often handicapped as regards either the mandible or maxilla by the shallowness of this sulcus after an injury.

But in the case of the maxilla it is not only a shallow sulcus which baulks him; there is also, in many cases, a sinus from antrum to sulcus steadily draining pus or muco-pus. Efficient nasal drainage of the antrum succeeds in diminishing the flow from the sinus, and probably in changing its character from pus to mucus or thin muco-pus. But the sinus

remains, and in its presence a denture will be provocative of general oral sepsis. The muco-periosteum surrounding the sinus is fibrous, firmly adherent to the bone, and avascular, for which reasons attempts to close the hole by a small plastic operation often fail.

The operation is repeated, and perhaps on the second or third attempt succeeds; but each attempt has used up a little more mucosa, and leaves the sulcus shallower and ever more shallow. So that, when the antral cavity is at last successfully shut off, the prosthesis has no room in which to work.

An epithelial inlay in these circumstances is unpromising; for the incision made to admit the inlay at once reopens infective communication with the antrum.

Observation of these cases in their earliest stages explains the sequence of events, which is partly preventable in the following manner:

The type of injury is usually a bullet (or piece of shell), which traverses one or both cheeks and one or both antra, and carries away parts of one or both alveolar processes.

If seen in the first few days there are generally rich folds of mucosa hanging down on the outer and inner aspects of the broken alveolus; on either of these aspects, but usually on the outer, there is a hole into the antrum. In about a week the folds of mucosa shrink; so that there is hardly membrane enough available for suture around the bare, broken alveolar margin, much less for making a flap to close the antral sinus. At this stage the antrum is drained intranasally by the surgeon.

But this intranasal drainage has come too late to save the mucosa from fibrosis and shrinkage. The prophylaxis against this would have been to open one or both antra widely into the nose *at the earliest possible moment*. A few days later the suture of alveolar mucosa may be performed; in this way the extensive sloughing of this valuable mucous membrane may be curtailed.

The prosthesis necessary after a massive loss of the maxilla

is a bulky affair; it is nowadays built in sections for ease of removal and cleansing.

That part of a prosthesis which takes the place of a missing premaxilla is most important, for it alters the whole aspect of the upper lip, columella, and nose. Moreover, it must be remembered that, from the point of view of function, a premaxilla, real or artificial, is essential to speech for the pronunciation of sibilants. The premaxillary part of a temporary prosthesis on which an upper lip is constructed should always have an exaggerated forward projection to allow for subsequent fibrosis and tightening of the plastic flap.

Omission of this precaution will result in great difficulty in replacing the prosthesis after its removal for cleansing. The prostheses used in the early weeks, while the new lip is contracting down, should project so as to give the patient a face of an almost extreme prognathous type.

Cleft-palate operations of various kinds may be required after gunshot injuries of the maxillæ. But it is to be remembered that the mucosa on each side of the gap is more or less cicatricial and avascular. So that a gap of a given size is less promising for plastic closure than a similar gap in a congenital case. In fact, I am sure that any surgeon relies on prosthetic closure in a larger percentage of his cases in proportion as his experience increases.

CHAPTER XIV

THE MANDIBLE : BONE GRAFTING

THE frequency of massive injuries to the jaws in this war has given an enormous stimulus to bone grafting. Until recently a bone graft to fill a hiatus in the mandible was regarded as a rather rare and, therefore, specially interesting procedure, and admittedly in the empirical stage.

But now so many grafts have been carried out, so many different methods repeatedly attempted, and such great improvements introduced into technique, that, although the operation is still in the pioneer stage, it has gained recognition as a practical treatment having a reasonable prospect of success. In the present state of knowledge, the advisability of bone grafting may certainly be debated in every case of ununited fracture of the mandible, even though there be no gap in the ramus; for, in such a patient, to close the gap with a piece of his own bone is at least as reasonable as to do so with silver wire.

Anyone who realizes the improved precision of modern technique in performing jaw grafts may wonder why the results are not uniformly successful with a percentage of 100.

Apart from unforeseen accidents (which are frequent), the technique has become stereotyped and almost mechanical. So that, if we consider only the cases in which no unforeseen accidents have occurred, cases in which the operation proceeded without a hitch, it would be reasonable to expect an equally good result in all.

And yet this does not happen. In the after-treatment, a case which heals by first intention and without a suspicion of sepsis may eventuate in absorption of the graft. In another case serum, followed by pus, oozes through the suture line; a sinus remains, at the bottom of which bare bone is

felt. But instead of sequestering, the bone lives. The sinus heals, and both clinical and skiagraphic evidence show that the graft becomes incorporated by bony union at one or both ends, firm fibrous union occurring at either end where callus is lacking.

The probable explanation of such paradoxical happenings lies in biological factors, of which we are still uncertain. For, although the technique has been so perfected, there still remain some debatable points as regards the manner of incorporation of the graft, or of regeneration of new bone, in the gap.

A consideration of the deductions made from the many carefully conducted experiments carried out at different times indicates two problems as having the most important bearing on the practical results of jaw grafts: firstly, the importance or unimportance of the periosteum; and, secondly, the true rôle played by the transplanted bone.

As regards the periosteum, the weight of general opinion inclines to regard it as important and helpful, though not essential, for the viability of a graft. Moreover, it is seemingly the deep, softer, "cambium" layer of the periosteum which has osteogenetic properties. On this latter point justifiable deductions have been made from the varying successes obtained with periosteal grafts according to whether this deeper layer has or has not been transplanted with the superficial fibrous stratum.

As regards the rôle played by the transplanted bone, the two extreme views held have been, on the one hand, that the graft is incorporated, and lives in its entirety; on the other hand, that it is entirely absorbed, and serves merely as a scaffolding for new bone thrown out from the freshened ends of the fracture gap. The intermediate opinion, more generally held, is that, although absorption does take place, osteogenesis simultaneously occurs in the graft; so that part of the tissue of the latter actually enters into the formation of the new bar of bone eventually laid down.

It will be seen at once that the answer to the first question (as to the importance of the periosteum) is dependent on

what is deemed to be the true answer to the second question (as to whether the graft as such actually lives or not). For if the graft plays no part other than that of a scaffolding, and the osteogenesis occurs only from the ends of the fracture gap, it would surely be immaterial whether or not the periosteum—either fibrous or cambium layer—were included in the transplant. And even if so included, the periosteum, with its attached bone, would be absorbed.

It is generally considered that speed in operating makes for the viability of a graft; as little delay as possible should occur between the moment when the graft is separated from its parent bone and the time when it is laid and fixed in its new bed. And during this short period of delay the graft is carefully protected—either wrapped in gauze or kept in warm saline.

Now, if the graft as such does not live even in part, it is difficult to understand what useful purpose can be served by such technical precautions. It would be quite immaterial whether a minute or a day elapsed while the bone graft was deprived of any bed; and the temperature at which it had been kept would also have no influence on the result.

Moreover, it has been universally agreed that an autogenous graft, taken from the patient himself, has a better prospect of living than a homologous graft, taken from another human animal; while a heterogeneous graft, taken from an animal of a different species, offers a so much smaller chance of success that it is nowadays never attempted.

To hold this opinion is surely an admission that the graft is expected and desired to live. For if it were only to act as an inert scaffolding the issue could not be affected by the species of the host from which it is taken; any piece of bone, or other absorbable material, provided that it be sterile, would serve.

The above remarks apply only to free grafts. In the case of pedicled bone grafts the case is different, and the arguments are stronger; to this reference will be made later.

Cases suitable for Bone Grafting.—Between the several stages of repair of injuries to the face and jaw a patient

should be allowed to go out and about: first of all, to a convalescent home; and, when well enough, to visit his relations or friends for a period of days, weeks, or months. At intervals he is examined, and from six to eighteen months after the wound he is ready for a bone graft if it is considered advisable.

Thus, although a good general condition of health is the first postulate before grafting, the man's general fitness is not likely to be called in question. For, since so long a time has elapsed since his wound, it will be obvious long before any grafting operation is considered whether or no he is a good subject. If he suffers from any constitutional taint, such as syphilis or tubercle, it will have been discovered in the interval. Or his general health may have been vitiated by a wound of an important organ received at the same time as his jaw wound. In one case in my recollection, although not under my care, the same shell which had smashed the patient's jaw had injured one kidney and the lung on the same side. This boy was hereafter always frail and anæmic, and took anæsthetics very badly. Circumstances such as this would naturally influence the surgeon in deciding against a bone graft.

Assuming that the patient has in every respect except his jaw a clean medical history, we pass at once from a consideration of his general to an examination of his local condition. As I said earlier, the progress recently made justifies us in considering every case of ununited fracture of the jaw, even without discoverable bony loss, as a potential candidate for a bone graft.

Cosmetic Considerations.—Each case will be considered on its merits, and from the standpoint that if a bone graft is recommended it will be entirely for functional, not cosmetic reasons. For from a cosmetic viewpoint there is no result effected by a bone graft which cannot be attained equally well by the skill of a modern prosthesis.

A fracture of the mandible, even with extensive loss of one ramus, is often hardly perceptible to the eye looking at the patient's face. And in cases where it is noticeable, it is

often so because the external scar of the facial wound directs attention to it.

If there is, apart from the facial scar, any cosmetic blemish, this will consist in a depression or flattening over the missing part of the mandible. Such a depression is more obvious to the eye when situated over certain parts of the jaw than when over other parts.

A flattening over the vertical ramus is not very noticeable or ugly, which is fortunate, since grafting here would be hardly likely to promise well, and a prosthesis cannot, as far as I know, be satisfactorily fitted to the upper part of this ramus. A flattening in the central part of one horizontal ramus is more obvious, but often not extremely so. A loss of the angle is distinctly noticeable, and somewhat alters the character of the face. But the gravest injury, from the point of view of appearance, is, of course, one which carries away the symphysis. The loss of the chin gives any man an appearance of indetermination and lack of intellectuality sometimes amounting to imbecility.

But, apart from function, any of these detriments can be remedied as effectually by a prosthesis as by a graft nowadays.

I say nowadays advisedly, because in former times there were many cases in which it was difficult to fit a prosthesis at all. The obstacle was always scar tissue. When this affected the overlying cheek, a plastic flap could be introduced into a space created by the excision of the scar. But when it affected the mucosa of the mouth the situation was more difficult, and the impediment sometimes insurmountable. A pedicled flap of mucosa often shrank down again owing to the contraction of fresh scar tissue. In particular, the space between mandible and soft tissues of chin had often filled with fibrous tissue; the gingivo-labial sulcus was so shallow that the mucosa appeared to pass directly from alveolus to lip without any dip whatever.

To this difficulty was often added a total absence of the normal projection of the alveolus, which had been shot away; so that the mucosa between jaw and deep surface of lip

did not even lie horizontal, but sloped upwards as a plane surface from the former to the latter. To crown these disadvantages, the teeth available for immobilizing a denture were often so unhealthy, few, or remote from the damaged region that, since there was no room on the outer aspect of the jaw into which he could fit a flange projecting from the denture, it was impossible for the prosthesis to make this appliance grip anything or anywhere.

The patient in the case under consideration would have to wear a denture which was never comfortable, and always slipping out of place. The alternatives would be, either to go through life without, for instance, a chin, or to have a bone graft for cosmetic reasons; and even if this latter course be adopted, success is uncertain, because a shapely chin is difficult to create by a graft.

The prospects of a patient in such a condition have more recently been vastly improved by the practice of inlay skin grafts into the gingivo-labial sulci. This certain means of deepening a sulcus has relieved the prosthesis of a desperate class of case.

Owing, then, to the extent of modern resources of the science of prosthesis, facilitated by the inlay grafting of skin, it may be taken as axiomatic that a bone graft should never be undertaken for cosmetic reasons alone.

The problem of function, therefore, confronts the surgeon.

Mastication.—The first question to be asked is, What can the patient eat?

In the stage which we are imagining he has been to a convalescent home, and after that living with his friends or relations for at least several months. During that time he will have tried to eat various kinds of food, and will be able to give an illuminating and precise account of his abilities.

If the fracture was single, and unattended by any demonstrable loss of bone, and the fissure has healed by firm fibrous union, occlusion and apposition of teeth will, of course, be good; and the power of mastication may be perfect. In such a case it is doubtful whether a bone graft should ever be recommended.

It should be noted that a man with this firm fibrous union presents exactly the same condition as does the end-result of many bone-grafting operations. For in these it is quite common for the graft to join the mandible by bony union at one end and only fibrous at the other. The net result to his jaw is, therefore, the same as if he had suffered a fracture without bony loss, and this fracture had healed by fibrous union.

Now in such a case the jaw after grafting as a rule functions admirably, and I have never heard it suggested to perform a second bone graft to replace the fibrous junction. At most freshening of the ends and wiring would be considered necessary. And the same reason therefore applies to a single fracture without displacement of the arch, and with firm fibrous union.

As a supplement to the question of eating, the man should be asked whether he can smoke a pipe. If he has in use a pipe which was newly acquired since his wound, and which has a mouthpiece of wood, vulcanite, or amber, an inspection of this mouthpiece gives a fair idea of his biting power.

If there has been a loss of bone the matter stands quite differently. The slightest shortening of the arch of course upsets dental occlusion; the jaw is deviated, usually to the injured side, with shortening of the gap. The upper and lower teeth do not oppose each other, and useful mastication is impossible. A prosthesis may be supplied to fill the gap; it bears teeth to take the place of those lacking, and it is fixed to remaining teeth, in front of and behind the gap. As a further means of correcting the displacement, a sliding flange prosthesis may also be fixed to the sound side of his upper and lower jaws (see p. 268). But it is a dreary prospect for the patient to wear an appliance for the rest of his life if a bone graft is feasible. This type of case is eminently suited for grafting.

Let us suppose, then, that for reasons of function it is considered that a patient requires a bone graft; there are several points to be considered, because they affect the prospect of success.

The Condition of the Overlying Soft Tissues.—These may or may not be scarred, fibrosed, inelastic. The most favourable cases as regards this point are those in which the missile entered through the cheek or neck of the opposite side, or in any case at a point remote from the spot where it fractured the jaw, and in which this missile remained either in the mouth or in the tissues of the neck, or was spat out—at any rate, it made no exit wound over the site of fracture. The overlying skin, except perhaps for the small scar of a healed sinus through which sequestra have been removed, will then be normal, and the cellular tissue beneath only slightly fibrosed.

When, however, the missile created a gaping wound at the site of fracture the skin will be scarred, puckered, inelastic, to varying degrees.

In this case the scar will require excision. The surgeon must decide whether simple excision will suffice, with slight undercutting of the margins of healthy skin and suture; or whether the area to be excised is so large, and the tension of surrounding skin so great, that a plastic flap is required.

In the latter contingency the grafting must be delayed until several months after the skin plastic. But in the former case a few weeks suffice; indeed, if the scar be merely linear, with no excessive surrounding tension, it may sometimes be excised at the same time that the graft is placed.

The Richness of the Soft Tissues surrounding the Mandibular Ramus.—This is also of importance. At the lower border of the mandible the mucosa of the buccal floor must, for the success of a bone graft, be separated from the submaxillary skin by a certain amount of muscle or fascia; if the latter have been so far destroyed that skin and mucosa are practically contiguous, there is considerable risk that in dissecting up a bed for the graft the mucosa will be pierced—an annoying accident which entails the abandoning of the operation.

It is difficult to dogmatize as to what is the minimum thickness of submaxillary soft tissues justifying operation, but I should say about $\frac{1}{8}$ inch. The several types of bone

graft (pp. 296 to 300) are likely to require each a different thickness of soft tissues.

A pedicled graft clearly requires a reasonable thickness of these, otherwise there is no pedicle. This was forcibly impressed on my mind in Case Private R., p. 305. In this case only a very thin pedicle was available. This I carefully dissected up after sawing off the graft; but when I arrived at the latter the pedicle came away from it, so that I was left with a free graft.

A free bone graft requires a rather less thickness of soft tissues than a pedicled graft. Even if in the submaxillary region skin and mucosa are practically contiguous, all is well so long as they can be separated without perforating the mucosa. For here no pedicle is wanted; and when the operator arrives at the lower mandibular margin, he can make a more roomy bed for the graft by pushing inwards, with a periosteal elevator, the mucous membrane, which hugs the deep surface of the two extremities of the jaw at the margins of the gap.

A periosteal or osteo-periosteal graft is feasible with a more scanty thickness of soft tissues than either of the other two types. It can be folded in such a way that its own thickness is reduced to a minimum. Moreover, it is pliable, and so will bend wherever the mucosa tends to bulge outwards; and, in fact, it will in a general sense take up the size and irregularities of its bed in a way which is impossible for rigid grafts.

The Situation of the Gap.—A gap very far back, towards and including the angle, is not easy to graft. The posterior vertical fragment is displaced, as a rule, very much upwards and inwards. The dissection to expose it involves cutting through dense masses of granulation tissue, intermixed with muscle, and often parotid gland. When the graft is placed in position it is difficult to maintain good apposition between its posterior end and the lower or anterior end of the posterior fragment; this fragment, as a rule, ends behind the last molar, so that it is not controllable by any splint.

A gap in front of the mental foramen is not in a favourable position for a graft. Such a gap is usually bilateral, crossing the middle line. In these patients the soft tissues of the chin have always been retracted backwards, and will remain in that position and shape unless forcibly altered.

A periosteal graft, of course, exerts no force which could give the chin a protrusion; it follows the line of least resistance, and the chin afterwards remains flat. A solid bone graft may be made with a convexity either by:

1. Cutting a straight graft, and fracturing it in one or two places.
2. Cutting a curved graft out of a long bone.
3. Using a piece of a bone which has a natural curve, such as a rib.

Even when one of these expedients is adopted the convexity of the chin will often be imperceptible by the time the graft is incorporated, because the latter has been rotated upwards or downwards by the pressure of overlying tissues. This is difficult to counteract by any internal or external appliance.

The most favourable situation for a graft is between the mental foramen and the first molar tooth. Here the operator has a flat surface to deal with; and there are often teeth on the posterior fragment for immobilization by a splint. The fracture becomes less favourable for grafting according to its distance in front of, but especially if it lies behind, this site.

The Size of the Gap.—Everything else being equal, the smaller the gap the more likely is restoration of the arch without displacement.

Before the operation is performed, displacement and malocclusion will be corrected by splinting. And since deviation is usually to the injured side, this procedure widens the gap. Moreover, in order to fit the graft on to an actively osteogenetic surface, the ends of the fragments must always be freshened, which involves a slight additional loss. So that if the surgeon expects at operation to fill a gap no larger than it was depicted in a skiagram taken before an appliance was fitted he will be greatly disappointed.

Displacement, and Control of Fragments.—As just now mentioned, the displacement is to be corrected by a firm appliance before operation. The appliance is in the nature

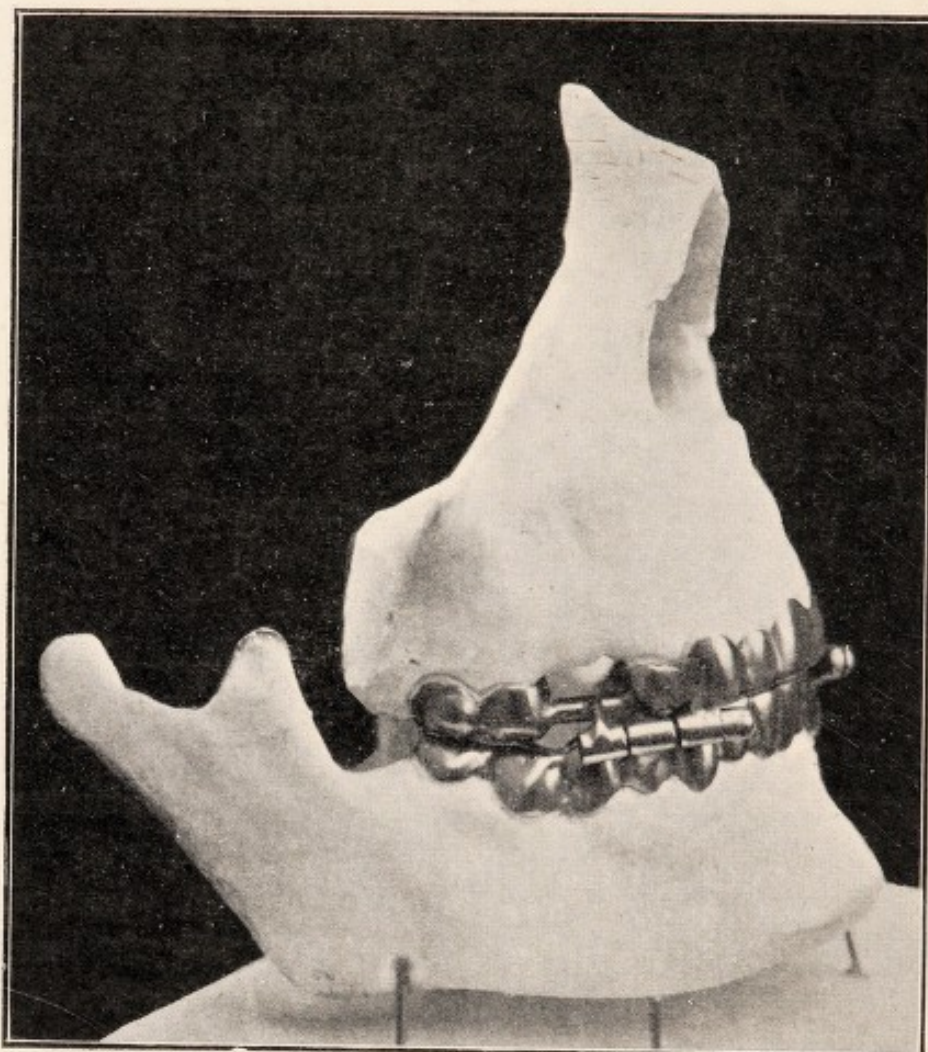


FIG. 113.—Double metal cap-splint, suitable for controlling the fragments of a fractured mandible before, during, and after a bone-grafting operation. The two sections are cemented to the upper and lower teeth two or three days before operation. They are exactly fixed together by a screw-bolt passing through the metal tubes attached to the upper and lower sections, as shown. The mandible may be instantly freed (for instance, at the wish of the anæsthetist during the operation) by unscrewing the bolt. As used at the Queen's Hospital, Sidcup.

of a double metal cap-splint, the upper and lower parts of which are joined and adjusted by removable bolts or screws (Fig. 113).

This appliance fulfils a double purpose. It gives firm

resistance to the broken jaw, preventing it from yielding when sawn or chiselled; and it ensures perfect apposition of the remaining teeth after it has "taken"; that is to say, the apparatus controls the fragments both during and after the operation.

The appliance depends for its stability on the number and condition of the teeth to which it is fitted. So that the patient's remaining teeth become an important factor in success of bone grafting.

Technique.—On this subject very little will be said here, because the reader, if wishful to know all the many details, should consult reports of those who have, during the war, devoted the greater part of their time to this special subject. He will also naturally go and watch their work, from which more will be learnt in an afternoon than from reading for a week.

Here it suffices to give a bare outline of certain cardinal points.

Asepsis.—This is, beyond all argument, as important for this class of work as in any branch of surgery. The preliminary cleansing of patient, surgeon, assistants, and nurses, should be so exacting in detail as to amount to a relentless ritual. And after this stage the same finicking caution should be adopted throughout the operation.

The "Lane" technique—according to which no part of the patient is even touched with the gloved hand or with anything but instruments—is, of course, ideal. This technique requires practice to be acquired; the operator will at first unconsciously use his fingers to take up swabs or to examine the bed which he is preparing for the graft. An additional refinement is to tie all stitches with two pairs of forceps.

Fresh instruments should be taken at various stages of the operation. Those used on the leg should not be used on the face. After making the skin incisions over the mandible, it is best to use other instruments to dissect down to the fracture-ends.

The practice of performing these operations under rectal

oil-ether is followed not only because it provides a satisfactory anæsthesia, but also because the anæsthetist is far away from the patient's head nearly all the time, and so avoids chance contamination. The surfaces surrounding the operation area should be kept covered with sterilized gauze or linen through the whole procedure. As soon as a flap of skin has been turned up the raw surface is to be similarly covered, the gauze being preferably stitched to its edges. The surrounding field is thus entirely cut off, so that nothing but the operation wound is visible.

Rapidity.—The whole operation should be as rapid and expeditious as possible. This is a counsel of perfection, easily upset by any hitch in the proceedings.

Especially should delay be avoided when once the graft has been severed from its parent bone. From this moment as few minutes as possible should elapse before it is laid in its new bed. To ensure rapidity at this particular stage it is necessary that the bed should be prepared. Therefore the operator should have the area for its reception ready before he begins to cut the graft. He should see that the bed is sufficiently large and deep; that the soft tissues are fully rugined off the ends of the bone; that these ends are adequately freshened; and that when wire is used for retention the holes are drilled for it and the wire already looped through them. All these things he should attend to before he turns to the tibia, or whatever bone he uses for the graft.

Splinting.—The immobilization of the mandibular fragments which limit the gap is one of the most indispensable elements of success, for two reasons:

Firstly, without such immobilization it is difficult to secure coaptation of graft to fragments. One of the latter will become drawn out of place, so destroying close contact between diploë of graft and diploë of fragment.

The result is likely to be fibrous union instead of callus.

Secondly, even if apposition of the graft be successfully maintained, this will be in faulty position. The final result will then be that upper and lower teeth lack their normal occlusion. Either the jaw must be refractured and reset

(perhaps by wiring), or, if not, the graft has been, from the point of view of function—which is the chief consideration—a failure. The means of maintaining good position by a double metal cap-splint have already been referred to (p. 290). Case Rifleman R., p. 302, is most instructive as regards immobilization, and seems to show that in the after-treatment the only essential is that the jaws should be kept in perfect position when shut, and may be left uncontrolled during frequent intervals when they are allowed to open.

Fixation of the Graft.—There are many ways of steadying the graft in its bed. Some surgeons who have used bone pins or screws repeatedly speak highly of them. My own experience is too limited to justify an opinion.

Wire of silver or phosphor-bronze may be used for solid bone grafts. In the case of a free graft, the wire should be passed through the ends of the graft as well as of the fragments. In the case of pedicled graft, the wire, having been passed through holes bored in the fragments, need embrace only the edges of the pedicle of the graft; this plan is quite satisfactory. I have not yet found it necessary subsequently to remove the wire from a grafted mandible. Thick cat-gut may also be used for solid grafts, and is the only useful form of fixation for periosteal grafts. A stitch is passed through fascial tissues (taking care not to perforate the oral mucosa), once above and once again below the bed where the graft is to lie. The length of the stitch is transverse to that of the graft, and between the two points where the stitch is threaded through the connective tissue it forms a free loop. From one to four such stitches are passed. The graft is insinuated beneath the loops; the ends of the stitches are then brought together across the graft and tied. The result is that each stitch forms a double arch across the graft, and the fascial connective-tissue bed is drawn round the graft so as to encircle its upper and lower edges.

Sewing up the Wound.—In introducing a free graft of solid bone or of periosteum the incision is made close to the lower mandibular margin. The flap of soft tissues elevated has no great width, and therefore the raw area which can sup-

purate is small. Accordingly the incision may be entirely closed. But in performing a pedicled bone graft the flap which is raised has its lowest limit anywhere between the levels of the upper and lower borders of the thyroid cartilage.

When this flap is replaced its deep surface comprises a much larger raw area available for sepsis or a hæmatoma. For such it is wise to leave two very small drainage openings, formed by two plaits of three or four strands of salmon-gut. These emerge at opposite points of the incision, and allow serum to drain out; one may be removed after twenty-four, and the other after forty-eight hours.

Difficulties and Hindrances in Technique.

There are many possible occurrences to interfere with the success of a bone-grafting operation, and, as has already been mentioned, any hindrance which occurs after the separation of the graft from its parent bone is especially to be prevented if possible. For this introduces delay in fixing the graft in its new bed, and we believe this delay to be injurious to the delicate osteogenetic cells.

The anæsthetist may have difficulty in maintaining the air way, the two jaws being splinted together. This may necessitate unfastening the bolts which join the two sections of the splint (see p. 290, Fig. 113), which may be a serious matter if it happens late in the operation. Similarly the splint may require releasing for post-anæsthetic vomiting.

The possibility that for any such reasons it may be necessary to release the lower from the upper jaw absolutely interdicts the use of a splint in which upper and lower sections are immovably fixed together, for then the only way of releasing the mandible is to break the cement on the lower teeth. This happened in the case of Private C. (see p. 311). The two sections of splint should be joined by removable bolts or screws.

Among other advantages of rectal oil-ether, it is rare for the anæsthetist to have to interfere with the operation; and post-operative vomiting is also apparently unusual. But it must be remembered that the proportion of ether absorbed

from the rectum varies in different subjects; and although the anæsthetist can use his judgment as to the amount of ether administered, he cannot control the proportion absorbed.

The variability of this factor probably accounts for the differences in the post-operative condition of patients. While some recover rapidly, others have a running pulse and other signs of collapse for twelve or more hours subsequently, during which time we must suppose that there is a constant absorption of ether.

In such cases the patient's breath smells strongly of the anæsthetic as long as he remains collapsed. So it seems possible that this form of administration might conceivably be responsible for an ether bronchitis or pneumonia.

Now on p. 307 I shall relate a case who eventually died of pneumonia and empyema, and on whom the rectal oil-ether method had been used. And it is there claimed that the anæsthetic cannot be inculpated; but I make this claim, not only (for reasons just given) on the grounds that the anæsthetic was administered by the alimentary canal instead of the respiratory tract, but chiefly on account of the long period (six days) of perfect health following the operation.

The force used in clearing and freshening the bone fragments may result in the lower splint breaking away from its cemented union to the teeth, or in a fresh fracture of the mandible. Great care will naturally be exercised. But despite extreme gentleness, it is often difficult to avoid one or other of these accidents when using a chisel or saw. The freshening of the fragments may usually be effected with bone forceps, which exert less of a jerk than a chisel and less pressure than a saw. But in forming a pedicled bone graft some form of saw—either a hand-saw or one of those electrically driven, such as Albee's—is essential.

If the lower splint becomes uncemented during the operation, it should be refixed about the third or fourth day.

In making a pedicled graft it is easy to tear the pedicle away from the bone, especially if the former be very thin (see p. 305).

In the various stages through which a mandible passes

after bone grafting, the evidence afforded by skiagraphy is helpful as regards alignment and occlusion of jaw and teeth; while, as regards the viability of the graft, its evidence is indispensable. Nevertheless, any temptation to have skiagrams taken at short intervals must be resisted, because it is considered probable that the rays destroy the vitality of the delicate osteogenetic cells. Once every six or eight weeks is sufficient for skiagraphy to indicate progress.

The Various Methods of Bone Grafting the Mandible.

These are all of one of the following types, of which examples will be given below. For details textbooks should be consulted.

1. **The Free Solid Bone Graft.**—A piece of bone is taken from the internal subcutaneous surface of the tibia; less often from the crest of the ilium or a rib.

Let us suppose the tibia is used. A crescentic flap of all tissues except periosteum is raised, having its base on the anterior tibial border and its maximum convexity just reaching the flexor muscular mass. The flap is raised from the middle of the length of the tibia. The length of the flap exceeds that of the desired graft by 3 inches.

The length of the graft has been decided beforehand by accurate measurement. In width it should be $\frac{1}{2}$ to $\frac{5}{8}$ inch.

Bearing in mind these dimensions, which bound a rectangular parallelogram, the periosteum is incised all around this area.

The periosteal incisions are made parallel to what will be the sides and ends of the graft, but outside them by $\frac{1}{8}$ to $\frac{1}{4}$ inch. Thus the periosteal incisions also describe a rectangular parallelogram, but of a larger size than that of the intended graft; so that the periosteal area includes a margin which encloses the graft.

This periosteal margin is now rugined inwards off the bone all around its boundaries; so that when the graft is eventually removed it has a cuff of periosteum.

The bone itself is cut with a circular saw or chisel, or both.

If a saw is used it may be driven by a dental engine or electro-motor. The modern sets of bone-grafting instruments include twin circular saws; these, which may be set at any desired distance apart, make simultaneous and parallel cuts. The ends of the graft are cut through with a smaller, single circular saw, or a chisel.

A convenient plan is to begin cutting all four margins with saws, and complete the deeper parts of the cuts with a chisel. But the use of a chisel tends to fracture the graft, either transversely or parallel to the tibial surface.

A transverse fracture is not necessarily a disadvantage. If the jaw fragments are efficiently immobilized, the splint firmly fixed in place, and the periosteum uniformly attached to the graft, this will keep its shape and position despite one or two transverse fractures. Indeed, such fractures may even be an advantage, in that they set free more osteogenetic cells, and throw open a larger callus-forming surface. Guided by this idea, some operators go so far as deliberately to drill several holes partly through the graft.

A fracture parallel to the tibial surface, on the other hand, is probably detrimental, for it results in a thinner graft. A thin piece of cortical bone is left behind, and, of course, the medulla is not reached.

This is to be deprecated, on the well-founded hypothesis that the cortical cells immediately abutting on the medulla are actively osteogenetic, and that it is therefore desirable that the graft should bring away with it a very thin layer of marrow.

The graft is now transplanted to its new bed, and fixed there, periosteum outwards.

2. The Periosteal, or more correctly named Osteo-periosteal, Graft.—A quadrilateral area of periosteum is marked out on the tibia as in Method 1 above.

With a mallet and a chisel this periosteum and about $\frac{3}{8}$ inches of underlying cortical bone is elevated over this area.

In detaching the graft the bone usually fractures in several places; this is immaterial, since the attached periosteum holds together the mosaic of bone beneath; moreover, on

the principle that it is an advantage to multiply callus-forming surfaces and scatter small masses of osteogenetic cells, these fractures are to be encouraged even to the extent of comminution.

The graft is removed, rolled on itself with periosteum outwards, transplanted, and fixed. On the tibial wound there are a few scattered slivers of cortical bone left lying. These are utilized by scattering them along the outer surface of the graft.

3. **The Pedicled Bone Graft.**—A **U**-shaped flap (of skin only) is raised from the submaxillary region. The graft consists of only a part of the width of the anterior or posterior fragment; this is sawn off for the necessary length from its alveolar border. From each end of the graft an incision is made through platysma and other muscular and fascial tissues down to the lowest points of the original **U**-shaped skin flap. The pedicle is raised down to this lowest point. The graft is shifted so as to fill the gap in the mandible, and fixed there.

For manipulating a pedicled bone graft while everting it to dissect up the deep surface of the pedicle a pair of angular forceps may be used to hold the bone. These forceps bear sharp spikes (like those in the soles of running-shoes). The holes made by these little spikes in gripping the bone are liable to the same favourable criticism as made above when speaking of fracturing and drilling a graft (p. 297); they set free actively osteogenetic cells. The flap is now replaced and stitched.

It will be noticed that this type of operation is founded on simple physiological principles. The graft is never completely separated from its vascular supply. And at the conclusion of the procedure the patient's condition much resembles that of a man afflicted with a double fracture of one horizontal ramus, and with no bony loss at either site of fracture.

The technique of a pedicled bone graft is less easy of execution than it is on paper. The special points of difficulty characterizing this form of grafting operation are,

firstly, making the short vertical end-cut in the bone which mobilizes the graft. A very small saw must be used, otherwise it is impossible to avoid either injuring the submaxillary soft tissues by cutting too low down, or carrying the saw-cut unduly high into the alveolar margin by cutting too high up. A chisel transgresses the narrow bony operation field less than a saw. But a chisel is even more likely than a saw to

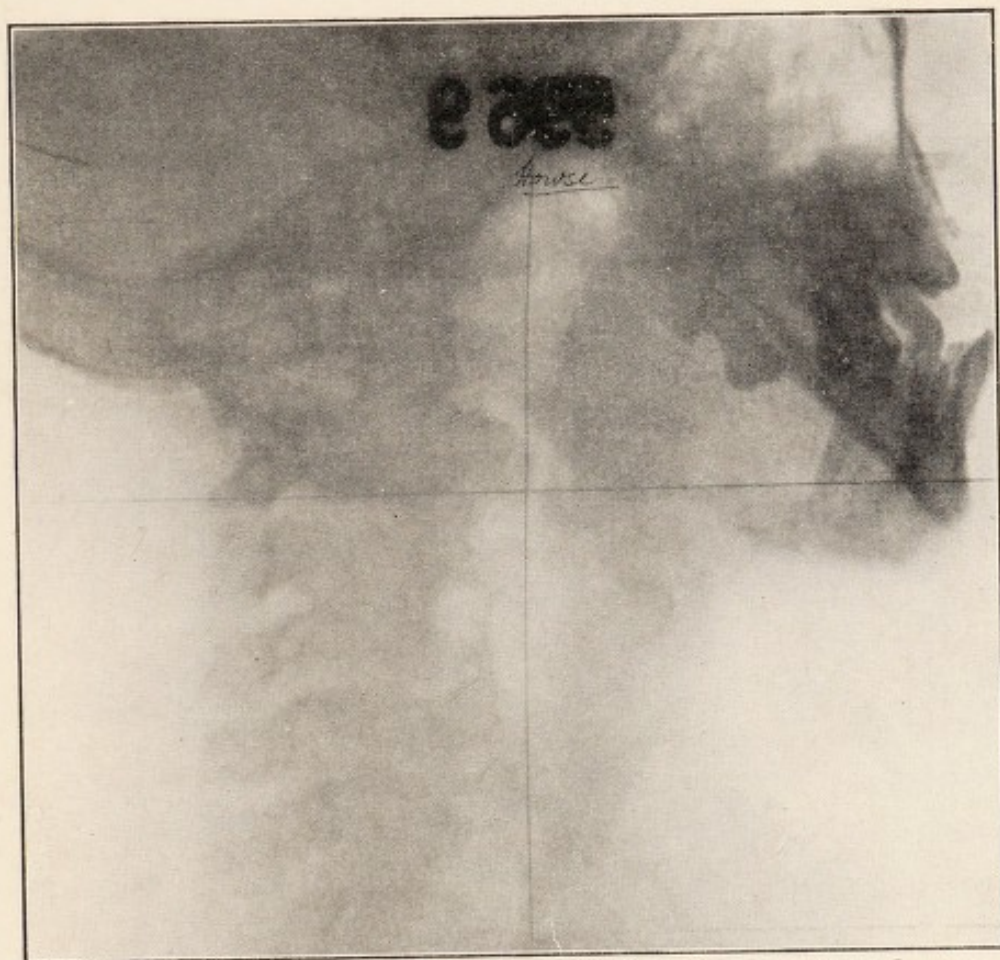


FIG. 114.—Private H. Fracture with comminution of both horizontal rami of the mandible.

cause a common accident—fracture of the splint cement, and forcible disarticulation of splint from upper or lower teeth. This accident is exemplified in the case of Private C. (p. 311).

The second probable difficulty lies in dissecting the pedicle at its uppermost part in such a way as to leave it sufficiently bulky to carry a reasonable blood supply to the graft, and yet avoid penetrating the mucous membrane of the mouth. In attempting to reconcile these two essential conditions the

pedicle may partly or wholly come away from the graft. In this case it is best to discard the latter and take a tibial graft. Case Private R., Fig. 120, p. 305, exemplifies a case in which it was necessary to fall back on this resource.

Tibial Grafting.—Private H. Shrapnel wound of jaw.

The first skiagram (Fig. 114, p. 296) shows extensive comminution of both horizontal rami of the mandible. The left



FIG. 115.—Private H. Whole-thickness tibial graft, twenty-six days after its insertion in the mandibular gap.

side eventually united by firm callus. A gap of 1 inch remained in the right horizontal ramus, midway between the symphysis and the angle.

Operation, June 24th, 1918.—Anæsthetic, oil-ether *per rectum*. Immobilization by upper and lower metal capsplints cemented on to the remaining teeth. Graft from tibia (whole thickness of bone, to medullary cavity). Fixation by catgut sutures through fascial bed (see p. 293).

Three weeks later a small sinus, oozing very thin pus, appeared in the external suture-line.

Skiagram (Fig. 115, p. 300), twenty-six days after operation, shows the graft in good position; and, despite the sepsis, there is so far no evidence of rarefaction.

The mild degree of suppuration steadily diminished, and six weeks after the operation the flow was intermittent, slight, and serous, not purulent.

October 11th (fourteen weeks after operation).—The graft feels quite strongly incorporated, but very slight movement



FIG. 116.—Private H. Fourteen weeks after the insertion of a free tibial graft. Position is good. Although a dry sinus is still present, there is no visible sequestrum to correlate with this sinus.

is obtainable on firm palpation. The sinus is still present, but no pus or serum emerges, nor can any be obtained by pressure. The probe detects in one small area bare bone.

The skiagram taken to-day—October 11th—(Fig. 116, p. 301) shows a healthy graft, with no bony absorption.

Function and apposition of teeth are good.

Probably there is fibrous union with a small superficial area of sequestration.

Osteo-periosteal Bone Graft.—Rifleman R. Wounded October 14th, 1917.

The skiagram showing condition before grafting is, unfortunately, missing; but the subsequent skiagrams illustrate the important points.

There was a gap of $\frac{5}{8}$ inch in the right mandible 1 inch in front of the angle; there were no remaining lower teeth on this side.



FIG. 117.—Rifleman R. Twelve weeks after osteo-periosteal graft. Good position and firm union.

Operation, June 3rd, 1918.—At the last moment it was found that, owing to some hitch in the arrangements, only the upper half of the metal cap-splint had been cemented to the teeth. The lower half, fitting the teeth on the left side, had not been cemented. I believe this oversight was due to an error of my own.

But the anæsthetic, rectal oil-ether, had been given for

half an hour before the mistake was discovered. The operation was proceeded with.

There was a radiating stellate mass of scar tissue below the mandible; this was excised at the same time that the grafting operation was performed. A tibial osteo-periosteal graft was used. The graft, $2\frac{1}{2}$ inches long, was rolled on itself as a sleeve, bony surface inwards, and laid across the gap, overlapping the freshened ends of the fragments by



FIG. 118.—Rifleman R. Sixteen weeks after osteo-periosteal bone graft. Firm union.

nearly an inch fore and aft. Fragments of bone were also placed on the surface of the periosteal sleeve over the site of the gap. Fixation was attained by three loops of thick catgut, inserted as described on p. 293.

Result.—Primary union.

Skiagram, August 24th (Fig. 117), twelve weeks after operation, showed good position and firm union.

Skiagram, September 25th (Fig. 118), sixteen weeks after

operation: Excellent alignment. Firm bony union. Perfect apposition of upper and lower jaws.

Skiagram, December 3rd (Fig. 119), twenty-six weeks after operation: The graft is incorporated in the jaw. Clinically, result also is excellent.

Commentary.—From the moment of operation the lower jaw had free movement, since its teeth were never cemented to the splint. Therefore there was nothing to preserve dental apposition when the mouth was open; but on closing the mouth the lower teeth had perforce to close into the lower cap-splint. So that the teeth were compelled to *bite into* perfect apposition.



FIG. 119.—Rifleman R. Twenty-six weeks after grafting. The graft has become incorporated. Clinically the union is rigid.

On reflection I found this result, as regards apposition, less remarkable than at first sight it seemed, because there had at the outset, before the grafting, been no gross lateral deviation beyond the patient's control. Nevertheless, the success of this ruse, which was the outcome of the accidental unreadiness of the splint, led me to try it deliberately in another case (Private C., p. 310), in which it was equally satisfactory.

Private R. Wounded.

Skiagram, July 20th, 1918, shows a gap $\frac{3}{4}$ inch long from the symphysis to the right mental region (Fig. 120). The free end of the anterior (left) fragment consists for its first

$\frac{1}{2}$ inch of a separate rounded fragment, whose size is barely $\frac{1}{2}$ inch in each diameter; this is united to the anterior fragment by fibrous tissue only. The anterior $\frac{3}{4}$ inch of the posterior fragment consists of a bar only $\frac{3}{16}$ inch square in section. The total thickness of soft tissue between mouth cavity and skin of cheek was barely $\frac{1}{4}$ inch.

Operation, July 29th, 1918.—A pedicled bone graft was attempted.



FIG. 120.—Private R. Gap in region of symphysis and right mandible, before insertion of osteo-periosteal bone graft.

The graft was taken from the posterior fragment, and comprised its anterior narrow prolongation and a small piece of bone behind this.

The pedicle, when dissected up, was so thin that the portion of bone sawn off came away as a free graft.

This was therefore discarded, and the gap was filled by an osteo-periosteal graft from the left tibia. Before fixing the graft in its bed the anterior surface of the small free rounded piece of bone, which formed the extremity of the anterior (left) fragment, was freshened. The necessity of

prolonging the graft over the anterior surface of this anterior (left) fragment caused the graft to extend well to the left of the symphysis, instead of being, as had been expected, a graft of the right side only. The later skiagrams were accordingly taken in the antero-posterior position. Fixation was obtained, as in the previous case, by heavy catgut loops (see p. 293).

Skiagram, August 14th (Fig. 121), two weeks after operation, shows the newly forming bone across the symphysis.

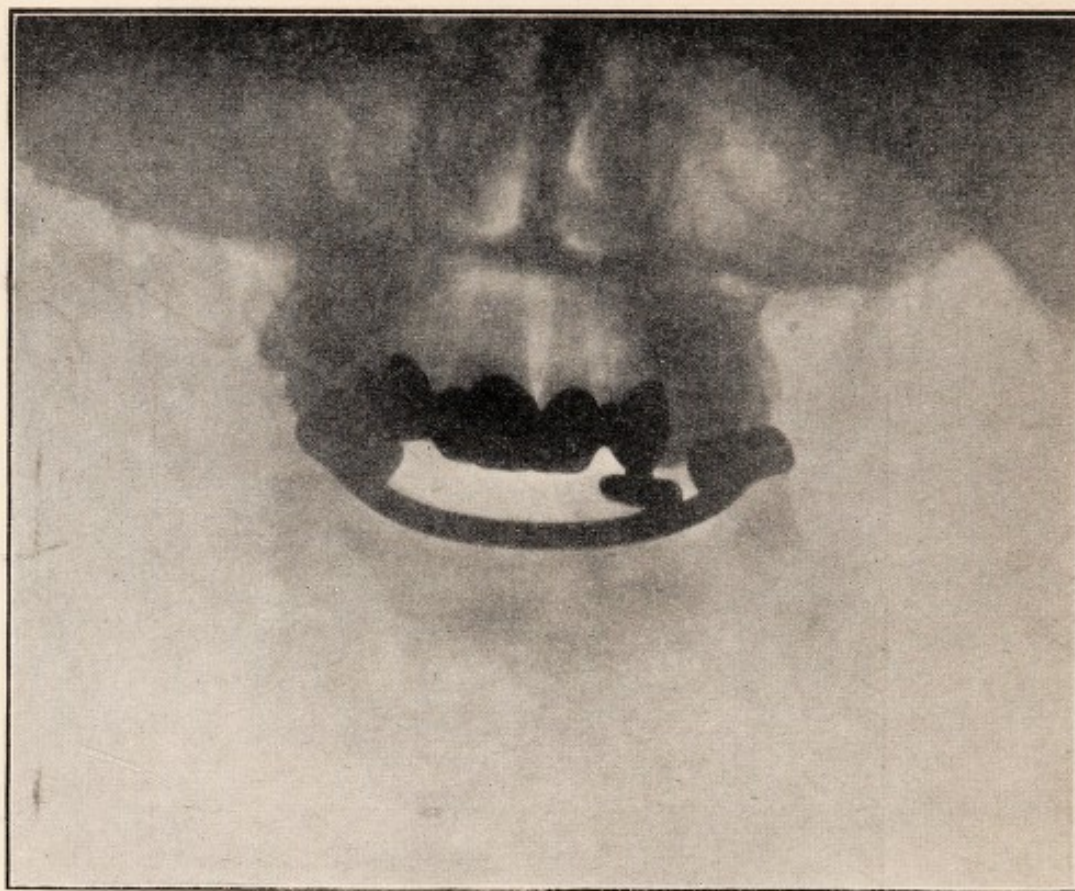


FIG. 121.—Private R. Two weeks after osteo-periosteal bone graft 4 inches long across symphysis, from premolar to premolar. The new graft (or bone) casts a distinct shadow.

Skiagram, October 21st (Fig. 122), twelve weeks after operation, shows a uniform bony bar, with faint areas of slight rarefaction. On removing the splint the bone was found to be firm and thick. There was immovable bony union on the right; on the left side (anterior end) of the grafted area there was possibly very slight yielding of the junction when firm bimanual pressure was made. The union here may be only fibrous, or very young callus. The

whole was considered by the dental department to be quite thick and strong enough to take a permanent denture.

Commentary.—In this case I intended to perform a pedicled graft, but was compelled, by the circumstances related above, to select the osteo-periosteal method.

Pedicled Bone Graft.—Private R.

In this distressing case the patient died seven weeks after the operation. As will be seen from the history set out

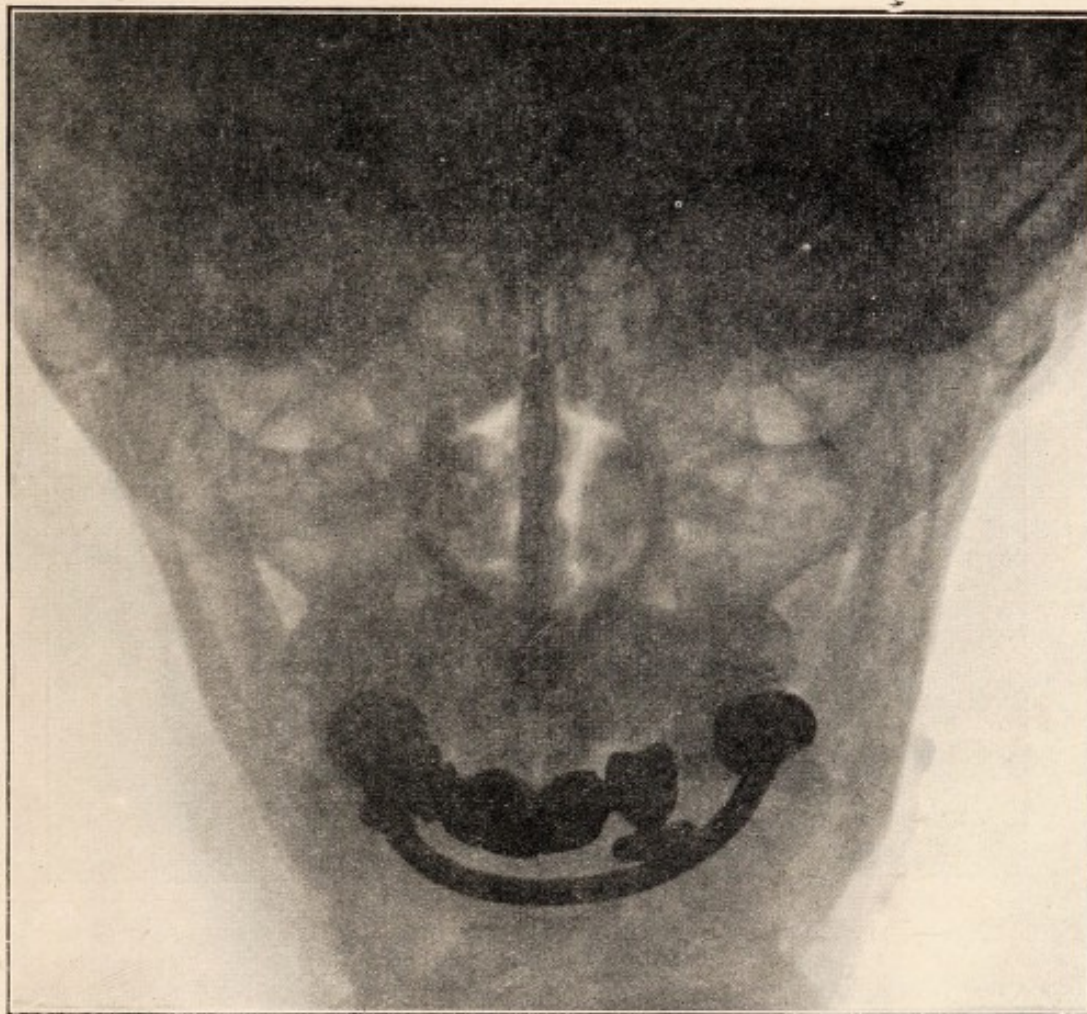


FIG. 122.—Private R. Twelve weeks after the placing of an osteo-periosteal graft a stout bar of bone has formed.

below, it is difficult to correlate the operation with his death. And although he died of pneumonia and empyema, it is equally difficult to regard the anæsthetic as responsible, for he remained well until the sixth day after the operation. And the anæsthetic was not given by inhalation, but *per rectum* (see p. 295).

Under the circumstances, the chief interest from a bone grafting point of view lies in the changes undergone by the graft during the seven weeks which the patient lived. So I am publishing only two illustrations—one a photograph, and the other a skiagram—of the mandible, which was removed at autopsy.

The patient was wounded on October 9th, 1917, suffering a fracture of the right mandible. There was here a gap measuring $1\frac{3}{4}$ inches from the level of the canine tooth backwards.

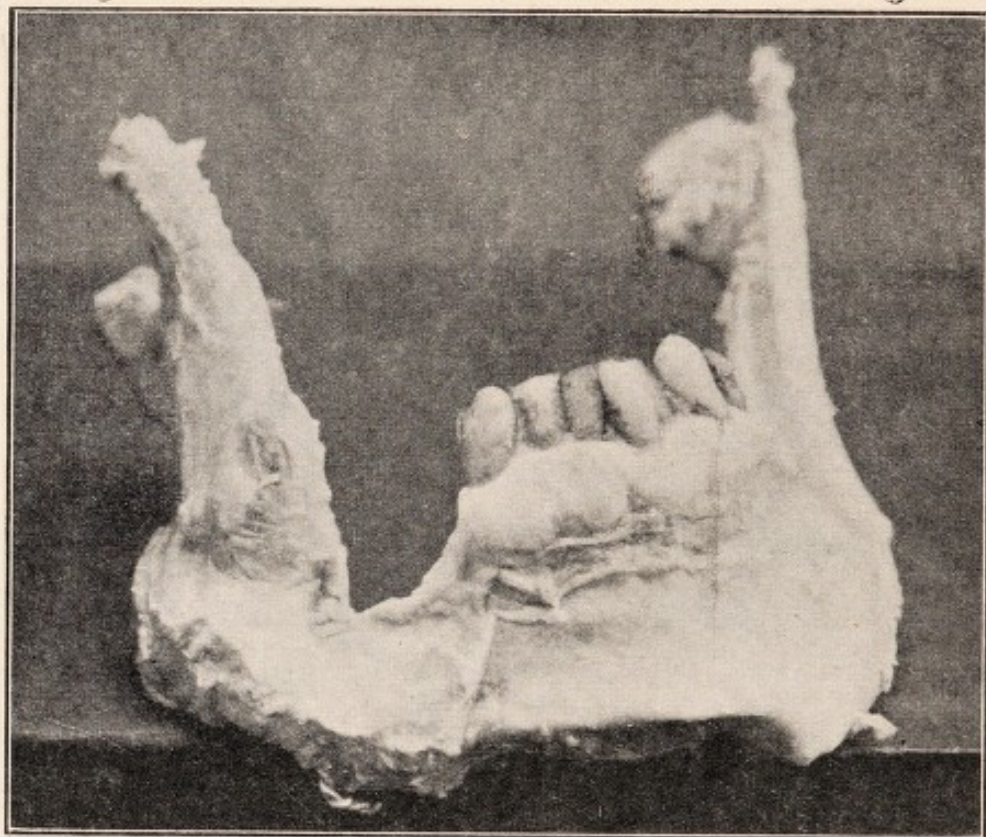


FIG. 123.—Private R. The mandible removed at autopsy, seven weeks after a pedicled bone grafting operation.

Operation, July 1st, 1918.—The jaws had two days previously been splinted in closed-bite position.

A pedicled bone graft was taken from the lower border of the anterior fragment. The ends of fragment were slightly cut away until bleeding diploë was exposed.

Apposition was maintained by silver wire, which was passed through both of the free ends of the mandible, through the ends of the graft, and also through its pedicle. Drainage by two fine tubes, one removed after twenty-four, the other after forty-eight hours.

The skin incision healed by first intention.

July 6th.—General malaise; temperature 99° .

July 7th.—Cough; doubtful signs in chest.

July 8th and onwards.—Temperature fluctuated from 99° to 103° , pulse from 104 to 120. Respiration averaged 34. Very little wasting. Breath foul; not much sputum. Physical signs suggested fluid at left base, confirmed by skiagram. Acupuncture and aspiration of the chest yielded no result.

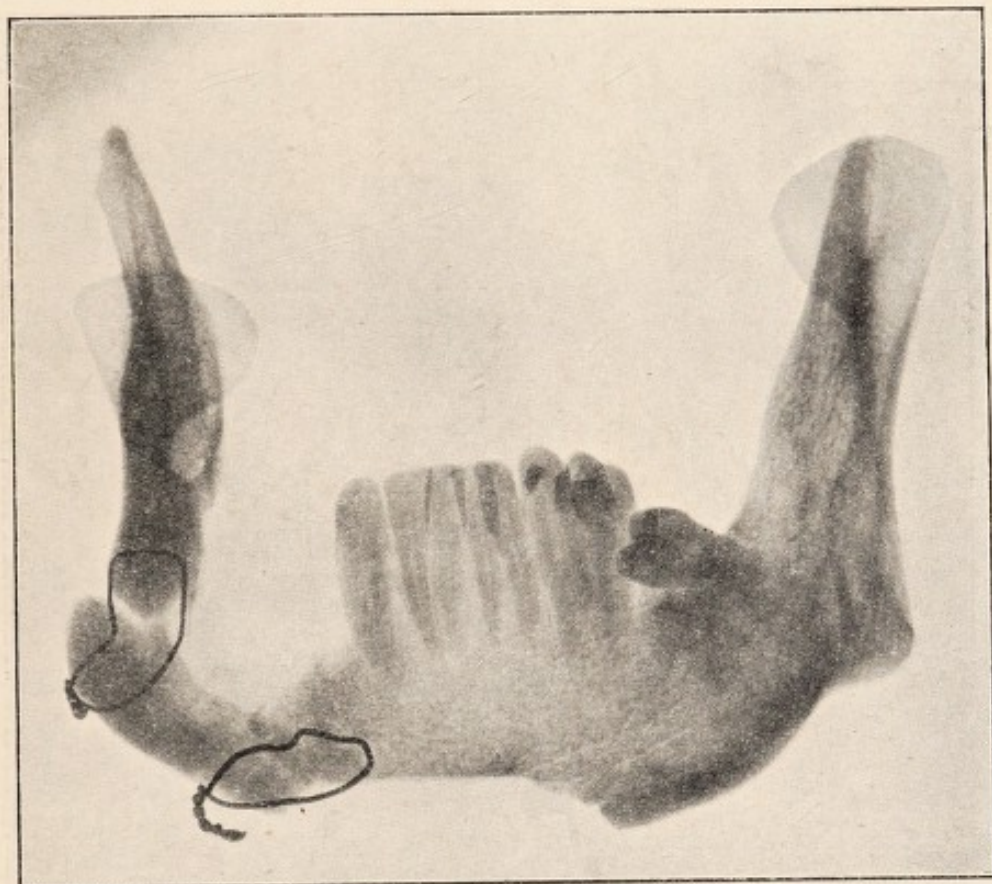


FIG. 124.—Private R. The skiagram shows that seven weeks after a pedicled bone-grafting operation, the anterior end of the graft had synostosed, but the posterior junction was of fibrous tissue only.

August 6th.—Six ounces of foul pus aspirated from left side.

August 8th.—Large empyema (left) evacuated by Lieut.-Colonel Newland, D.S.O.

For the few days following there were persistent signs of pneumonia and (?) fluid in the pleura, on the right side.

August 17th.—Aspiration of right pleura; only a little frothy blood obtained.

August 19th.—Died.

Autopsy.—The lower two-thirds of the left lung was gangrenous. The right lung was solid (red hepatization). There were no peribronchial abscesses.

The Jaw.—The anterior end of the graft had joined by callus, as yet feeble; the posterior end by fibrous tissue only. The whole was firmly fixed (Figs. 123, 124).

Private C. Shrapnel wound of the jaw, October 5th, 1917. September, 1918.—The skiagram (Fig. 125) shows a gap

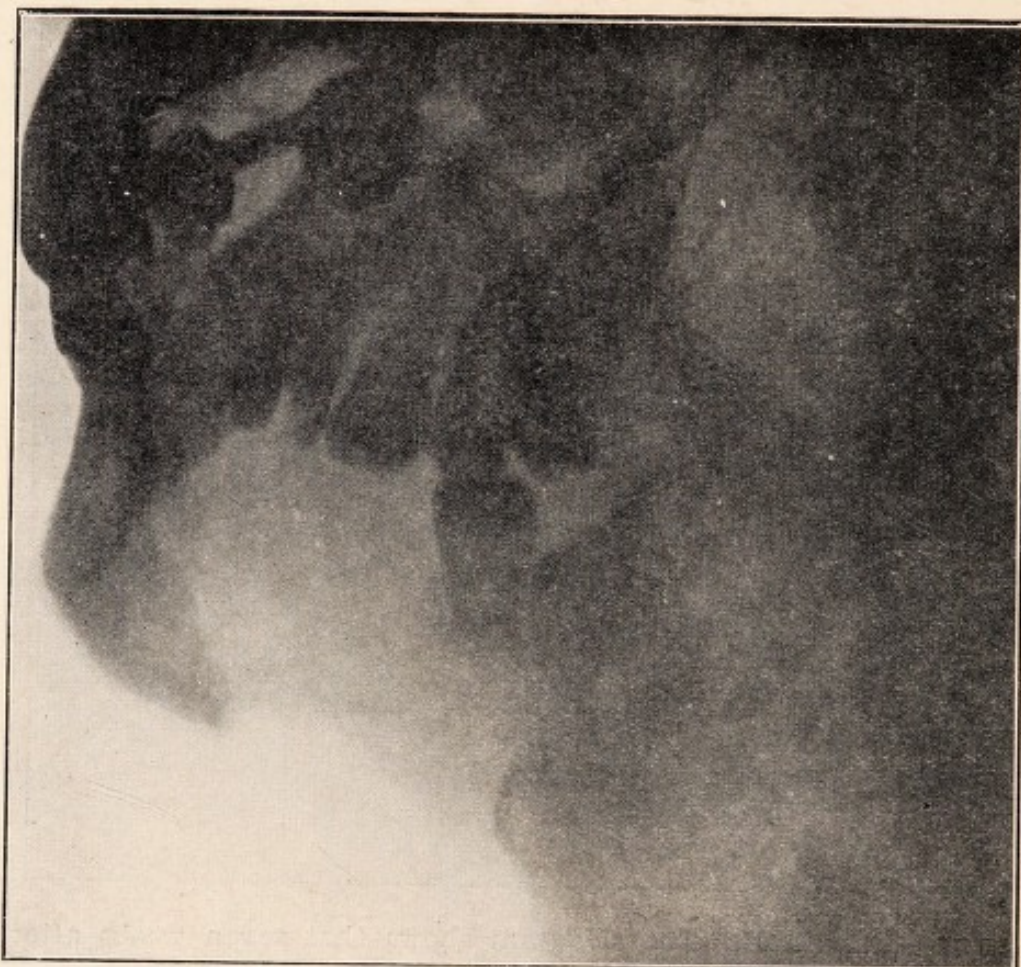


FIG. 125.—Private C. Gap in left mandible, before insertion of pedicled bone graft.

2½ inches long on the left side, extending backwards from the region of the mental foramen. The posterior fragment is much drawn upwards and inwards.

September 16th.—Teeth on the upper jaw of the right side and in front were cemented to the upper half of a double metal cap-splint, fixed together by two screw-flanges. The lower (right) teeth were not cemented into their cap-splint, but allowed to close or open freely.

Operation, September 18th.—Rectal oil-ether anæsthesia. A pedicled bone-graft operation was performed, and the special features were as follows:—

There was no means of immobilizing the posterior fragment; so that saw or chisel could not be used on it. Consequently the graft had to be taken from the anterior fragment.

In the skin of the left submaxillary region there was a large patch of unhealthy scar tissue. It was therefore

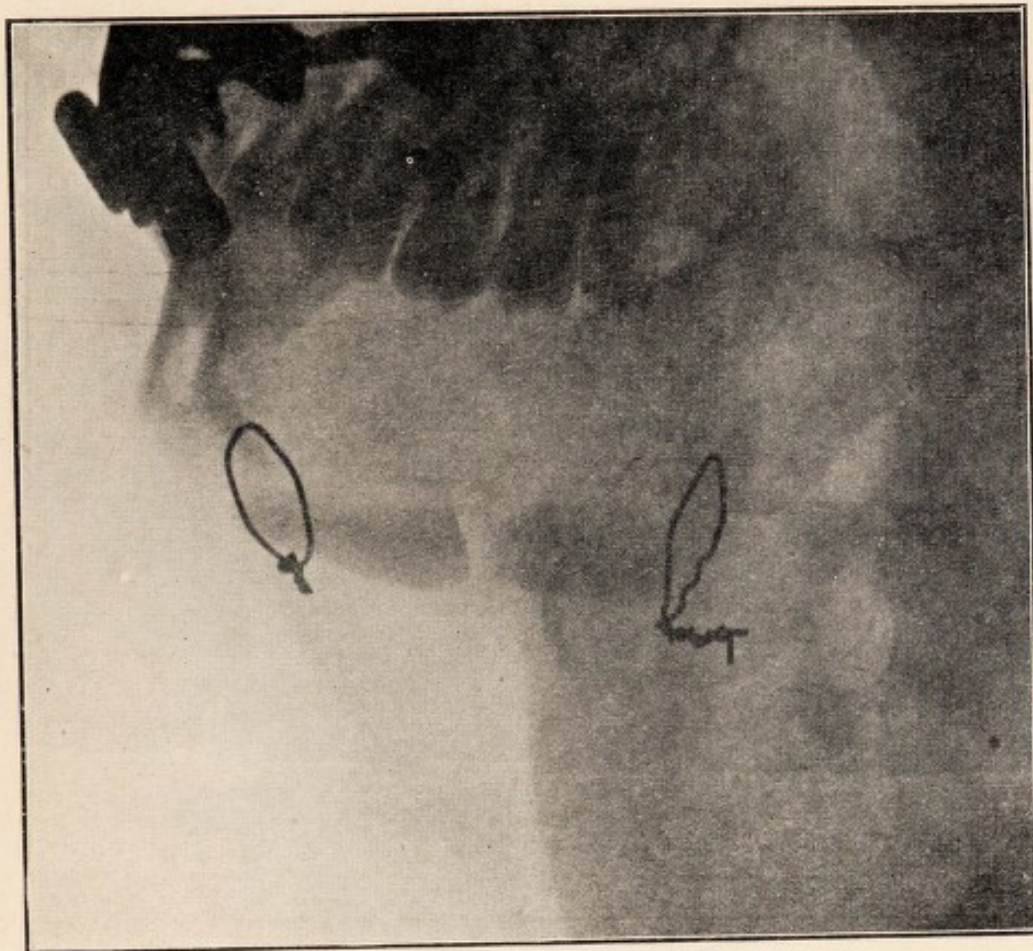


FIG. 126.—Private C. The graft is in good position.

necessary to avoid this cicatrix by carrying the incision for the U-shaped skin flap much lower down than usual; its lowest point reached to below the Pomum Adami. Moreover, since the graft would have to be taken from the symphysis region, the flap had to extend far over to the right side. It was difficult to dissect up so large a flap without buttonholing the scar-tissue.

In sawing off the graft the upper splint became uncemented.

When the graft bone had been sawn off and the pedicle dissected out, the graft so produced had, of course, the curve of the symphysis. In order to make it flat to lie in the gap it was sawn through as far as the external periosteum.

Retention was maintained by silver wires passed through the ends of the fragments, and through the edge of the graft pedicle, but not through the graft itself. To strengthen the pedicle opposite the centre of the graft, where it had been deliberately sawn and fractured, one thick catgut suture was

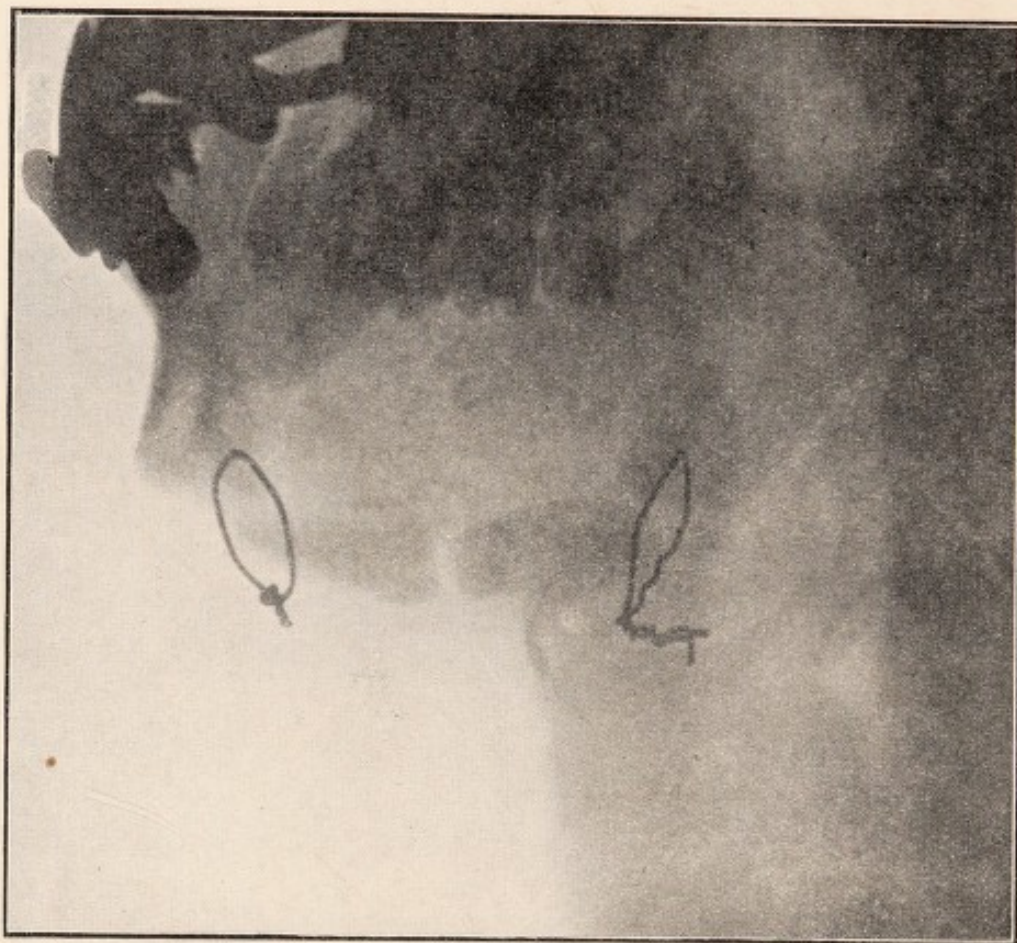


FIG. 127.—Private C. Nine weeks after operation. All four ends of the graft are slightly rounded, suggesting slight absorption. (See text.)

inserted, embracing $\frac{1}{2}$ inch of pedicle just below the lower border of the graft; otherwise the tension on the two ends of the graft might have torn the periosteum, which was the only structure to prevent the two halves of the graft from coming asunder.

Drainage was obtained by two fine tubes, one removed after twenty-four and the other after forty-eight hours.

October 1st, 1918 (thirteen days after operation).—*Skiagram* (Fig. 126): Graft in excellent position.

November 18th, 1918 (nine weeks after operation).—Judged by bimanual palpation, there is only fibrous union; this is true of both ends of the graft, and probably also of its fractured centre.

Skiagram (Fig. 127): The appearances are much as on October 1st (Fig. 126). The position is excellent, but there

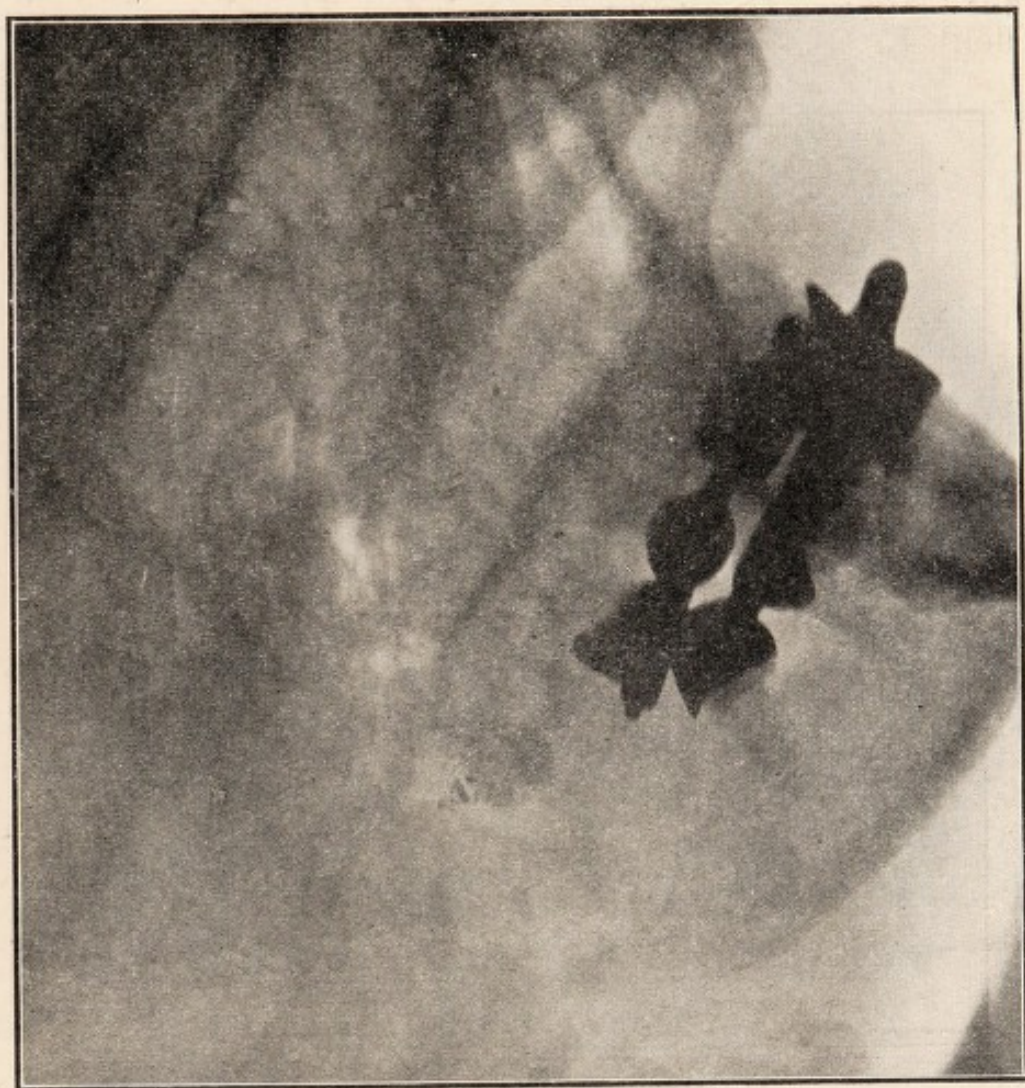


FIG. 128.—Sergeant J. From the right angle forwards, for half an inch, there is a gap in the mandible.

is no bony union. But careful inspection shows that all four ends of the graft (*i.e.*, not only where it abuts on the fractured jaw, but also in its divided centre) are more rounded than on October 1st (Fig. 126). This suggests slight absorption, and raises the question as to whether the creation of two extra fracture surfaces (in the centre of graft) has not taxed osteogenetic activity too highly.

The next day, November 19th, the lower cap splint was, for the first time, cemented on to the teeth (right).

The reason for this was as follows:

In the case of Rifleman R. (p. 302), the lower splint had never been cemented to the teeth. For the whole period of union of the graft, therefore, the position of the lower jaw was uncorrected whenever the mouth was open, and only controlled by its teeth being forced to bite into

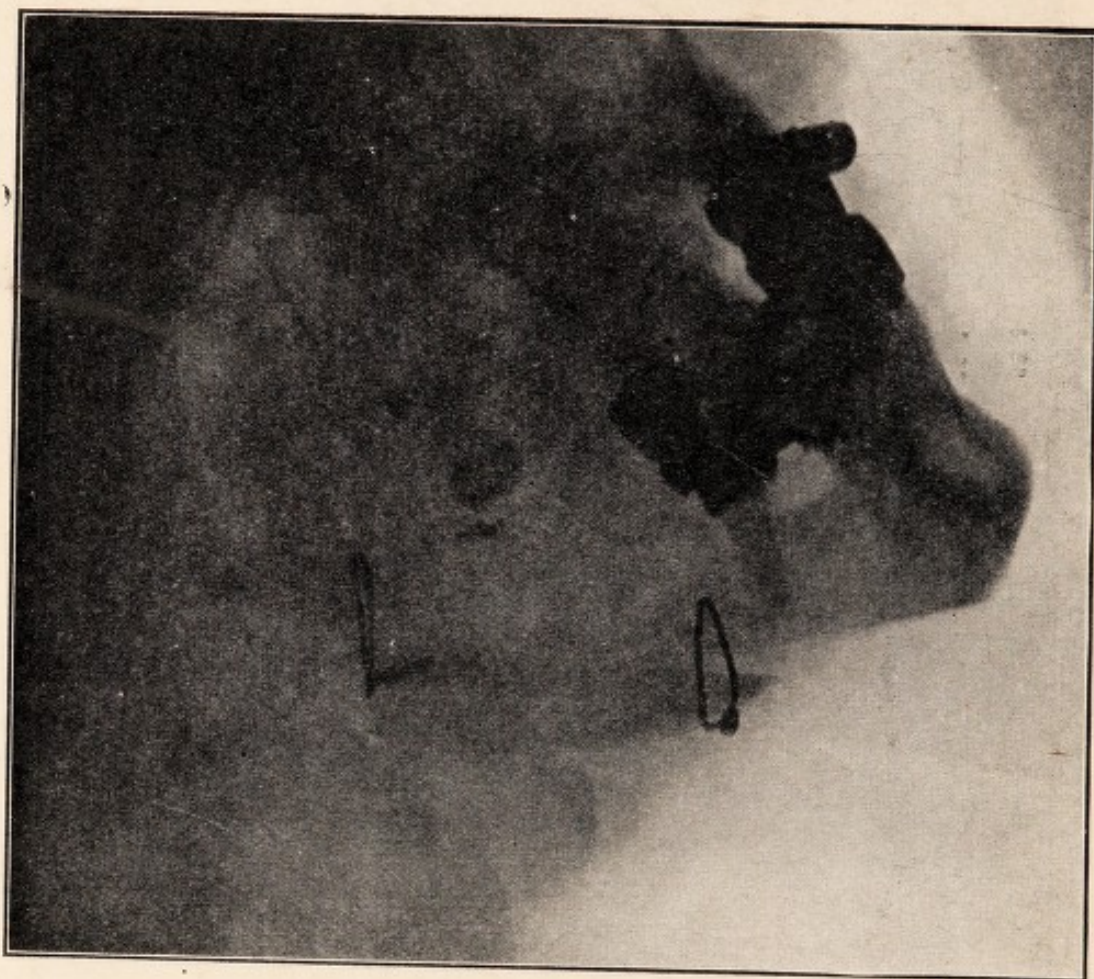


FIG. 129.—Sergeant J. Three weeks after pedicled bone-grafting operation. Graft in good position.

the splint when the mouth was closed. And the result was good.

In the present case I was attempting to profit by this previous experience by leaving the lower jaw free.

But now, nine weeks after the operation, since there was no bony union, it seemed wiser to cement the lower teeth into place. Before doing so I was satisfied that biting power was excellent.

Sergeant J. Wounded November 6th, 1917.

Skiagram (Fig. 128), July 23rd, 1918, shows a gap in the right mandible $1\frac{1}{2}$ inches long, extending forwards from the right angle of the jaw. Fixation of the posterior fragment was therefore impossible. An upper and lower metal cap-splint was cemented on to the remaining teeth, fixing the jaws in closed-bite position.

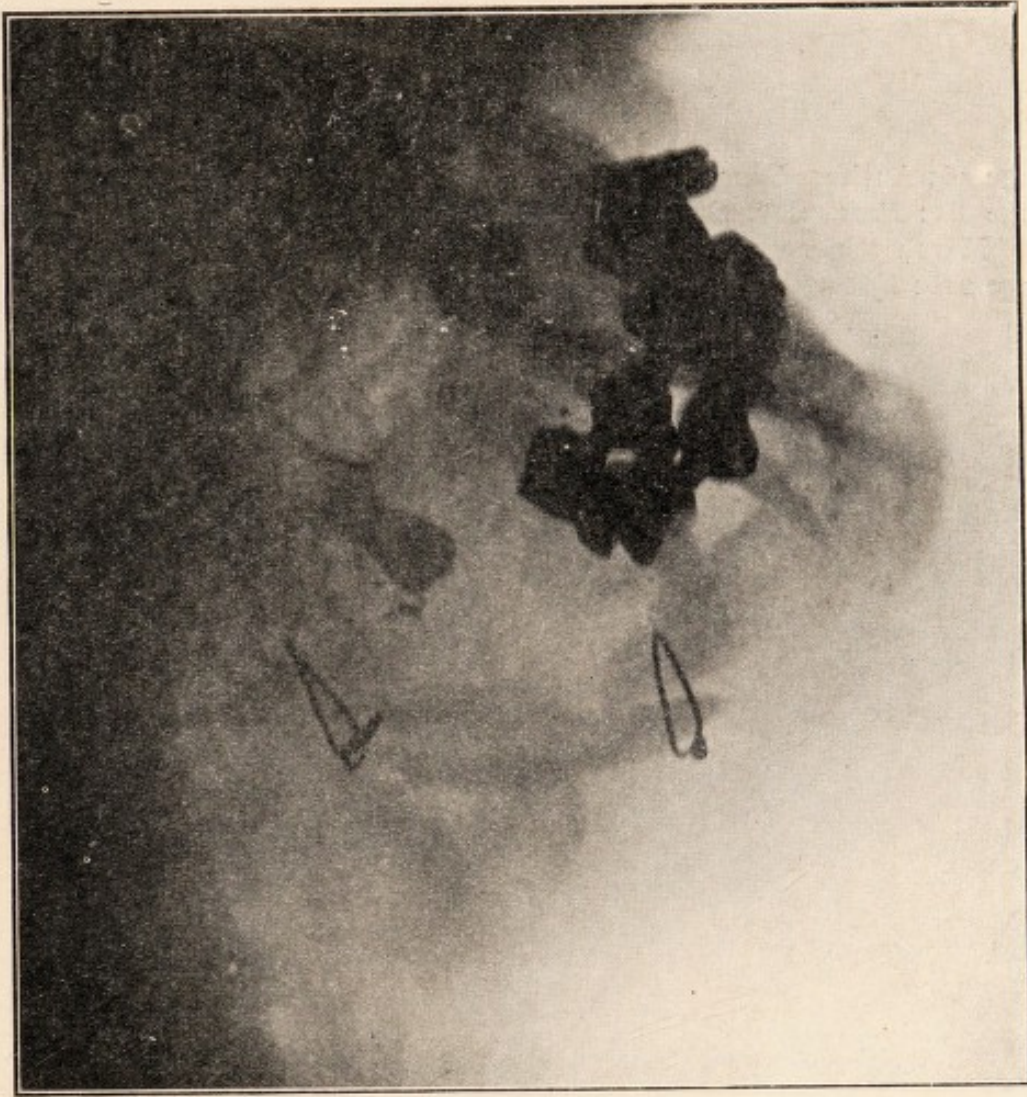


FIG. 130.—Sergeant J. Nine weeks after operation. The graft has united by bone, strong at its posterior end, but as yet very thin at the anterior extremity.

Operation, July 29th, 1918.—Rectal oil-ether anæsthesia. A pedicled bone graft was taken from the lower border of the anterior fragment to fill the gap. Retention was obtained by silver wire passed through the ends of the fragments and the borders of the pedicle. Drainage, as in the other cases, by two tubes. Healing by first intention.

Skiagram, August 20th, three weeks after operation (Fig. 129): Graft in good position.

Skiagram, October 1st, nine weeks after operation (Fig. 130): There is bony union at both ends, but the bony bridge uniting the graft to the anterior fragment is as yet thin.

On removing the splints it was found that alignment, solidity, and biting power were very good.

REFERENCES.

Page 46: Author, *Lancet*, September 29th, 1917.

Page 82: *Proc. Roy. Soc. Med.*, Laryngolog. Section, February 5th and March 5th, 1915.

Page 216: Iglauer, *Journ. of Americ. Med. Assoc.*, December 23rd, 1916.

INDEX

A

- ABSCESSSES** in neck, 5. See also
 Mediastinitis
 prevertebral, 34
 stitch, 166
Adhesions, gingivo-labial, 46, 113,
 265
 intranasal, 98, 100, 119, 141
Air-passages, opening, 59
Alæ nasi, 177, 179, 192
Alar cartilages, 173
Albee's saw, 295
Alveolus, upper, fracture of, 113,
 278
 lower, fracture of, 284
Anæsthesia, and fractured jaws,
 261
 intratracheal, 50, 261
 by Junker's tube, 261
 local, 13
 in lung infections, 39
 by nasal tube, 261
 rectal oil-ether, 261, 295,
 300, 302, 307, 311
Angina, Ludwig's, 63
Angle of mouth, injuries of, 229
Antrum, maxillary, access to,
 101, 113, 120
 Caldwell-Luc operation,
 110
 Canfield operation, 114
 deformity of, traumatic,
 114
 Denker operation, 114
 drainage of, 110, 112
 foreign bodies in, 24
 and fractured maxilla,
 272, 277
 radiating fractures into,
 110
 and sepsis, 272, 277
 through and through
 wound of, 109, 278
 and turbinectomy, 111

- Aphonia**, 57
 functional, 68
Artery, angular, 159, 218
 carotid, common, 10
 external, 9, 14, 93
 internal, 12, 82, 218
 facial, 8, 218
 frontal, 159, 218
 infra-orbital, 218
 lingual, 8, 14
 subclavian, 14
 superficial temporal, 159,
 218
 superior thyroid, 8, 10
 supra-orbital, 159, 218
Atropine for laryngeal œdema, 58
 for laryngitis, 73

B

- Bipp**, for frontal sinus, 130
 poisoning by, 30
Blood-clot as a dressing, 186
Blood-supply of plastic flaps of
 face, 218, 235
 of forehead, 163
Bone, conservation of, 257
Bone-grafting, 260, 280
 autogenous, 282
 best site for, 288
 chiselling, 295, 299
 closure of incision, 293
 contra-indications, 283
 control of fragments, 290
 cosmetic considerations, 283
 difficulties, 294
 examples, 300
 fate of graft, 281
 fixation of graft, 293, 297,
 300, 303, 306, 312, 315
 fracture of graft, 297
 free, 288, 297, 300
 functional considerations,
 285

318 INJURIES TO THE HEAD AND NECK

Bone - grafting, heterogeneous,
282

homologous, 282

immobilization of jaw, 290,
292, 300, 308, 310

and mastication, 304

osteogenesis in, 281, 297,
313

osteo-periosteal, 288, 302,
305

pedicled, 288, 298, 305, 307,
311, 315

periosteum, rôle of, 281,
296

sawing, 297, 299

and scar-tissue, 287

sepsis in, 292

skiagraphy after, 296

speed in, 282

splinting, 292

suitable cases for, 282

symphysis, 289

technique, 291

Bridge, nasal, 153

Butterfly dressing, 211

Buttons, tension, 186, 190, 212

C

Cap-splint for teeth, 290

Cartilage, costal, duration in fore-
head grafts, 158

encapsulation of, 161

insertion in forehead,
153

removal of, 152

suppuration of, 163

viability of, 161, 176

Casts, plaster, 302

Cerebral complications of ear
wounds, 78, 81, 85, 94

Cerebro-spinal otorrhœa, 88, 91,
93

Chin, loss of, 284

Chylous fistula, 35

Cleft palate, traumatic, 279

Cochlea, 89

Cold, effect on grafts, 165, 185,
193

Collateral circulation, 14

Columella nasi, 160, 178, 181,
191

Composition, Stent's, 46

Contour of nose, 172

Cranial fracture, 93

D

Dacryocystitis, traumatic, 135

Deafness after ear wounds, 77

Deformity after injuries to acces-
sory sinuses, antral, 114

after injuries to accessory
sinuses, frontal, 132

Dental arch, impairment of, 259

Dentures, 285

Depilation of face, 154, 177

Desquamation of frontal bone,
157

Dissection for foreign bodies, 29

Douches for face and mouth
wounds, 204, 213

for nasal wounds, 97

Dressings for face wounds, 204

after rhinoplasty, 185

for wounds of head and
neck, 4, 29

Dyspnœa, 18, 57, 254

E

Ear, external, 78

internal, 88

middle, 79

skiagraphy for, 75, 89

Emphysema, surgical, 64

Empyema, antral, 102

pleural, 40

Endoscopy, 53

Ethmoid, access to, 102, 118, 122
foreign body in, 22

Ethmoidal cells, 133, 163

skiagraphy of, 123

Eye, destruction of, 118, 124

Eyebrow, cicatricial elevation of,
156

F

Facial bones, fracture of, 104

paralysis, 76, 82, 91, 94, 95,
114, 226

surgery, failures in, 232

limitations of, 222

wounds (see also Flaps),
drainage of, 213

lavage of, 204, 213

massage after, 214

radiotherapy for, 204,
214

Fascial planes of neck (see also
Mediastinitis), 28

Feeding after face wounds, 203
 after fractured mandible, 255
 after œsophageal wounds, 47
 Fistula, buccal, 41, 208
 salivary, 41
 test, labyrinthine, 95
 tracheo-œsophageal, 49
 Flaps, plastic, depilation of, 154, 177
 double, 236
 fascial, 116
 fat, 117
 forehead, 158
 muscle, 116, 237
 rotated, 168, 245
 size of, 142, 159, 218
 sliding, 219, 237
 sloughing, 219
 temperature of, 161
 tension of, 163
 translated, 249
 undercutting, 237
 Foreign bodies (see also various regions and structures), in neck, 32
 not removed, 27
 wandering, 22
 Fossa, digastric, 87
 spheno-maxillary, 27
 Fractures of facial bones, 104, 273
 of jaws. See Mandible, Maxilla
 of skull, 87, 93
 Frontal sinus, injuries of, 122
 after-treatment, 134
 Bipp for, 130
 Bridge operation, 124
 deformity after injury, 132
 and middle turbinec-tomy, 124
 posterior wall of, 123
 skiagraphy of, 123, 127
 Frost, effect on plastic flaps, 165, 185, 193
 G
 Gas gangrene, 64
 mustard, 70
 Giddiness in ear injuries, 89
 Gingivo-labial sulcus, 46, 113, 265, 284

Grafts, autogenous, 150, 282
 bone. See Bone-grafts
 cartilaginous. See Cartilage
 facial, free, 233
 inlay, 46, 234
 tension of, 234
 types of, 233
 homologous, 150, 166, 282
 Krause, 170, 234
 pedicled. See Flaps
 Thiersch, 170
 Guérin's fracture. See Maxilla

H

Hæmatomata in rhinoplasty, 186
 Hæmorrhage. See also Arteries and Veins
 aggravating causes of, 1
 from floor of mouth, 256
 incisions for, 7
 and oral sepsis, 2
 plugging for, 4
 from scalp, 161
 from tongue, 8, 256
 Hair-line in rhinoplasty, 154, 168
 Hare-lip type of operation, 221
 Hearing tests, 77, 89
 Hemiplegia, 11
 Hydrogen peroxide, 5, 29, 86, 204

I

Ice, use of, 58, 255
 Infra-orbital incision, 101
 Infundibulum of frontal sinus, 134
 Infusions, intravenous, 14
 Inhalation infections. See Lung
 Inlays. See Grafts
 Internal ear, 88
 jugular. See Veins
 Intracranial complications. See Cerebral complications
 Intranasal adhesions. See also Adhesions
 clearance of, 100
 treatment of, early, 98
 of late, 100
 Irreplaceable tissues, 222
 Irritant gas in larynx, 70

J

Jugular veins. See Veins

K

Keloid scar, 251

Killian operation on frontal sinus, 124

Krause grafts, 170

L

Labyrinth of internal ear, 77, 88, 91, 95

Lachrymal sac, 135

Laryngeal wounds requiring military regrading, 74

Laryngitis from irritant gas, 70

Laryngotomy, 63

Larynx, local anæsthesia for, 59
œdema of, 57, 60, 71
reconstruction of, 66
stenosis of, 68

Lateral sinus, 85, 91

Lips, 226, 230, 241

Lowering the nose in rhinoplasty, 176

Lungs, gangrene of, 40, 310
infections of, 13, 37, 261, 295

M

Mandible, fracture of, 56, 253
displacement, 254
feeding, 255
fixation, 260
impaction, 262
interdental ligatures, 255

and pneumonia, 261

prosthesis for, 265

pterygoid pull, 268

and quinsy, 262

and salivation, 254

sequestra, 258

splinting, 255

transit of patients, 263

and trismus, 262

grafting. See Bone-grafting

Massage for face wounds, 214

Mastoid apex, removal of, 84

cells, residual, 84

operations, after-treatment of, 87

radical, 84

Mastoid, skiagraphy of, 75, 89

wounds of, 75, 81, 84

Mattress sutures, 179, 190, 193

Maxilla, fracture of, 269

displacement, 270

Guérin's, 270

prosthesis for, 278

reduction, 271

repeated, 100, 276

splinting, 271

unsuspected, 276

Meatus, auditory, external, 78

Mediastinitis, 30, 33

Membrana tympani, rupture of, 79

Metaplasia of mucosa, 184

of skin, 178

Middle ear, 79

Mucocele, ethmoidal, 163

Mucous membranes, 220

Muscle flaps. See Flaps

Muscles of nose, 173

N

Nasal prosthesis, 141, 181, 189

support, 141, 144, 159

vibrissæ, 178

Neck, abscesses in (see also Mediastinitis), 5

foreign bodies in, 31

Nose, accessory sinuses of. See Sinuses

shaping, 171

Nostrils, stenosis of, 142, 178

Nystagmus, 89, 91, 95

O

œdema, buccal, 255

laryngeal, 57

œsophageal tube, 47, 67, 203, 255

œsophagoscopy, 53

œsophagotomy, 49, 51, 54

œsophagus, foreign body in, 51, 53

Oral sepsis, 2, 259

Osteogenesis, 281, 297

Otorrhœa, cerebro-spinal, 88, 91, 93

Oxygen, subcutaneous administration of, 30

P

- Palate, 43, 142, 279
 Pedicles, blood-supply of, 159
 division of, 166
 return of, 168
 Perichondrium in rib-grafting,
 152, 157
 Pericranium in rhinoplasty,
 157
 Periosteum. See Bone-grafting
 Pharyngotomy, 60
 Phonatory air-waste, 65
 Photographic records, 198
 Pinna, 78, 82
 Pituitary fossa, 18, 102
 Plaster casts as records, 202
 Platysma, 219, 298
 Pleurisy, 40, 152, 162
 Pneumonia, 38, 295
 Post-nasal plug, 23, 118
 Premaxilla, 279
 Prevertebral abscess, 34
 Primary suture of facial wounds,
 205
 Probe, telephone, 18
 Prosthesis, maxillary, 278
 nasal, 179, 181, 189, 191

Q

- Quinsy in jaw fractures, 262

R

- Radiotherapy, 214
 Records, photographic, 198
 Red line of lips, 221, 239
 Repeated fractures of jaws,
 276
 Retropharyngeal abscess. See
 Prevertebral abscess
 Rhinoplasty, cheek flaps for,
 146
 classical types of, 138
 difficulties of, 162
 dressings for, 161
 early preparation for, 139
 from forehead, 149
 size of flaps, 159
 without cartilage, 156
 Rose position, 118
 Rugæ of forehead, 228
 of lips, 226

S

- Sac, lachrymal, 135
 Saliva, drooling of, 254
 Salivary fistulæ. See Fistula
 Scalp, bleeding from, 161
 scarring of, 170
 Scar-tissue, facial, 214
 keloid, 251
 Sepsis, oral, 2, 259
 Septicæmia, 27
 Septum, nasal, 100
 Sinuses, nasal accessory. See
 also Antrum, Ethmoid,
 etc.
 disease and sequelæ, 104
 early treatment, 101
 late treatment, 103
 repeated operations on,
 105
 and rhinoplasty, 107
 venous, lateral, 93
 petrosal, 85, 93
 sigmoid, 86
 Sinusitis, multiple, 120
 Skiagraphy (see also various
 regions and structures), 17
 Sphenoidal sinus, 102, 105, 119,
 121
 Spheno-maxillary fossa, 27
 Splints, jaw, 255, 265, 292
 Stenosis of external auditory
 meatus, 78
 laryngeal, 68
 nasal, 98
 Stenson's duct, 247
 Stent's composition, 46
 Stitch abscess, 166
 Stitches, tension, 212, 248
 Subcutaneous oxygen, 30
 Sunlight, use of, 204, 214
 Suture, primary, of facial wounds
 205
 Sympathetic nerve chain, 33, 37,
 51

T

- Teeth, conservation of, 256
 Temporo-maxillary joint, 75,
 79
 Tension of grafts, 234
 sutures, 212
 Thoracic duct, 35
 wall, operative infection of,
 162

Thrombosis, arterial, 12

venous, 91, 102

Tongue, hæmorrhage from, 8

Tracheotomy, 62, 67

removal of tube, 73

Transfusion, 15

Travelling after wounds of

antrum, 102

of jaw, 263

of nose, 99

Trismus, false, 214, 220, 262

Tuning-fork tests. See Hearing

Turbinectomy, 120, 124

Tympanum, wounds of, 81

V

Vagus nerve, 11, 30, 34, 67

Veins, common facial, 9, 13, 92

external jugular, 13

facial, 102

internal jugular, 11, 14, 92

Vibrissæ narium, 178

W

Warmth in plastic surgery, 165,

185, 193

Wax models as records, 202



