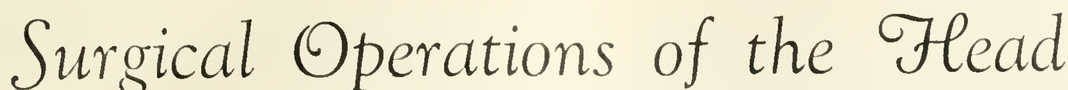
SURGICAL OPERATIONS



Surgical Operations of the Head

ILLUSTRATED BY CLINICAL OBSERVATIONS, FOR

PHYSICIANS AND SURGEONS

BY

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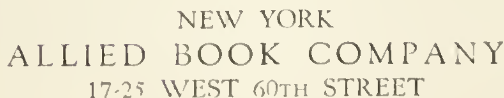

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PREFACE

For many years it has been my intention to present an exposition of the operations of surgery from their clinical aspect. According to this plan, each individual case was to be supplied with a history, a short account of the symptoms, as well as an adequate statement of the course and after-treatment, and, in the cases which ended fatally, with the more important findings from the autopsy record. The preliminary labors have advanced so far in the last few years that we are now approaching the completion of the entire work, and are able to present to the public the first section.

Exact protocols of the various operative procedures have been dictated by me, while Max Landsberg, painter, without in any way interrupting the course of the operation, has prepared sketches of the different steps. This material forms the foundation for a representation which, as I believe, will be practically exhaustive for the particular purpose intended; for the extraordinary variety of diseases which are met with in the Augusta Hospital offers us all the surgical operations in such number that we can exercise a strict choice. At the same time I have considered it a duty to publish an inclusive review of this interesting material, such as will be found in the following chapters.

Since I hold to the point of view that specialization in surgery should be avoided, if one desires not to become one-sided, I take particular satisfaction in being able to devote my career to a hospital in which, since Ernst Küster's effectual work, general surgery in the truest sense of the term has been practiced. Even those operative procedures which for a long time have been separated from surgery into specialties of their own, for instance, those of gynecology and those of aural surgery, find a place with us. For that reason we have introduced in addition a series of operations on the female organs and on the auditory apparatus, in so far as, according to my conviction, every hospital surgeon is confronted by them and must be in a position to carry them out.

In my chief physician of many years' standing, Dr. Emil Heymann, I have found an experienced collaborator, who has given me great assistance in mastering the extensive material, and who is accordingly associated with me in this publication.

The purpose of the book consists in this, that it offers to every properly trained physician a foundation upon which he can independently undertake the operations described. In order to fulfill this purpose in all its details, pictures true to nature explaining the different phases of each operation have been liberally supplied on special plates, and I cannot omit expressing my particular thanks to the publishers for their liberal coöperation in this.

As the work not only includes all departments of surgical therapy, but also takes up systematically the surgical affections in the manner in which they are considered in the lecture room, it may also be properly employed as a text-book by students.

FEDOR KRAUSE.

Berlin.

FOREWORD OF THE AMERICAN EDITOR

In presenting this first volume of the Krause-Heymann system of operative surgery to English-speaking physicians, a word of introduction may not be out of place. Naturally an undertaking of such magnitude is not entered into without mature consideration, and particularly in face of the fact that we are already richly supplied in this country with text-books and manuals of surgery, some of which represent a high grade of excellence.

The book is, primarily, a text-book of operative surgery. Its purpose is to tell how to operate, and it fulfills this purpose with all the exact detail for which the German mind is noted, interpreted by a wealth of illustrations surpassing any text-book I know of.

It approaches its subject in a novel way, by the presentation and discussion of actual cases, which are carefully followed from the beginning, through the operative treatment, to the end-result. These cases illuminate the text and give a touch of practical interest to what might otherwise be a dry discussion. This is, in fact, an application of the case-teaching method to surgery.

It is distinctly a personal work, dominated by the genius of Fedor Krause, whose extensive experience over the entire field of surgery, together with his known ability as a teacher, has made him eminently fitted for the task. A rich supply of clinical material was directly at hand, in the Augusta Hospital. But the presentation is by no means a narrow one; various methods and modifications of technique are discussed, their advantages compared, and the reasons given why one should be preferred over another.

In this American adaptation I have attempted first of all to give an accurate transcription of the German text, even at the expense of fluency. I have modified and re-arranged freely wherever it seemed advisable. Where German practice differs from ours, I have entirely rewritten sections and paragraphs. Technical and controversial discussions have been abridged; new matter, illustrations, and cases have been added. To avoid complicating the text, no attempt has been made to distinguish the alterations and additions.

I have, in short, attempted to naturalize this German book, to adapt it for the serious study of the American student, and for the reference and assistance of the working American surgeon.

ALBERT EHRENFRIED.

Boston.

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PART I. GENERAL SURGICAL TECHNIQUE

CHAPTER 1—PREPARATION FOR OPERATION

EXAMINATION OF THE PATIENT

Preceding the operation a routine physical examination of the patient should be made, in order to anticipate the effects of the anesthetic upon the organism, to take measures to prevent operative shock, and to institute any necessary drug treatment. Particular attention should be paid to an investigation of the functional ability of the heart and vascular system, the kidneys and the lungs. Examination of the urine for sugar and albumen should never be omitted.

GENERAL PREPARATION

On the evening before operation, the patient should receive a warm bath in which the skin is scrubbed with soap and brush, and the finger and toe-nails cleaned. This precaution is omitted only when the patient's physical condition contra-indicates it. After this cleansing bath, the field of operation is shaved. In preparation for a celiotomy the shaven area should extend from the nipples to the groins; upon the limbs to the joint above and below. In operations upon the brain and other procedures on the skull, the scalp should as a rule be competely shaven. In women, however, a certain amount of hair may be allowed to remain in order to prevent mental depression. For instance, in operations upon the cerebellum, the front hair may be preserved. Also in operations upon one side of the skull, for instance upon the Gasserian ganglion, the other half of the skull may go unshaven. But under no circumstances should asepsis be endangered out of regard for the wishes of the patient. On account of the innumerable bacteria which reside in the scalp, after shaving it should be washed with ether and a dressing of ½ per cent. formalin applied, to be removed at the beginning of the operation.

DIET

On general principles a diet should be selected which will increase the strength and well-being of the patient as far as possible in the days preceding the operation, and prevent physical weakness after the

operation. The food should, therefore, be nourishing and easily digestible, and of a sort to which the patient is accustomed. A sudden change in diet, and starvation, even in affections of the intestinal track, is useless and may be harmful. Tobacco and liquor should not be suddenly withdrawn in persons who have been long accustomed to smoking and drinking, for sudden abstinence may, in conjunction with operative shock, entail a dangerous and under certain circumstances fatal breakdown in the strength of the patient.

Undernourished and fluid-starved patients should receive in the days preceding the operation, twice daily, a subcutaneous injection of about one quart of physiological salt solution, with, if indicated, an intramuscular injection of one or two c.c. digalen. Fluids may be introduced into the body also by means of enemata; to a rectal injection of eight ounces of salt solution, it may be well to add a glass of red wine, or in the presence of diarrhœa, from 10 to 20 drops of tincture of opium. Rectal injections may be less conveniently given by the drop method, and in certain cases nutritive enemata may be used.

The administration of fluids is particularly indicated in patients with stenosis of the pylorus and dilated stomach. The tetany which occurs as the result of inanition and the drying out of the tissues in these cases disappears, as a rule, as the fluid balance is restored. Occasionally patients with severe trigeminal neuralgia must receive salt solution or nutritive enemata during the preparatory period, in case they have almost completely stopped eating or drinking on account of pain, as not infrequently happens, and as a result have reached a low grade of vitality; at the same time they should receive morphine to overcome the pain. Ordinarily the administration of fluids in weak patients exerts a favorable influence upon the action of the heart, powerfully increases diuresis, and thus promotes elimination of the toxic agents which have assembled in the body, including the anæsthetic.

On the day of the operation, as a rule, the patient should receive nothing by mouth, except perhaps water or some other drink. If the operation comes late in the day, it will be of no harm for children to receive a glass of milk, or for adults to take a little tea, a cup of broth, or a glass of wine, if they only get it early.

NARCOTICS

In order to help a nervous patient meet the surgical procedure with as much vigor and equanimity as possible, he should receive on the

evening before the operation 10 grains of veronal in hot wine or tea. Morphine should be given if on account of severe pain the milder narcotic does not work. If veronal is not well borne, any one of the many sleep-inducing agents, such as sulphonal, trional, or adalin, may be given in its place. In children a narcotic before the operation is given under exceptional circumstances only.

SPECIAL PREPARATION

MEDICATION

In emergency operations and in the majority of other operations special preparation of the system by means of drugs is unnecessary. The administration by mouth or subcutaneous injection of drugs for the disinfection of the tissues, of the gastro-intestinal track or other organs in order to increase their resistance to infection is ordinarily useless. When physical examination shows the necessity thereof, the patient should be given a course of drug treatment for several days or longer, preceding the operation. Patients with cardiac insufficiency should be given some digitalis preparation, and those with nervous disturbances, such as epileptics and persons with exophthalmic goiter, should receive potassium bromide or some other sedative. Patients with bronchitis should be assisted in the solution and riddance of the secretion by the administration of expectorants. In dry catarrh the irritative cough should be controlled by means of codein and similar drugs. Patients with jaundice are given for several days 45 grains of calcium chlorate per day in order to increase the coagulability of the cholemic blood.

PREPARATION IN DIABETICS

Careful attention should be given to the preparation of patients with diabetes. It is recognized that in diabetics even slight wounds on the extremities easily lead to infection and possibly gangrene of the entire limb. The cause of this is the sugar and allied acids contained in the tissues, in conjunction with the arteriosclerosis which always co-exists in a greater or less degree. The presence of these elements will be recognized by examination of the urine, and whether sugar is present alone or with acetone, precautions should always be taken. In emergency operations, to be sure, such as acute appendicitis, time does not allow, but in any case, before or immediately after the opera-

tion attempts should be made to bring about at least a diminution in the sugar or acid saturation of the tissues.

If a low grade of diabetes is present, with little sugar and without acetone or diacetic acid in the urine, the patient should be carried along on a diet free of carbohydrates until the last traces of sugar have disappeared before the operation is undertaken.

If the patient presents a severe grade of diabetes, therapeutic measures will depend upon the results of the antidiabetic diet, and the urinary findings. Either a large amount of sugar is being eliminated and the quantity is not decreased under absolute dietary restrictions, or in addition to sugar acetone is present in the urine. In the first case the limitation of carbohydrates before operation is only carried so far as the patient can stand without weakening. A small remnant of glycosuria before operation is less dangerous than an extreme reduction of the body resistance by an otherwise advantageous diet.

In the other form of severe diabetes, in which the sugar excretion is combined with the excretion of acetone or diacetic acid, therapeutic measures will depend upon whether the acids appear in the urine only after the withdrawal of carbohydrates from the diet, or if they diminish simultaneously with the sugar, or if they increase in spite of the deprivation of carbohydrates. If the acetone first appears while the sugar is decreasing in the urine, the strict diet must be relieved until the acetone has disappeared, for the presence of these acids in the tissues will interfere more with wound healing than the presence of sugar. The outlook for wound healing is more favorable if the acetone and the sugar disappear simultaneously, for a severe diabetes may in such cases for a considerable time at least be converted into a mild form, with the help of dietary restrictions. At the same time one should be sure in these cases that too great an inroad into the patient's vitality be not allowed.

The prognosis is worst when the elimination of acids cannot be influenced in spite of the withdrawal of carbohydrates. In these cases diabetic coma is a threatening danger. All precautions should be directed to the neutralizing of the acids which are present in the body, and for this purpose the patient should receive large quantities of sodium bicarbonate, in teaspoonful doses by mouth, and by rectal injection with opium, to the amount of three ounces per day. If coma appears intravenous injections of 5 per cent. soda bicarbonate solution may be given, and it should be continued until the urine shows an alkaline reaction. Von Noorden advises in the case of increasing acid

elimination and threatening coma in spite of complete abstention from carbohydrates, to interrupt the diet temporarily by the administration of oat-meal. Umber recommends the simultaneous administration of large doses of morphine or opium, by means of which the distressing thirst is also controlled.

PREPARATION OF SPECIAL REGIONS

Before anesthesia is started, the mouth should be washed out with 4 per cent. boric acid solution or 2 per cent. hydrogen dioxide, and the teeth should be mechanically cleaned with a tooth brush. In this way the bacterial flora of the mouth is diminished, and the possibilities of infection of wounds in the mouth and tongue incurred during anesthetization, and of infection of the respiratory track, are lessened.

Irrigation of the bladder is performed preceding operation on the urinary organs only in the presence of cystitis. A 2 per cent. boric acid solution or a one to two thousand or one thousand solution of corrosive sublimate may be used. In every case it is of advantage to promote diuresis by taking non-carbonated waters, reinforced by urotropine, which may be given up to seventy-five grains per day. In addition every patient should empty the bladder before operation, for a full bladder may be a source of trouble during a celiotomy, and if it is emptied during the operation, either spontaneously or by means of a catheter, asepsis is disturbed. Before gynecological operations, the vagina should be washed out with alcohol, boric acid solution, or lysol.

Evacuation of the stomach followed by lavage is indicated only when it is difficult or impossible for the stomach, on account of narrowing of the pylorus through scar contraction or new growth, to empty itself. In every operation on the stomach or duodenum the retained and partially digested food should be washed out through a stomach tube with a solution of warm water, 3 per cent. boric acid, soda bicarbonate or one to two thousand corrosive. The irrigation must be continued until the water comes back clean. This precaution should never be omitted if it is probable that the stomach contents may be inspired during vomiting in the course of or after the anæsthesia, for instance, in the presence of intestinal obstruction, or in emergency operations which are undertaken shortly after a meal.

On the day before the operation care must be taken that the intestines are well cleaned out. Frequently assistance must be given by means of castor oil, Carlsbad salts, or an enema. Only mild laxatives should be used, in order that the patient be not unnecessarily weakened

through diarrhœa. This precaution should be taken before operation not only to increase the comfort of the patient, but in order that it shall not become necessary to take measures soon after the operation, for with the effort necessary to bowel movement a freshly operated case may be placed in some danger. Also after operations upon the peritoneal cavity, the belly muscles are weakened from the incision, and normal bowel activity is interfered with; and on account of the intestinal paresis which follows celiotomies, with the resulting danger of toxic absorption, a previous catharsis is necessary. In particular the lower bowel should be emptied because it frequently has to be employed in the first days after the operation for the administration of drugs and means of nutrition.

CONTRA-INDICATIONS TO OPERATION

A contra-indication to the carrying out of any necessary operation can only be established on pressing grounds, after a careful investigation of the entire system. Neither extreme age nor early infancy is to be considered a hindrance. Weak and exhausted patients are at the present day anesthetised by such gentle and harmless means that the attempt to bring operative assistance should always be given weight against sure death. Obese and very anemic patients, diabetics and leukemics appear to be particularly endangered by major procedures.

During menstruation operations upon the genitalia and in their neighborhood should be avoided, unless delay is dangerous. Likewise in pregnancy, unless some special indication exists, the operation should be postponed until after delivery.

In the presence of hemophilia only the most urgent operations should be undertaken. Before every operation one should protect himself against error in this respect by a careful history. Preparatory treatment by means of hydrastis or gelatin (by rectal or subcutaneous injection or as an addition to the food), and by injections of a foreign serum (diphtheria antitoxin) may be of great advantage in increasing the coagulability of blood.

THE OPERATING ROOM

For an operating room any room with sufficient natural or artificial light may be used on occasion. The one necessary condition is that it should be free of dust. For that reason a room without curtains, hangings, carpets and similar dust retainers should be chosen. In any

case such furnishings should not be disturbed immediately before the operation. The floor should be carefully wiped with a moist cloth, but not dry swept. For major operations an operating room completely equipped and with a good staff of attendants is preferable to any makeshift. In case of necessity a single flat kitchen table may be used for an operating table. For hospital use special models have been developed in Germany, which are built entirely of metal and stand solid upon a central pedestal; they may be thoroughly cleansed and their various parts readily adjusted. The top of this table may, by means of an oil pump, be raised or lowered on a level or it may be tilted to either side or lowered at either end. The typical American table stands upon four legs and has a sectional top of glass or enameled steel. The leg section may be folded down, or the head section lifted, and the table as a whole may be tilted by means of a crank so that the head is depressed and the foot elevated.

POSTURE

The patient is to be placed in the position which best facilitates approach to the field of operation. At the same time respiration or cardiac activity should not be interfered with by compression of chest or abdomen.

Procedures on the front of the body are customarily carried out with the patient upon his back, whether they involve the head, trunk or extremities. The head of the patient lies upon the same level as the body, or, better still, is carried slightly backwards in order to make it easier for the anesthetist to lift up the lower jaw and pull forward the tongue in case the airway is obstructed. The arms lie ordinarily at the side of the patient. For celiotomies, involving the lower portion of the abdomen, the forearms may be carried across the thorax, and held rolled up in the patient's night-gown; for operations in the upper portion of the abdominal cavity the hands are laid flat, palm downward, under the buttocks on either side. Care is to be taken that one of the arms does not hang over the edge of the table, as paralysis may result. The anesthetist follows the pulse by palpation of the facial or temporal artery, or by stethoscope strapped to the precordium.

Trendelenburg's position, which consists of an elevation of the pelvis with the knees bent, is employed in all abdominal gynecological operations, in operative procedures on the bladder, and upon the lower segment of the colon. The legs are tied down, to prevent the patient from slipping. Its advantage lies in the fact that the small intestines

and the omentum are carried by gravity into the upper portion of the peritoneal cavity and do not interfere with the operation. Patients with arteriosclerosis should not be kept too long in this position, because the blood pressure within the cranium may be increased to dangerous proportions. This holds true also for old persons with prostatic hypertrophy. In every case the horizontal position should be restored as early as possible, at any rate before one starts sewing up the abdominal wall. The stomach and intestines fall at once into their original position, but the omentum is apt to remain in the upper portion of the peritoneal cavity. Accordingly at the end of the operation the omentum should be unfolded and drawn down over the intestines. If this is omitted, serious circulatory disturbances may take place in the omentum, and symptoms of obstruction may appear in the rolled up, and possibly kinked off, transverse colon.

In the lithotomy position the patient, placed upon his back, is pulled down until the buttocks project beyond the end of the table. Both legs are held flexed at the hips, either by assistants, or in leg-holders which attach to the lower end of the table. This position is necessary in operations upon the anus and rectum and in gynecological operations through the vagina.

The lateral position is employed in operations upon the thorax, the kidneys and ureters, and the hip joint. If possible the patient should be placed upon his right side, as in this position the heart is less restricted. As in the Sims position the under arm is drawn through to the back, to prevent pressure paralysis, and the upper leg is sharply flexed at the hip and knee. A pillow or bolster is placed in front of the thorax. In operations upon the cerebellum, the spine, cord and the back generally the patient lies flat on his stomach, with the head projecting beyond the table to facilitate etherization. The forehead is supported by the lap of the anesthetist, or by a specially constructed frame.

In operations upon the skull and face the patient may advantageously be placed in a half sitting posture, as in this way the flow of blood is better controlled. The head is held by an assistant with both hands, by whom it may be moved forward or backward, rotated, or laid on the shoulder at will.

Pillows, rolls and sand bags of various shapes and sizes may often be used to advantage. With a small sand bag one may raise when necessary certain parts of the body, and it is particularly useful in supporting a limb upon which chisel and mallet are to be used. Hard

stuffed rolls may be shoved under the shoulders, in operations upon the neck, to allow the head to hang back and thus put the soft parts of the neck on the stretch. In operations upon the lower thorax, to increase the lateral flexure and widen the aperture between the ribs, a pad may be placed under the side. In operations upon the gall-bladder and bile ducts, a sand-bag or roll is placed under the back in the region of the diaphragm to facilitate exposure. For these purposes as well as for kidney operating the Cunningham elevator is of great convenience.

Paralysis may occur in the arm or leg as the result of pressure during the operation. It is more common in the arm; if the arm hangs to one side the musculo-spiral nerve is pressed between the humerus and the edge of the table, or if it is held high above the head or lies under the body in the lateral posture, the brachial plexus may be squeezed between the clavicle and the first rib. In the leg the peroneal nerve is most apt to be involved, although peroneal paralysis occurs comparatively infrequently. Insufficient padding of the leg holder causes pressure of the nerve against the head of the fibula.

In order to avoid serious cooling of the body surfaces of the exposed patient the operating room must be as warm as may conveniently be borne by the operator and his staff. All portions of the body which lie outside of the operative field should be wrapped in woolen coverings. In celiotomies and perineal operations each leg should be completely encased in a flannel boot, and the chest and shoulders also well covered. It is best to leave the coverings, if they are still dry, upon the body of the patient after the operation, particularly if he has perspired freely, and to remove them only after the patient has been transferred to a previously warmed bed.

CHAPTER 2—ANESTHESIA

In order to carry through major operations without pain we ordinarily employ inhalation anesthesia, less frequently spinal and local anesthesia. The results with intra-venous and rectal anesthesia have not yet justified their general adoption. For inhalation chloroform, ether and nitrous oxide or some combination of these are used, according to the indications, and the experience and preference of the surgeon.

Inhalation anesthesia is ordinarily without danger with any of these agents, if overseen by a careful and experienced anesthetist. But over against its beneficence for the patient and its advantages for the operator have to be placed the possibility of danger to the patient, during the administration, or from the subsequent effects. These depend chiefly on the fact that the patient during the anesthesia is absorbing a poison, and that the loss of sensibility to pain is only one manifestation of a general intoxication.

THE SPECIAL PROPERTIES OF CHLOROFORM AND ETHER

The activity of both these agents depends upon the fact that the inhaled vapor, carried by the blood, invades all the tissues and penetrates to the cells of the cortex. In order to induce narcosis the sensory paths and the cortex must be overcome. For even in comparatively deep anesthesia the motor paths from the cortex are active, as may be shown by electric stimulation of the motor region during an operation for the relief of epilepsy. Also the peripheral portions of the motor tracks always respond to stimulation in spite of deep narcosis, as may be seen by the contraction of a muscle which results when a motor nerve is touched. The cerebellum is affected earlier than the cerebrum, for at the beginning while consciousness still persists, there appears a high grade of ataxia, similar to that resulting from alcoholic intoxication.

In order to completely overcome the motor tracks large quantities of the anesthetic are necessary. Such a motor paralysis involves considerable danger, particularly as paralysis of the nerves in the pons and medulla is synonymous with respiratory and cardiac paralysis. This condition appears only when large quantities of pure vapor are

given unmixed with air. The loss of motility of voluntary muscles during anesthesia depends upon the paralysis of the cortex and of the will power, and destruction of the reflexes depends upon the paralysis of the sensory portion of the reflex arc.

Since chloroform and ether are toxic the quantity used is of significance in relation to their injurious effects. Ordinarily a considerable amount of ether may be necessary to induce anesthesia, quantitatively considerably more than chloroform, but as the operation proceeds the amount of ether which is necessary decreases, and at the same time the danger of respiratory paralysis.

Coincident with the poisoning of the central nervous system injurious effects are produced upon other tissues and organs. The toxic influence of either agent may become apparent in its most dangerous form at the beginning of its absorption, as in the cases of sudden death at the beginning of the anesthesia. This sort of toxic effect occurs usually in patients with status thymicus or lymphaticus. In their later toxic symptoms the two agents differ from each other. Chloroform works an injurious effect upon the heart muscle in smaller quantities than ether, but the effect upon the kidneys is more prolonged in the case of ether than in the case of chloroform. The small traces of albumin in the first few days after chloroform anesthesia usually disappear rapidly, while uremic symptoms are sometimes met with after a long ether anesthesia. The parenchyma of the liver is more seriously damaged by chloroform, and fatty denegeration and general icterus are not infrequent sequelæ. After etherization the coagulability of the blood is decreased.

The effect of ether upon the mucous membranes is its most serious drawback. While irritation of the mucous membrane of the stomach and intestines seems to be without harmful results, except as it occasionally induces prolonged vomiting, the effects of this agent upon the bronchial mucous membrane may be dangerous. They present themselves clinically in the well-known evidences of irritation, such as bronchitis and broncho-pneumonia. Whether ether is employed by rectum, intravenously, or by inhalation, it induces an active and immediate secretion of mucus. If the mucus collects in the air passages and is not cared for by lowering the head and clearing out the pharynx with gauze the patient is in danger of choking or of inspiring it. In addition, in long continued anesthesia, the irritation of the mucous membrane may lead to inflammation, out of which ether pneumonia may develop.

SUDDEN DEATH DURING ANESTHESIA

Death through syncope after the first whiffs of chloroform vapor occurs quite infrequently; with ether it is rare. Death during the course of the anesthesia may develop with the employment of ether as well as with chloroform, and here also chloroform exhibits itself as the more dangerous agent, on account of its great toxicity, if recklessly applied.

This form of anesthetic death with chloroform may be avoided practically without exception if the anesthetist notices in time the warning signals which precede every danger, and immediately removes the mask and starts methods of resuscitation. Thus chloroform death during the course of anesthesia is often to be ascribed not to the toxicity of the agent alone, but to the ignorance or inattention of the anesthetist as an accessory. Death during the course of etherization is less frequent, but it may happen if a deep narcosis with inordinately large quantities of ether is continued for a long time, with a closed or semi-closed inhaler. This danger is reduced to a minimum if ether is employed judicially, by the drop method. As regards the dangers which develop after the end of the anesthesia, chloroform has some advantage over ether.

SEQUELÆ OF CHLOROFORM AND ETHER

Patients with sound heart muscle, particularly young persons, stand chloroform well, but it exercises a dangerous and sometimes fatal effect upon degenerated and insufficient heart muscle. This explains the not infrequent cases of death in the days following the operation. Cardiac paralysis may however occur in certain cases after ether anesthesia, even if limited quantities are used, death being due to nothing but atonicity of the heart muscle.

Other late results of chloroform, such as vomiting, headache and psychic disturbances are observed also after ether. The serious danger with ether lies in its injurious effect upon the bronchi and the alveoli of the lungs. Not only is post-operative broncho-pneumonia in the first days after ether anesthesia more frequent than when chloroform is employed, but the type of inflammation is more severe. It involves larger areas of the lung, and is more difficult to treat. This is the case even when the ether is chemically pure, and is not given in great concentration. Post-anesthetic pneumonia may also be caused by emboli, which are set free from thrombi in the veins, and carried by the general circulation to the lungs. In this regard also ether is

the more dangerous agent, because it decreases the coagulability of the blood. Thrombosis of the extremities, apoplexy, and hematuria are, therefore, more frequently observed after ether than after chloroform anesthesia. With chloroform, after recovery from the anesthetic the greatest danger is over, while with ether a certain danger of complications persists for several days. Moreover, with chloroform anesthesia can always be induced in patients who go under ether with difficulty, and only by the use of large and harmful quantities.

SELECTION OF THE ANESTHETIC

The choice of anesthetic will depend on the result of the physical examination. Patients with uncompensated heart lesions, such as edema, cyanosis, coronary sclerosis and cardiac dilatation should never receive chloroform, particularly when the insufficiency is the result of myocarditis. Also arythmia of the pulse demands ether. Degenerated and weak heart muscle cannot stand the toxic action of chloroform, and the patient who survives the operation may go to pieces within a few days after the anesthetic with symptoms of progressing cardiac weakness. But it must be admitted also that a heart with degenerated muscle fibre usually does not stand ether well. Nor should chloroform be employed in fresh cases of endocarditis; but in compensated heart lesions, on the other hand, it may be used without hesitation in limited quantities. On account of its paralyzing effect upon the heart, chloroform is dangerous in all patients with arteriosclerosis; to be sure these patients also stand ether poorly and thrombosis and brain hemorrhage are particularly to be feared as complications. Also the employment of chloroform in diabetes is to be avoided. But the use of ether may not prevent the onset of an attack of diabetic coma. Chloroform is also contra-indicated in status thymicus and lymphaticus as well as in Basedow's and Addison's disease, and in advanced tuberculosis with amyloid degeneration.

On the other hand where a tendency to pneumonia and to catarrhal manifestations of the organs of respiration exists, ether should be avoided as an anesthetic, because the particles of ether circulating through the body, whether inhaled as vapor or introduced in any other way, for instance by rectum or intravenously, irritate the mucous membrane of lungs and bronchi and set up a considerable secretion. Through aspiration of mucus and saliva and as a result of the direct toxic effect of ether upon the alveolar and bronchial epithelium, post-anesthetic pneumonia is apt to occur in the presence of existing disease

of the respiratory track. In operations upon the chest and the abdomen it is important that the patient should be relieved of the strain of coughing, and particularly of all changes of position which may be necessary for better ventilation of the lungs. Ether is not toxic to the heart, but the heart functions do not always suffice to overcome a pneumonia which is caused by ether, while the small amount of chloroform which is necessary for these cases hardly has any effect upon the heart.

Alcoholics and patients with kidney disease stand ether more poorly than they do chloroform. On the other hand ether may be administered by an unskilled person if necessary, in whose hands chloroform anesthesia would be attended by very grave danger. Frequent repetition of either chloroform or ether anesthesia should be avoided, especially in the young and the aged, on account of the cumulative effect of their destructive action on liver and kidneys.

SCOPOLAMIN AND MORPHINE AS A PRELIMINARY TO ANESTHESIA

Half or three-quarters of an hour before the anesthesia is started the patient may be given a subcutaneous injection of 1/120 grain of scopolamin hydrobromate together with 1/6 grain of morphine hydrochlorate. This injection is given once only and is not repeated. Scopolamin-morphine exerts a quieting influence upon the mental state, and upon humanitarian grounds it may be used in all cases where no contra-indication exists. The perturbation and anxiety which precede the operation give way to a peaceful unconsciousness and quiet sleep. The patient loses in large measure all memory of the moments preceding the operation, he remembers little or nothing of the transportation to the operating room, and often on awakening several hours after the completion of the operation, is astonished that the operation is already over.

As regards the anesthesia, the use of these agents possesses direct advantages, for the anesthesia can be induced with a smaller quantity of ether, and frequently no trace of the stage of excitement appears; moreover the anesthesia is less likely to be disturbed by spasm of the muscles or vomiting. Often for considerable intervals, for instance while intestines are being anastomosed, the anesthetic may be practically withheld without the patient awakening or becoming unquiet. The cumulative toxic effect of the anesthetic is unquestionably decreased, because when this combination is used a smaller quantity of the anesthetic is required.

Weak or anemic women and youthful patients may be given an injection of 1/150 grain of scopolamin. Alcoholics, on the other hand, require a larger dose in order to get the same result. More than 1/80 grain of scopolamin should never be given. On account of its toxic properties, children under the age of fifteen should never be given scopolamin.

Among other properties of the scopolamin-morphine injection must be reckoned the favorable effect upon the sequelæ of the anesthesia. Post-anesthetic lung affections and particularly vomiting are considerably less frequent after the operation when it is employed. This is explained by the effect of the scopolamin in drying the mucous membranes.

One drawback of scopolamin consists in the fact that it is a poison which is not readily excreted from the body after injection. Its toxic effect is recognizable particularly on the respiration and the blood vessels. Although fatal results are practically never heard of from the small doses described, disturbing concomitants may occur in the way of superficial breathing, collapse, and even a certain grade of cyanosis. The loss of the vessel tone and the paralysis of the arterioles and capillaries as the result of the action of scopolamin cause diffuse bleeding, and the wound of a head or face operation, for instance, may bleed like a squeezed sponge without it being possible to seize the small vessels and stop the bleeding by any other means than pressure.

On account of the cyanosis, the danger of collapse and the tendency to superficial breathing it is advisable in the second stage of cranial operations to avoid scopolamin, for patients with brain tumors are likely to suffer from disturbances of respiration as a result of pressure. Not infrequently this goes so far as to cause a complete cessation of respiration, and in this regard the scopolamin simply augments the action of the brain tumor. Attempts to overcome this paralysis by the aid of ordinary resuscitative methods or with antidotes are without result, for scopolamin is not readily excreted and its effect lasts for several hours. Its use should be avoided particularly in operations upon the nose, mouth, pharynx and larynx, for after such procedures it is necessary that the patient awake from the anesthetic as soon as possible, in order to cough up any blood which has been aspirated, or has flowed down into the bronchi unnoticed.

The substitution of pantopon for the morphine, particularly in skull operations, undoubtedly results in a decrease in the venous hyperemia

of the head during the anesthesia. Also the deep sleep of the patient at the end of the operation is not so prolonged with scopolamin-pantopon as with scopolamin-morphine, and the patient may be immediately awakened out of his slumber. In the same way the patient seems to suffer less from inactivity of the bowels in the first few days after the operation if pantopon is used. But on the other hand on account of the collapse which has been observed with scopolamin-pantopon immediately at the beginning of the anesthesia in celiotomies, it is wise to continue the use of morphine in all abdominal operations.

Either combination should never be used except in the hands of a skilled anesthetist. Its contra-indications as stated by Herb* are as follows: In patients in whom the respiratory centre is depressed or likely to become depressed through operative procedures; obstructive dyspnœa due to growth within or without the trachea, causing pressure, or exophthalmic goitre; in operations about mouth or throat; in the case of debilitated or cachetic persons or those suffering with continued sepsis; in patients presenting any degree of stupor or those susceptible to morphine; as well as in children and the elderly.

TECHNIQUE OF CHLOROFORM ANESTHESIA

In administering chloroform particular care must be taken that too large a quantity is not poured upon the mask at one time, and moreover, since concentration of the poison increases its danger to the heart, a sufficient quantity of air should always accompany the vapor.

The mask should never be saturated with chloroform and then applied to the face, but it should at first be held dry some little distance from the face until the patient, after a few inspirations of air, has become accustomed to it. Then the narcosis is begun with a few drops of chloroform, which are dropped upon the mask at intervals. In the beginning the patient thus receives chloroform vapor mixed with considerable air, and with a careful administration suffocation, nausea and anxiety do not appear. After a short period the frequency of the drop is increased and at the same time the mask is gradually approached to the face.

After the first few inspirations, the danger of syncope being over, the depth of the anesthesia is increased, the respiration, pulse and pupillary reaction and the color of the face being carefully noted. Loss of the pupillary reaction denotes the limit which the anesthesia

*Jour. Amer. Med. Ass., 1913, lxi, 834

should be allowed to reach; for this represents a paralysis of a portion of the brain which is in close relation to the vagus centre and to the centres which exercise an effect upon respiration and cardiac activity. Even slight disturbances of respiration should induce the anesthetist to interrupt the application of chloroform.

Disturbances of respiration may be caused mechanically or as the result of paralysis of the centre of respiration. Opening the mouth by means of a mouth gag is not sufficient to clear the entrance to the larynx because not only the epiglottis but also the tongue which has dropped back against the posterior wall of the larynx shuts off the passage-way. The tongue must be seized by tongue forceps, if the air way is obstructed, and pulled as far as possible out of the mouth. Paralysis of the centre of respiration in chloroform anesthesia is rare, but with ether it is less so. We have frequently seen cessation of respiration during operation upon brain tumor, but there is no question in these cases but that intracranial pressure is as much to blame as the anesthetic, for respiration has been seen to stop in tumors in the cerebellum even after the chloroform had been discontinued for some while, and patients have died of respiratory failure under local anesthesia, while the heart has been kept going by artificial means for several hours.

While paralysis of respiration may be largely overcome by the institution of artificial respiration, the disturbances of circulation during chloroform anesthesia are fraught with graver danger to the patient. Toxic paralysis of the heart muscle announces itself by a gradual loss in its power. The blood becomes dark in color, the face is cyanotic or white and the pulse becomes more frequent, as a rule, smaller in volume, and finally quite thready. Cardiac paralysis occurs at the beginning of the anesthesia, as well as with an anesthesia of long duration, for which large quantities of ether or chloroform are necessary. Naturally cardiac difficulties are more likely to arise during operations where there has been a considerable loss of blood, or reflex disturbances through irritation of the peritoneum and through changes in pressure within the thorax and abdomen. The careful and experienced anesthetist notices the gradually increasing weakness of the heart by the quality of the pulse and the color of the face. Since it never develops suddenly but always announces itself early by these symptoms, it can be met with cardiac stimulants, such as strychnine, camphor, caffeine, infusion of salt solution, and lowering of the head. We should make early and prophylactic use of the rapidly acting

camphor, because when injected subcutaneously, by its stimulant action upon the vasomotor system it readily overcomes the early signs of cardiac weakness.

If the heart has stopped beating all attempts by means of injection of drugs are useless, because they remain at the site of injection and on account of the failing circulation reach neither brain nor heart. In such case attempt must be made to stimulate the heart to action by means of indirect or direct massage. Short powerful thrusts must be made with the right hand lying upon the chest wall in the region of the heart at the rate of at least 60 times a minute. The heart is shaken through the chest wall and is thereby stimulated to contraction. This procedure usually succeeds. It must be accompanied by artificial respiration in order to overcome the supersaturation of the blood with carbon dioxide. As soon as the heart begins to beat again, one should inject stimulants in order to support its activity. If the abdomen is open the hand can be pushed through the celiotomy wound and the heart can be directly compressed and massaged against the chest wall through the diaphragm. As a last resort direct massage of the heart may be instituted after resection of the fifth costal cartilage on the left side and opening of the pericardium. Two fingers are shoved under the base of the heart and the heart rhythmically compressed against the chest wall, or carefully kneaded.

Care should be taken that chloroform is kept in a cool place and away from light. A fresh container should be opened for each operation, and when the operation is over the remainder in the bottle should be thrown away, and not used for anesthesia.

ADMINISTRATION OF ETHER

The conduct of ether anesthesia requires less care in the observation of the cardiac activity. Ordinarily the pulse remains full and strong, because ether is a stimulant to the heart muscle, while chloroform is depressant. For this reason, in patients who are sick ether is the anesthetic of choice. But after a prolonged administration ether begins to show a toxic action upon the heart muscle, and the same symptoms of cardiac depression appear as with the employment of chloroform.

On the other hand ether demands a more careful observation of the respiration, and the respiratory track. If the breathing remains strong, the inspired air being mixed with the richly secreted mucus makes a churning, gurgling noise. While this sonorous respiration

during ether anesthesia is to be taken as a sign that there is no obstruction, at the same time there is a certain amount of danger connected with it. So long as these secretions are limited to the mouth and the pharynx they are harmless, because they may be removed through lowering the head and wiping out the pharynx down to the epiglottis. But the secretion is more dangerous in the bronchi and bronchioles of the lung, from which they are not removed until the end of anesthesia. They remain there until the patient coughs them out. In this lies the greatest danger of ether anesthesia, for during deep anesthesia mucus and other material from the nose, mouth and pharynx run down into the bronchi or are inspired, and can only be removed through coughing and retching. For this reason preliminary cleansing of the mouth is particularly advisable. Many surgeons limit the otherwise copious secretion by an injection of one one-hundredth grain of atropin and one-sixth of morphine before starting anesthesia.

While in young and strong patients this mucus seldom forms a serious obstruction to respiration, nevertheless in weaker patients, and particularly those with poor hearts, it may threaten, during the course of anesthesia, to lead to suffocation. This is brought about by the fact that the tenacious mucus sticks together in a mass and in that way a narrowing of the respiratory passage results, which if the patient has not the strength to overcome, acts as an obstruction to breathing. The patient then does not become cyanotic, as would occur if the heart were affected, but pale, and the heart weakens simultaneously with respiration. The respiration and cardiac activity may be restored if at the right time the tongue is pulled out and the pharynx wiped clean.

Otherwise ether anesthesia is carried on just as chloroform. The ether is poured out of a drop bottle, at first slowly, and then faster, upon a mask which carries 12 or 16 layers of thick gauze, and the drops are increased rapidly until the stage of excitement is passed. Then when the patient sleeps quietly, as may be inferred from the sonorous respiration, the quantity is again decreased. In alcoholics the excitation is apt to be particularly severe, and it is sometimes difficult to get them under with ether alone. Instead of pouring on excessive quantities of ether, it may be advisable to start the anesthesia with chloroform or anesthol.

Experiments with the Connell anesthetometer* have shown that the inspired air must contain 30 per cent. of ether vapor by weight to

*Boothby, Jour. Amer. Med. Ass., 1913, lxi, 830.

saturate the blood sufficiently for the induction of full surgical anesthesia, and that after relaxation a 15 per cent. vapor is strong enough to prevent diffusion outward from the tissues and to maintain the requisite ether content of the blood. In alcoholics, ether apparently exerts greater excitatory power on the respiratory centre than in non-alcoholics. Naturally a greater quantity of ether is required to bring this larger volume of respired air up to the 30 per cent. requisite for induction. But an expert anesthetist using gauze and the drop method will induce an anesthesia rapidly and smoothly without causing excitement or suffocation and the deeper respiration which results. The percentage of the ether vapor may be raised by holding the hands in turn on the side of the mask, so as to increase the vaporization by their warmth.

ETHER IN MINOR SURGERY

In order to carry out minor procedures, ether may be employed in any one of a number of ways. The best known is the suffocation method, with a closed mask. A Blake cone with a close-fitting face-piece is stuffed tightly with gauze, or the outside of a Juillard mask is covered with an impermeable material, and inside is placed a tight wad of gauze the size of the fist. Upon the gauze about 2 ounces of ether is poured, the excess which is not absorbed by the material is shaken out, and the cone filled with ether vapor is set upon the face. At first the patient feels as if he must suffocate, particularly when a towel is wrapped about the edge of the cone to aid in preventing the access of air. Immediately there results a violent struggling and a sudden powerful excitation, which is increased as the irritation of the ether upon the mucous membranes causes a reflex closure of the glottis. In addition to the ether we then have the narcotic effect of the supersaturation of the carbon dioxid in the blood. This condition, which is dangerous to the heart and respiration, disappears as soon as the cone is lifted to allow a single inspiration of fresh air. The spasm of the glottis and sense of suffocation disappear, and inspiration of the ether vapor follows without further trouble until deep anesthesia is induced.

For the setting of fractures and the reduction of dislocations, for small amputations, and the incision of abscesses, this method works rapidly and gives a satisfactory anesthesia. It has been completely discarded, however, by most surgeons on account of the danger to the heart, from the sudden crowding of the ether, and the suffocation.

Naturally, it should never be used in old or weak patients or when the heart or the vessels are diseased.

A less dangerous modification of this method consists in pouring about an ounce of ether upon a cone and gradually approaching it to the face, until the irritative symptoms and the sense of suffocation have been overcome, when a large quantity of ether is poured on and the cone is placed upon the face. More ether is poured into the cone from time to time as required. This method takes longer than the suffocation method, and it demands a larger amount of ether, because it is diluted with air. But on account of the inspiration of concentrated ether vapor for a considerable time it is not harmless to the lungs and it in no way possesses the advantages of the drop method.

The method best suited for short minor procedures depends upon the employment of the analgesia which accompanies the stage of excitation at the beginning of anesthesia. This is similar to the methods of pre-anesthesia days, when the sensibility was deadened by alcohol and other exciting agents. In the ether "rausch," so called, the patient maintains consciousness, hears and answers questions, losing only the sense of pain.

The conduct of a primary etherization is carried on according to Sudek* in the following way: A mask such as is used for the drop method is laid upon the face dry, and when the patient has become accustomed to its presence a few drops of ether are applied, at first at long intervals and then more rapidly. There is no unpleasant sense of suffocation because the quantity at first is small and the dilution of the vapor with air is great. The patient may be directed to hold the arm up in the air, or to count out loud. At the end of about fifteen full inspirations, the anesthesia is tried by a needle prick. The right moment of loss of sensibility to pain is reached when the arm sinks, the counting is interrupted or the prick of the needle no longer felt. This primary etherization is not true anesthesia, for during its course the patient can answer questions and may talk in lively fashion, and sometimes even cries out, without later, at the end of the operation, being able to recall any sensation of pain. He is conscious, however, of the noise of the instruments; he hears, sees, and is physically aware of what is happening to him, but he appreciates no painful sensation. There is no danger of harmful results connected with this form of etherization; the patient may get up as soon as the operation is over.

This method is applicable particularly for the removal of stitches,

*Verhand. der d. Ges. f. Chir., 1909, p. 414.

the extraction of the roots of teeth, the incision of furuncles and the evacuation of abscesses and similar minor but painful procedures. Since reflex activity and muscle spasm are decreased but not entirely overcome, the application of this method to more extensive operations, such as the reduction of dislocations and the setting of fractures, is impracticable. The analgesia is at its height at the beginning of the "rausch," but it disappears rapidly as the administration is continued.

NITROUS OXIDE (GAS)

Nitrous oxide or laughing gas has been very generally used in America for minor surgical and dental work since its introduction in 1844. It was first applied to major surgery, in combination with oxygen, by Andrews of Chicago, in 1868. Recently, under the leadership of Crile, its use in major surgery has extended. In Europe nitrous oxide has not been adopted to any great extent, largely because the gas cannot be obtained generally at a reasonable cost and in portable form.

For minor surgical procedures it is probably the most effective agent at our disposal. It should not be given to the very young, or the aged, or those with heart or lung complications. It is not unpleasant, there is no troublesome preliminary stage of excitement, anesthesia is complete after 10 or 12 full inhalations, and recovery is immediate, without after-effects.

Naturally its use must ordinarily be limited to procedures requiring not more than a minute to carry out. However, with an experienced anesthetist, watching the color and the respiration, the patient may be kept under for as long as ten minutes, by alternating gas and air as required. It is not particularly good for setting fractures, on account of the necessary hurry, the spasm, and sometimes the involuntary movements of the patient. It is excellent for incision of abscesses, excision of carbuncles, and other rapid minor procedures, and for painful post-operative dressings. It has been generally applied in polite practice for some years as an agreeable agent for the induction of anesthesia as a preliminary to ether, using a gas-ether sequence apparatus, such as that of Gwathmey or Bennett.

The anesthesia under nitrous oxide depends upon a diminution of the oxygen supply to the brain, as part of a general pseudo-asphyxiation. Cyanosis is one of the accompanying phenomena. The zone of harmless anesthesia, however, is narrowly limited, and the pressure of the gas and the proportion of air must be regulated with watchful

care. With an over-dose the cyanosis increases, the respiration becomes stertorous and sometimes crowing, muscular twitchings appear, which develop into clonic contractions and possibly a general convulsive seizure, and the patient if neglected dies. Deaths under gas, however, are practically unheard of, as there is ample warning, and fresh air relieves the symptoms.

Gas can be purchased in containers of various sizes at the cost of a few cents per anesthesia, from makers throughout the country. Some hospitals make their own gas, and pipe it under low pressure to the operating rooms. The apparatus for its administration should be the simplest possible. It consists of a yoke, to make connection with the tank, which has a handle to control the flow. A large size rubber tube goes from the yoke to a rubber balloon, holding when inflated about two gallons. A short tube, about one inch in diameter, runs to the face piece. This should be made with an inflated rubber pad to fit the hollows of the face, or a rubber sleeve, to strap behind the head. It should entirely exclude all outside air. There should be a large expiratory valve, which may be closed, and a valve on the intake, which should allow of all gradations from pure air to pure gas, and for rebreathing into the bag.

For *major operative work* oxygen must be supplied with the gas, in varying proportions. The best apparatus, of which the Boothby machine is an example, are equipped with a device for turning ether vapor into the circuit also as needed. Crile has used gas-oxygen in over 4,000 general surgical cases, and he states that it reduces mortality and lessens suffering. Shock occurs less than one-half as frequently as with ether, and "apparently the worse the risk the better it acts." It is not unpleasant to take, the nausea is trifling, and complications rare. The cellular degeneration in brain, kidney and liver is probably much less than after the use of any other anesthetic agent. The post-operative impairment of vitality is distinctly less, and if occasion arises, the patient shows no hesitation about returning for another operation.

On the other hand it must be said that the apparatus for its administration is costly and complicated, and that the gas and oxygen are items of no inconsiderable expense, standing the occasional administrator in private practice $15 or more for a long anesthetization. No one but a skilled person should be trusted with the method, and he must give his undivided and intelligent attention to the patient. A preliminary injection of scopolamin-morphine is usually considered

necessary. On account of the persistence of muscle spasm ether vapor must frequently be employed, or novocain or some other local anesthetic injected into the muscles along the line of incision. The unaccustomed surgeon is hampered and the operating time is considerably lengthened by the increased venous hemorrhage, the spasm, and the time necessary for the local injections to take effect.

At the present stage of its development the method is distinctly one for hospitals where particular interest can be given, trained anesthetists developed, and the surgeon re-educated. According to Crile, the results well repay the effort.

ETHYL CHLORIDE

To obtain in the office or out-patient clinic a reasonably safe ephemeral anesthesia, ethyl chloride, such as may be obtained in glass tubes with a spring stopper, has been used for some years. The best mask is an ordinary chloroform mask covered with gauze, but over the gauze a piece of rubber tissue should be fitted, with a hole at the middle the size of a five cent piece. Upon this the spray of ethyl chloride is played; the warmth of the hand suffices after the stopper is open to vaporize the ethyl chloride and drive it out under pressure through the capillary canal in the neck of the tube. In children the spray is unnecessary, and the ethyl chloride may be given in smaller quantity drop by drop, by partially opening the stopper. One hundred drops or a spray which is played for about twenty seconds induces a complete loss of sensibility to pain. Patients may be lying down or in a sitting posture. They are not unconscious, but can open or shut the mouth and may grip the arms of the chair. A short period of reaction usually follows, during which the patient laughs and talks unrestrainedly or acts as if partially intoxicated. Ethyl chloride is economical because the tube allows its being used in small quantities. Ethyl chloride should not be used for complete anesthesia on account of its dangerous possibilities.

SPINAL ANESTHESIA

In old persons with degenerated heart muscle, arteriosclerosis, and chronic bronchitis, we have at times in operations in the lower abdominal region or on the lower extremities made use of spinal anesthesia after the method of Bier. At first we used stovain, but more recently we have employed the older and less dangerous drug, tropacocain hydrochlorate. It is less powerful as an anesthetic, but it is easily sol-

uble in water and may be freshly sterilized before use. Many surgeons use the drug in powder form, placing it in the barrel of the syringe and allowing it to dissolve in the aspirated meningeal fluid. A dose of 9/10 grain in a half dram (2 c.c.) of the fluid serves to induce anesthesia in five to ten minutes from the navel downwards. The tropacocain may be bought dissolved ready for use in glass ampullæ. Novocain has no advantage over tropacocain even when its effects are heightened by the addition of adrenalin.

The successful employment of spinal anesthesia depends chiefly upon the technique of injection. If when the needle has penetrated into the dural canal and the anesthetic has been injected, the expected effect does not appear, the fault lies either in incomplete solution of the powdered drug in the spinal fluid, or its mixture with blood, a leaking out of the fluid through the site of injection, or in the posture of the patient. With skilled technique these difficulties diminish so that with surgeons practised in the method bad sequelæ and death rarely occur. In our own limited experience we have seen neither death nor persistent disturbances of any sort, but at the beginning we had several failures.

The harmful results depend upon the toxic effects of the drug upon the nerve tissues. Particularly commonly observed are fainting and collapse, nausea and vomiting, and particularly the almost regularly occurring headache. The most dangerous is the disturbance of respiration, which in certain cases has proceeded to fatal paralysis of the respiratory centre. Some authors refer this to the use of the Trendelenberg position after injection, but this does not coincide with the experience of gynecologists. If the operation necessitates the Trendelenberg position, it should not be assumed until anesthesia has begun, in other words until the drug has gone into chemical combination with the nerve cells.

Others lay the blame upon too large a dose. Jonnescu believes that he can avoid respiratory paralysis as well as other disturbances by adding 1/640 grain of strychnine nitrate to the injection. A small addition of suprarenin to this mixture will lessen its toxic action.

In addition to respiratory paralysis many authors describe a form of muscular paresis, most commonly affecting the eye muscles. They appear for the most part after the lapse of a week, and disappear again after a short time. Disturbances in motility of the lower limbs and in control of the bladder and rectum seem to be only temporary, although they have, in certain cases, persisted for some time. Finally

among the deleterious results appears a group of meningeal irritative symptoms, such as neuralgia, paresthesiæ, and persisting head and back-ache. They are the least dangerous of the sequelæ, but they are the most pernicious and agonizing for the patient, and often resist large doses of morphine.

Spinal anesthesia is on the whole very well borne by old patients. Bier* recommends it in particular for the excision of carcinoma of the rectum and for extensive resection of the bony pelvis, and states that such patients after its use feel much better than those who have had general anesthesia. It may be employed also for the larger gynecological procedures, for instance, the Wertheim extirpation of the uterus. The method should not be used in children, anemic and septic patients, and all those with affections of the brain, spinal cord, and nerves, particularly when the same result can be obtained with local anesthesia.

The preparation corresponds to that for general anesthesia. The patients would stand the effects better, undoubtedly, if they were not obliged to fast. But fasting is necessary because it must always be reckoned that the method may fail and that general anesthesia may have to be used. Also care must be taken that the bladder and colon are empty, for we have observed soiling and fatal wound infection after paralysis of these two organs. Scopolamin-morphine is used just as before inhalation anesthesia.

To carry out the injection the patient sits across the operating table with his shoulders bent forward and legs hanging. The region of the lumbar spine and the sacrum is painted with tincture of iodine and the spinous process of the second lumbar vertebra is marked with a fine needle or with the point of a scalpel, by a superficial scratch. Exactly in the middle line, in the second lumbar space, a fine trochar carrying a cannula is inserted, pointing slightly upwards, until the patient expresses sensitiveness as the spinal dura is penetrated. The spinal canal is successfully reached when upon withdrawal of the trochar a clear liquor runs out of the cannula. In order to prevent too great a loss of spinal fluid the index finger is placed over the mouth of the cannula. Immediately the syringe in which the drug has been previously placed, either dry or dissolved in sterile water at a moderate temperature, is connected with the cannula and several c.c. of the fluid aspirated into it in order to make an even mixture of the liquor and the anesthetic. Then under gradual pressure the contents of the

*Verhand. der Deutsch Ges. f. Chir, 1909.

syringe is emptied into the dural canal. Then the syringe and the trochar are pulled out and the skin puncture is sealed with gauze. Thereupon the patient is laid upon his back and from time to time the progress of the anesthesia is tested by means of the point of a needle. It usually takes ten minutes for the motor and sensory paralysis to reach the desired grade.

Anesthesia obtained with 4/5 grain of tropacocain on the average lasts for an hour, while stovain anesthesia lasts longer. First the perineum becomes insensitive, then the leg, and finally the skin of the abdomen as far up as the navel. The anesthesia disappears in the reverse order. If after an interval of fifteen minutes the anesthesia is absent or incomplete, the injection may be repeated in the same place or in the next intravertebral space, above or below.

Anesthesia may be successfully induced to a higher level than the navel if a higher intravertebral space is employed for the injection. There is no question, however, but that the dangers of injury to the cord and paralysis of respiration increase with the height of injection. Jonescu has carried out the stovain-strychnine injection several times without fatality in the cervical cord itself. The danger of injury of the spinal cord is very small in the region of the third lumbar vertebra and below, for from the second lumbar vertebra down the dura contains only the cauda equina. In this region the broad cysterna lumbalis of the arachnoideal sac protects the roots.

The upper limit of the anesthetic zone may be raised above the navel if after the injection the patient be changed from the horizontal to the Trendelenberg position, and held in this position for a short time. In this way the higher spinal roots are bathed in a portion of the solution. If this change in position is not made immediately after the injection, the solution will affect only the nerve roots proximate to the point of injection; but there is a certain risk in assuming this position just after the introduction of the solution, as there is danger that fibres of the phrenic nerve may be paralyzed. But later on this position has no prejudicial effect on the length or the danger of spinal anesthesia, as may be understood from the experience of gynecologists. The least dangerous method for extending the anesthesia consists in the distribution of the anesthetic over a greater extent of the spinal cord. This may be attained by aspirating more than 5 c.c. of spinal fluid into the syringe and reinjecting it into the dural canal. By mixing 4/5 grain of tropacocain with eight to ten c.c. of spinal fluid the loss of sensibility as a rule reaches as high as the margin of the

ribs, so that even a celiotomy may be carried out without pain and without muscle spasm.

Since most failures depend upon faulty technique, the following points must be observed with particular care: It is important that a fine needle be employed so that the injected fluid will not run out through the opening in the dura. This will happen if the puncture is large, because the pressure of the fluid in the dural canal is rather high, even under normal conditions. Quincke states that the normal pressure varies from 50 to 150 mm. of water and the pressure must be over 200 before it can be called abnormal. This explains how, in case the internal pressure is increased, a certain amount of fluid may be forced out through the puncture before it has time to act upon the nerve roots. It is also important that the instruments which are brought in contact with the anesthetic are absolutely free from remnants of soda bicarbonate, for even minor traces of alkali will neutralize the solution, which is active only in an acid medium. For this reason the necessary instruments and vessels should be sterilized in plain water or any adhering soda must be washed off with salt solution from all parts of syringe and cannula. If this is omitted, failures will sometimes result therefrom in spinal and even in local anesthesia.

Lack of skill in lumbar puncture may cause failure. To find the dural canal and inject the solution among the roots without injury to the cord, the puncture is made exactly in the middle line in the second or third interlumbar space. At the level of the first lumbar disc the conus medullaris frequently is not completely threaded out into the fibres which make up the cauda, and its lower end may be exposed to injury from the point of the needle. Such a contingency would prevent the fluid from reaching the surrounding nerve roots. The same thing is to be feared when the needle is inserted from a point to one side of the spinous process, or in the lateral posture. To be sure it is sometimes impossible to reach the dural canal through the middle line on account of a kyphosis of the spinal column; or when the spinous processes of the lumbar vertebræ instead of being horizontal are oblique, and if the intervertebral space is unusually narrow. The attempt is then made to introduce the needle from the side, between the laminæ. In this case the position of the point of the needle cannot always be exactly located, and it is possible that the injected fluid comes in contact only with the nerve roots on one side, in which event an irregular hemianesthesia results. Similarly it is unwise to insert the needle with the patient in the lateral posture on account of diffi-

culties which arise in attempting to give the needle the desired direction. Failure from these sources may be avoided if the patient is seated, with the upper portion of the body bent forward so that the vertebræ are separated as far as possible.

If the counting off and marking of the second lumbar interspace has been omitted before the disinfection, the hem of a sterile towel is stretched between the crests of the iliæ. This will cross the middle line at the spine of the fourth lumbar vertebra and from this point the second space may be easily arrived at.

Another source of failure lies in the mixture of the solution with blood. Occasionally a certain amount of bleeding may not be avoided, particularly after puncture in the middle line. It spoils the injection, because the solution goes into chemical combination with the blood before it has a chance to come in contact with the nerve roots. For that reason the fluid which flows from the cannula must be as clear as water. Bleeding usually occurs when the needle does not reach the dural canal, but scrapes the surface of the lamina. When this happens it must be slightly withdrawn, and reinserted in an altered direction. Veins in the ligamentum subflavum may be the source of bleeding, particularly in punctures made from one side of the middle line, and if the needle is introduced too deeply it may meet veins lying along the opposite wall of the dural canal. As long as a blood-tinged fluid appears from the cannula the injection must be postponed. To avoid the point of the needle meeting the anterior wall of the dural canal it should not be introduced in thin persons deeper than 5½ cm., or in obese persons more than 6½ cm. If when the mandrin is removed clear fluid does not flow out, it may be obtained sometimes by simply twisting the cannula. Before it is pushed in deeper it should be withdrawn ½ cm. or so in order to be sure that it has not already met the front wall of the canal. If it is to be pushed in further the mandrin must always be replaced.

LOCAL ANESTHESIA

While general anesthesia is caused by the influence of a drug upon the cortex, local anesthesia depends upon the paralysis of the sensory nerve endings within the operative field or upon an interference with the conductivity of the nerve tracks which supply the field of operation.

Of the various methods which are employed at the present time for instituting local anesthesia many have been in use for a considerable period. For instance, cold has long been known to overcome sensi-

bility to pain, and anesthesia by freezing is now induced by chemical means.

FREEZING

Freezing in superficial operations is now accomplished by the use of ethyl chlorid. This highly volatile fluid may be obtained in glass tubes with a spring stopper. When the stopper is removed the fluid, which is volatilized by the warmth of the hand, squirts out through a capillary opening in the neck of the tube. A limited area or a strip of skin may by means of this spray be rendered insensitive to pain. The liquid spray striking the skin abstracts the heat necessary for its volatilization, as is shown by the formation of a layer of stiff frost. When this appears, the surface is ready for incision. It will form more rapidly if one blows meanwhile upon the skin. If the spray is long continued, superficial necrosis may result.

For the opening of furuncles and incisions for the removal of foreign bodies or the puncture of an aspirating needle this form of local anesthesia suffices. However, one must be careful not to use the Paquelin cautery on a surface frozen with ethyl chlorid, for the preparation is inflammable and burns of the skin may result. Freezing fails as soon as deeper layers of the tissues are to be separated. In order to render regions below the skin anesthetic for operative purposes the employment of drugs by injection is necessary.

INFILTRATION AND CONDUCTION ANESTHESIA

COCAIN AND ITS SUBSTITUTES

The development of local anesthesia, which is at the present time employed not only for superficial procedures, but for almost all known operations, began with the introduction of cocain into ophthalmology by Koller. Cocain has a strong toxic action which even after the injection of small doses may induce collapse and fainting and in larger doses cramps and paralysis of respiration and of the heart. With a maximum dose of 4/5 grain evidences of toxic action may appear. In no case should the amount used in any given operation exceed 1½ grains. Moreover, cocain diluted to 1 per cent. may cause active symptoms of irritation at the site of injection, but the burning pain disappears as soon as the drug has taken effect upon the nerves.

In spite of its toxicity and the irritation which it causes, cocain is still used to-day for superficial anesthesia of the mucous membranes of

the nose, pharynx and mouth. Strong solutions of five to twenty per cent. are used; they are applied by means of a sterile brush or a pledget of absorbent cotton. In the conjunctiva of the eye a three to ten per cent. solution is instilled. Within a few minutes anesthesia occurs, followed immediately by a strong anemic action, so that superficial procedures may be carried out with a clear field and without pain.

The infrequency of cocain poisoning in spite of its use in strong concentrations as a local application depends upon the slow absorption, which results from the contraction of the vessels. But toxic symptoms are always possible. They are especially likely to appear if cocain is injected under pressure into the meshes of the skin or into closed cavities such as the bladder. On this account its use even in mild solutions is being given up for less dangerous and at the same time less anesthetic preparations such as eucain, alypin, tropococain and particularly novocain. Novocain has given general satisfaction on account of its freedom from local irritation, so that injections may be made without pain and without later disturbances of the nutrition of the tissue, and on account of its high relative freedom from toxicity; it is much less toxic than cocain and large quantities may be injected into the skin without danger.

For the production of local anesthesia many methods are described. The widely used *Schleich infiltration method* consists in saturating the tissues by layers in considerable quantities of a very weak cocain solution. A wheal appears as the result of the first subepidermal injection, and a line of these is created across the operating field, corresponding to the line of incision, by inserting the needle each time obliquely at the edge of the wheal just created. Then through this insensitive field the dermis is infiltrated. After the skin is divided, the deeper layers are infiltrated and cut. With this technique the tissues are puffed with fluid, and assume a glassy aspect, so that the normal appearances are considerably disturbed. The lack of sensibility to pain depends upon the fact that the nerves are saturated with the solution at the same time as the other tissues.

Conduction anesthesia consists in a paralysis of the nerves which go to the operative field. Hackenbruch arrives at this result by making a series of injections encircling the field without infiltrating the skin or the subcutaneous tissue of the operative site itself. Since all the nerves going to the operative field must be met in such a procedure, anesthesia through infiltration is unnecessary. The method of Oberst in the same way depends upon a paralysis of nerve con-

ductivity. In operating upon fingers and toes the nerves which go to the middle and the terminal phalanges are met in the connective tissue close to the periosteum of the first phalanx, as near as possible to the hand or foot, by means of a series of injections completely surrounding the digit. The effect of the anesthetic is increased by first rendering the part anemic by means of an Esmarch bandage and turniquet, because in a part which is empty of blood and with the circulation interrupted, absorption is hindered and the local effect is increased. The same effect may be obtained by the use of suprarenin. Braun originated a similar procedure for the amputation of limbs. After Esmarch anemia has been obtained, the cocain solution is injected close to or about the nerves which supply the limb so that the solution may diffuse into their substance. More advantageous is the endoneural method of Cushing, Matas and Crile, by which each separate nerve trunk is freed up by dissection and the injection made directly into its substance.

Each of these various methods has its own peculiar disadvantages, with the single exception of the method of Oberst, which prevent their general employment. The painfulness of the wheal formation at the beginning of infiltration anesthesia, and of the application of the Esmarch bandage in regional anesthesia, the unnatural appearance of the tissues, which are swollen with fluid from the injection, and finally the danger of poisoning even when a small quantity of cocain is used, added to the difficulties of technique for a long time created a prejudice against local anesthesia, so that frequently, even where it might properly be used, inhalation anesthesia was given the preference. The swing in the pendulum began with the recommendation of Braun that cocain might be replaced by the non-toxic and unirritating novocain, and its present popularity began to develop with his discovery of the advantage of the addition of suprarenin to the solution.

BRAUN'S PROCEDURE

The active principle of the extract of the suprarenal gland, first recognized by Furth and obtained in crystalline form by Takamine, possesses the power of inducing strong contraction of the blood vessels, and as a result, of producing an almost bloodless zone in the tissues. This effect appears even if the drug is strongly diluted. When it became possible to produce the drug synthetically and chemically pure, which could even withstand sterilization by boiling for a

short period, no further theoretical objection to its use for injection appeared. Ten to fifteen drops of one to a thousand solution in 100 c.c. of a 1/2 per cent. novocain solution admirably answers all purposes. In a short time after the injection an anemia of high degree appears at the site of injection, which is equivalent to the anemia obtained by the procedure of Esmarch. As the result of the reduced or practically suspended circulation of the injected limb, an early absorption of the drug takes place, and at the same time its general toxic action is limited and its local effect increased. For this reason when combined with suprarenal extract only small quantities of novocain are necessary. But on the other hand larger quantities of novocain may be used, if the operation is extensive enough to make it necessary, without causing danger of poisoning.

By means of this combination of the anesthetic with suprarenin it was first successfully brought about that the slow and often painful infiltration anesthesia of Schleich, limited in its application to the subcutaneous tissues, and conduction anesthesia for the deeper parts, might be combined and developed as the basis of a safe and harmless method of wider application. And moreover it became unnecessary to inject directly the nerves which serve the operative field, for as a result of the anemia-inducing action of the suprarenin the anesthetic remains for a longer time at the site of injection, and if this occurs in the neighborhood of a nerve, it diffuses into it sufficiently to overcome its conductivity.

ADVANTAGES AND DISADVANTAGES OF LOCAL ANESTHESIA

While at first local anesthesia was limited in its applicability to minor surgery, with the recognition of the advantage of the combination of novocain and suprarenin and with the development of the technique of injection, the field has gradually broadened, so that to-day it has become possible to employ it for all the typical operations upon the head, trunk and extremities without pain and without the aid of inhalation anesthesia. For certain operations local anesthesia is practically necessary, because general anesthesia is contra-indicated. This is true of all procedures upon the air passages and in their vicinity. It is indicated also in all cases in which the danger of general anesthesia is out of proportion to the importance of the operation, and when disease of heart muscle forbids inhalation anesthesia. The harmlessness of local anesthesia is its greatest advantage.

In spite of recent wide extension of its use in major surgery, it

would not be advisable to consider that local anesthesia can replace general anesthesia in every case, for there always remains a certain class of patients in whom the procedure for technical reasons cannot readily be carried out, or whose psychic state contra-indicates its use. Even when nervous perturbance and anxiety have been largely overcome by the previous use of scopolamin-morphine, which we never omit in large operations under local anesthesia, the excitation of such patients, during the operation, may increase to such a stage that it is not without danger to the heart and mind, and the bodily agitation also endangers asepsis. Most of the patients who have been trephined under local anesthesia state that they have felt no pain from the incision, but the sawing and chiseling of the bone brings back frightful memories. And the psychic trauma arising during the preparation and the course of the operation is not to be looked upon lightly, and in order to impress this, it is necessary only to recall the reports from the period before the use of anesthetics, according to which patients have died in shock waiting for a tooth or nail to be extracted. Hysterical and nervous patients and most children are not fit subjects for local anesthesia, and on humanitarian grounds it is only right that if a patient desires general anesthesia it should be given, if there is no contra-indication.

Certain physical conditions contra-indicate the general employment of local anesthesia more definitely even than mental states. It is to be regretted that the very patients who cannot stand general anesthesia on physical grounds are also poor subjects for local anesthesia. Among these all cases of sepsis which are not definitely localized, and advanced arteriosclerosis, particularly when it is combined with gangrene or diabetes, are to be reckoned. Also it must be stated as a principle that malignant growths should not be removed under local anesthesia, because the insensitive field of the conduction anesthesia is limited, and the course of the operation not infrequently makes it necessary to overstep the bounds.

With the exception of hernia we can find no advantage in the employment of local anesthesia for celiotomies. The abdominal wall can always be opened without pain, but handling, tying and cutting in all portions of the mesentery cause agony. Fainting with weakening of the pulse, and disturbing pallor, may be the accompaniment of a rapidly carried out appendectomy as soon as tying off of the meso-appendix is begun. Also in patients who are reduced by starvation as the result of stricture of the pylorus or at the cardiac end of the

stomach, the establishment of a gastro-enterostomy or of a gastric fistula under local anesthesia has no advantage over inhalation anesthesia. One can readily succeed in reaching the stomach without pain in every case, but the collapse and the reflex shock caused by the handling of the viscera of a patient who is not completely anesthetised is at least as dangerous as the small amount of anesthetic necessary to put such an emaciated and weak patient to sleep. And the proportion of fatalities during the first week after establishment of a gastrostomy under local anesthesia is no less than under general anesthesia. And moreover it can be said definitely that post-operative pneumonia after celiotomy does not disappear with the employment of local anesthesia. Although we have for a considerable time carried out operations under local anesthesia on aseptic and uncomplicated stomach cases, inguinal hernias and interval appendices, without picking patients in whom inhalation anesthesia might be contra-indicated on any grounds, several of these did not forbear to develop on the second or third day a typical broncho-pneumonia. None of those so operated on died, but the fact itself has determined us to employ local anesthesia in laparotomies only when some definite contra-indication to general narcosis exists.

Finally one other circumstance cannot be omitted in considering the subject of the general application of local anesthesia. Cocain and novocain do not allow of the most acceptable sterilization, and suprarenin is particularly sensitive to boiling. It breaks up just as cocain does when once heated, so that the solution cannot be satisfactorily sterilized. In the same way the tablets of novocain and suprarenin which are on the market and are said to be free from bacteria, show the presence of bacteria when the solution is prepared. We have had one fatal case of infection following the extirpation of the Gasserian ganglion, resulting from not boiling the solution before injecting. Previous to this case no single anesthesia with the so-called bacteria-free tablets simply dissolved in sterile salt solution had resulted in infection. But on the other hand it has been found to be a rule that novocain-suprarenin solution after efficient sterilization loses a good part of its activity, and that boiling the solution once does not suffice to kill all pathological bacteria, and we consider ourselves justified in laying the blame of the infection in this case upon the injection, because in eighty-one extirpations of the Gasserian ganglion carried out under exactly the same conditions there appeared no disturbance of asepsis.

TECHNIQUE OF LOCAL ANESTHESIA

For injection we use an all-glass syringe holding five or ten c.c., to which thin needles of various lengths, straight and angular, may be attached by means of a push or bayonet joint, which allow ready removal of the empty syringe, and the attachment of a freshly filled one, without disturbing the needle. All instruments and vessels with which the novocain solution is brought into contact are not allowed to be boiled in soda solution, as even traces of alkali break up the suprarenin and the novocain and render them useless.

To make this solution we use a novocain-suprarenin tablet which contains 2 grains of novocain and 1/500 grain of L-suprarenin. One tablet is dissolved in 7 drams of physiological salt solution, which gives a ½ per cent. solution, which suffices for infiltration and usually also for conduction anesthesia. Although the tablet is guaranteed sterile, nevertheless in our experience several cases have shown this to be uncertain. For that reason we employ the method of H. Braun for making and sterilizing the solution. He advises that one, two or four tablets be placed in a sterile test tube and covered with physiological salt solution, to each liter of which three drops of diluted hydrochloric acid have been added, and dissolved by boiling. This stock solution may be diluted to any strength by the addition of sterile physiological salt solution.

ANESTHESIA OF THE SUPERFICIAL AND DEEP TISSUES

Local anesthesia is best adapted for the superficies of the body, since a series of injections into the areolar sub-dermal or sub-mucous connective tissue after the method of Hackenbruch can be relied upon to destroy all sensibility. As all the sensory nerves reach the skin and the mucous membrane through the connective tissue, the solution after a little time will diffuse sufficiently into the nerve bundles. Accordingly, circumferential injection suffices for small wounds or foci of disease, such as furuncles, papillomata and small tumors, but for lipoma and larger fibroma, sebaceous and mucous cysts and other more extensive growths, which penetrate into the subjacent tissues, an injection of the deep layers is also necessary. Movable tumors should be lifted up as much as possible so that the needle does not enter the tumor but the loose tissue about it. Naturally it will often be necessary to make injections even under the fascia in order to block the nerves there. While anesthesia appears rapidly in small blocked-out fields in the skin or mucous membrane,

in more extensive blocking and in subfascial injection a longer time, five to twenty minutes, is necessary. Braun explains this by saying that the terminal nerve filaments which are without sheaths in the vicinity of the end organs take up the anesthetic more rapidly than the larger nerve trunks. With these the diffusion of the injected fluid acts slower, because the fibres as well as the larger bundles are surrounded by a protective sheath, which becomes thicker as the nerve proceeds toward the cord.

Upon this principle depends our method of anesthetization of the deep layers of tissue. Utilizing our knowledge of anatomy, we attempt to inject a few centimetres of the solution as near as possible to the nerve fibres which supply the operative field. As soon as this has been done to all of the nerves which have to be taken into account, the deep layers of the skin are infiltrated in a broad strip, which covers the line of incision. This injection is made last, because the anesthesia of the skin occurs very rapidly. The deep layers become insensitive after an interval of about fifteen to twenty minutes, and remain so for about an hour.

BLOCKING OF LARGE NERVE TRUNKS

For the blocking of large nerve trunks we never use a solution stronger than ½ of 1 per cent., although as strong as 1 or 2 per cent. has been recommended. The quantity of injected solution, however, as we have shown, is not an important matter, and we have never seen evidences of toxic absorption, although we have used at times more than 5 ounces of the ½ per cent. solution. If it happens that an injection does not reach the vicinity of the nerve, another attempt must be made.

In fat patients it is hard to reckon the depths of the nerve, as this may not be constant. One will succeed much more readily in reaching the neighborhood of the nerve if its location is determined by a bony prominence or by some other readily palpable landmark.

CIRCUMINJECTION OF THE VESSELS

The proximity of large vessels is not particularly a matter of anxiety so far as the injection goes. One cannot always avoid meeting them, and in order to recognize the injury immediately we use the following scheme: The needle is introduced attached to the syringe, and as soon as the point has reached the desired place the piston is

slightly withdrawn. If blood is sucked into the cylinder, the needle is drawn back and reinserted in another direction. By the color of the blood one may recognize whether a vein or artery has been injured; in either case the incident should have no result upon the anesthesia. Even when the solution is injected not into the tissues, but into a vessel, no harm results. In order to make as small a wound in the vessel as possible in all deeply penetrating injections, we make use of as fine a needle as possible, which adds something to the difficulty of the injection. If the bleeding from the puncture does not stop immediately, temporary light pressure with a sponge will overcome it. Moreover, the tiny wounds of the vessel wall close themselves rapidly under the influence of the suprarenin.

This vaso-constrictive action is also of significance in other respects in carrying out conduction anesthesia in the deep tissues. To induce anesthesia injection about the nerves is sufficient, but in conjunction with the loss of sensibility to pain one also obtains usually an excellently clear field which is not in the least obstructed by bleeding. This results from the fact that the vessels and nerves run together practically all over the body, and both are equally affected by the influence of the suprarenin. Where this is not the case, for instance in isolated venous plexuses, lying upon muscle or bone, or in the case of arteries running by themselves, one can induce anemia of the operative field by injecting the solution about these vessels, in addition to the perineural injection. This does not always follow, but we have carried it out satisfactorily several times, particularly in procedures upon the skull.

The amount of suprarenin contained in the tablet is sufficient to induce a complete closure of the small vessels and a narrowing of the larger ones, but its influence is not sufficient to stop bleeding from the large vessels. This is of importance as regards the final hemostasis, as all the bleeding points which appear during the operation and which represent vessels which have become anemic under the influence of the suprarenin must be caught and tied, if there is to be no question of secondary bleeding and hematoma formation after the operation. Tying of the vessels will be found very painful if the anesthesia is inadequate, and for that reason it is necessary in order to create a satisfactory anesthesia to carry out the separate injection of the nerves and the vessels, in so far as they are separated from each other.

CIRCULAR INJECTION OF THE SOFT PARTS AND BONE

All the remaining soft parts which lie in the deeper layers of the body may be rendered anesthetic in a similar way through conduction anesthesia. The brain and most of the viscera as well as bone possess themselves a very low grade of sensibility and no particular experience is necessary in order to operate upon them painlessly, but on the other hand the parietal layers of the pleura and of the peritoneum, tendon sheaths, wide muscle fasciæ and aponeuroses, the dura mater and periosteum as well as the perichondrium, are usually sensitive. But since their nerves lie outside of the organs which they protect, to induce anesthesia it is sufficient to inject superficially the sections which fall within the operating field.

Peritoneum and transversalis fascia are also so insensitive that for them a circumferential injection of the connective tissue under the deepest layer of abdominal muscle suffices. A special injection of the fascia or even of the peritoneum is unnecessary. In thin belly walls the danger of puncture of the peritoneum is very slight, because if the needle is introduced slowly the resistance of the transversalis fascia can be felt distinctly. In muscular and fatty abdominal walls one cannot always depend upon introducing the needle to the desired level, so as just to feel the resistance of the transversalis fascia.

In the same way it is unnecessary to introduce the solution under the periosteum in order to operate without pain on the periosteum and bone. From the connective tissue between it and the soft parts which surround it the nerves and vessels penetrate to it and likewise to the bone itself, and it is at this point that the conductivity is interrupted.

Muscles are the most sensitive at the place where the nutritive vessels and nerves enter, but large sections are so insensitive as to allow themselves to be cut without pain, even without anesthesia. Similarly operations may be performed without pain on the long tendons; they are sensitive and require anesthesia only where they are covered by tendon sheaths. Bone, muscle and tendon are all anesthetized on the same principle, that is by the saturation with the anesthetic of the connective tissue which surrounds them and which contains the nerves and vessels which go to them, from several points in front and behind, above and below.

SPECIAL PROCEDURES

In accordance with these general remarks it is evident that as many methods may be conceived for its accomplishment as there are opera-

tions. Any one who understands the mechanism of anesthesia and is acquainted with the course of the more important nerves can in any particular case easily and satisfactorily render the operating field insensitive. For that reason it is unnecessary to explain methods for conducting an operation under local anesthesia which are self-evident. But one must recognize the value of the work of Braun, who first showed the advantage of joining suprarenin with the anesthetic agent, and of combining infiltration and conduction anesthesia, by which cocaine operations are no longer limited to minor procedures upon the peripheral portions of the body, but are extending rapidly to include complicated cases in the depths and in the large body cavities.

LAMINECTOMY

Some time ago we did our first laminectomy under novocain-suprarenin anesthesia. The fluid was injected a few finger-breadths above and below the spinous process of each vertebra involved. After a few wheals were formed in the middle line along the planned-out incision, in order to make the skin insensitive to the deep punctures, the needle was next inserted through the wheal to one side of the spinous process down to the lamina, and by elevating and then depressing the point, about 5 c.c. was injected above and below. Then it was drawn nearly out and passed down the other side of the spinous process, where the same procedure was repeated. This process was carried out for each of the wheals. Before the needle was completely withdrawn, the skin was rendered insensitive by subcutaneous injection.

Incision of the skin and muscle as well as the removal of the periosteum from the spinous processes and laminæ were entirely painless and there was practically no bleeding. The trephining of the lamina was painless and, following this, the cutting of the lamina with the laminectome was painful as often as the instrument came in contact with the dura. If this was avoided, however, the biting off of the remnants of the lamina with the rongeurs was hardly to be felt. Pain was only experienced during the extradural probing between the dura and the laminæ and in sponging the dura, and with every contact with the posterior surface of the cord, and particularly the posterior roots.

TREPHINING

We have also employed local anesthesia for trephining, in the attempt to avoid the dangers and injurious effects of a general anesthetic. The technique of this procedure presents no difficulties; it

consists of a circumferential infiltration of the field of operation, under the aponeurosis as well as subcutaneously, from various points. It is unnecessary to insert the needle under the periosteum, and this is without any advantage, and causes pain. Anesthesia of the periosteum and bone appears in ten to fifteen minutes. Injection renders unnecessary special procedures for hemostasis, for within the given time the field which has been encircled by injections becomes so empty of blood that few if any vessels have to be caught and tied. In trephining over the cerebellum the depth of the occipital fossa makes it necessary to introduce the needle through the entire mass of the muscles of the neck. A separate injection should always be made in the neighborhood of the occipital artery, which may be met near the tip of the mastoid process behind the sterno-mastoid muscle.

In spite of the fact that the technique of local anesthesia for trephining presents no difficulties and that anesthesia may be induced with assurance, it is a question whether the procedure presents unconditional advantages for the patient. For trephine cases the contraindications which we have noted above hold against a too general employment of local anesthesia. The psychic influence of fear and anxiety are not to be taken lightly, and scopolamin-morphine cannot be employed for brain tumors because the cardiac and respiratory centres are usually damaged from increased intracranial pressure and the scopolamin works a similar paralytic effect. The patients are usually considerably stirred up during the cutting of the trap door in the skull and they complain considerably during the process, and for a long time afterward, because they have been deprived of the advantages of general anesthesia. Moreover, we have several times had the experience that patients after the injection fall into a deep sleep, out of which they awaken for a moment, but do not stay awake long enough to take a deep breath. Particularly we would like to call attention to the fact that one patient with a tumor of the temporal lobe in whom local anesthesia was employed without the prophylactic scopolamin injection succumbed as the tumor, which had grown onto the dura, was lifted out, without it being possible to differentiate the manner of death from such as is sometimes observed in brain cases which have had general anesthesia.

OPERATIONS ON THE FACE

Procedures on the face may as a whole be carried out very satisfactorily under local anesthesia, because the branches of the trifacial

nerve are readily accessible to injection outside of the skull. Thus the frontal nerve may be found at the supra-orbital notch, the infra-orbital nerve at the infra-orbital foramen, or, deeper, on the floor of the orbit, the inferior dental nerve inside the mouth just above the lingula, which projects over the inferior dental foramen of the lower jaw, and the lingual nerve at the side of the mouth in the fold of mucous membrane between the tongue and the floor of the mouth. The teeth of the upper jaw may be rendered insensitive by injection at the juncture of the gum with the mucous membrane of the lip, although a considerable time must elapse to allow the fluid to diffuse through the thin shell of bone comprising the outer wall of the antrum of Highmore. H. Braun has shown that in the extraction of upper teeth the gum about them should always be injected. The lower teeth may be readily anesthetized through an injection of 5 c.c. above where the lingula of the lower jaw can be felt with the finger.

To carry out extensive operations upon the soft parts of the face such peripheral injection does not suffice to create a satisfactory anesthesia. On account of the rich anastomosis of the terminal branches of the trifacial it must be supplemented by a circumferential infiltration of the operative field. There is considerable advantage in the fact that such a complementary injection of the field facilitates operation greatly by its effect of limiting the flow of blood.

The extraction of branches of the trifacial in the treatment of neuralgia can only be carried out painlessly when they are anesthetized as closely as possible to the Gasserian ganglion, either at the base of the skull or in the ganglion itself. For the first branch, on account of its intracranial course and its close relations to the optic nerve and the nerves supplying the muscles of the eye, this is impossible; for the second, which passes through the foramen rotundum in the greater wing of the sphenoid we follow the method of injection described by Matas; the third root is met in the vicinity of the foramen ovale, or the injection is made in its two branches, the inferior dental and the lingual. For the anesthetization of all the roots at once, the following method, which we have now employed for the *extirpation of the Gasserian ganglion* four times, may be used with advantage to replace general anesthesia.

In a forty-year-old patient the second branch was first injected at the foramen rotundum. For this purpose a needle 10 cm. long was introduced laterally beneath the bony prominence which marks the junction of the malar bone with the malar process of the upper jaw

(Fig. 1). The needle proceeded inward along the lateral wall of the antrum until its point, at a depth of about 5½ cm., impinged upon the external plate of the pterygoid process. It was then withdrawn about 1 cm., the portion outside the cheek strongly depressed and its point turned further toward the eye until, after repeated attempts, at

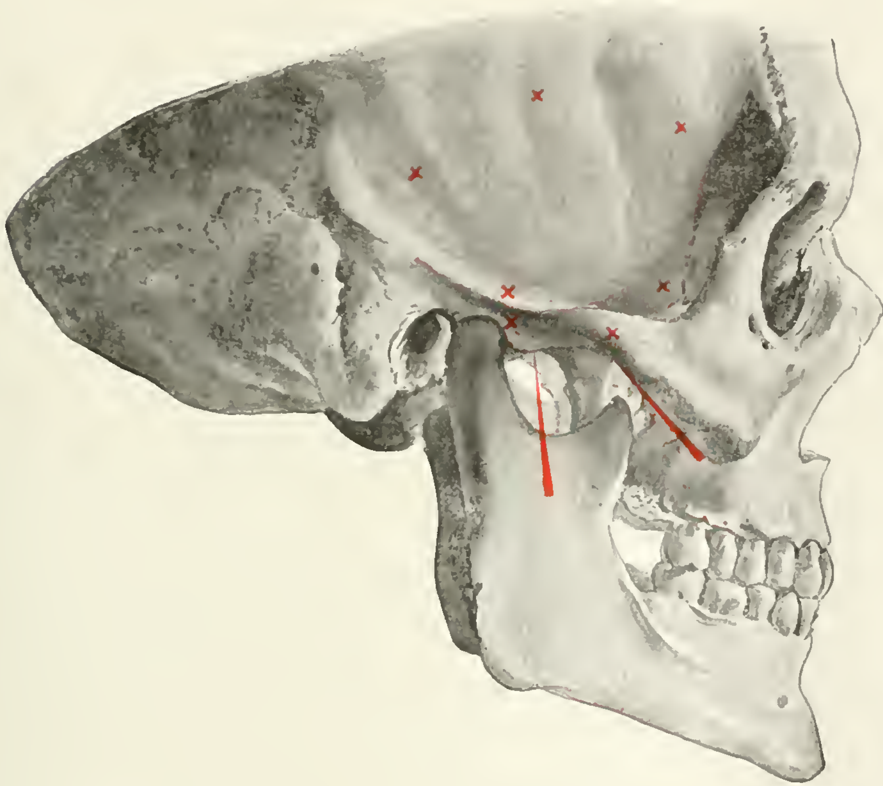

Fig. 1—Local anesthesia for extirpation of the Gasserian ganglion.

The red lines give the direction for the introduction of the needle for injection at the foramen rotundum and the foramen ovale. The red crosses show the points of insertion of the needle for anesthetization of the temporal fossa and the zygoma.

a depth of about 6½ cm., it was no longer in contact with bone. A skull which was held near at hand clearly showed that the point of the needle lay in the sphenopalatine fossa. Upon withdrawing the piston no blood was aspirated, and 5 c.c. of ½ per cent. novocain solution could be injected without danger. Since the patient had previously received scopolamin-morphine, he did not feel the pain in the teeth of the upper jaw which is taken by Schlösser, Braun and other authors as a criterion for the proper position of the needle.

In order to anesthetize the third root in the foramen ovale the

mouth was opened wide, to separate the coronoid process of the lower jaw as far as possible from the zygoma. Thereupon the needle was introduced through the skin of the cheek a finger's breadth below the middle of the zygoma just above the tip of the coronoid process, inward toward the base of the skull and forward toward the pterygoid process. When it met this at a depth of $5\frac{1}{2}$ cm. it was withdrawn 1 cm. or more and its direction altered by lowering the portion outside and carrying it in the direction of the mouth until the point of the needle glided by the posterior edge of the external plate of the pterygoid process and passed in along the base of the skull about 1 cm. further. Although the patient even now had no pain in the teeth of the lower jaw, a comparison with the skull showed that the point of the needle must lie in the vicinity of the foramen ovale. At this point also 5 c.c. were injected.

Then a circumferential injection of the temporal fossa was made. Through each of five points of insertion the needle is carried in various directions and the injection made above and below the temporal muscle and its fascia. Finally at the anterior and posterior ends of the lower edge of the zygoma a subfascial and subcutaneous injection of about 5 c.c. was made, so that about 110 c.c. of the solution in all was employed.

A quarter of an hour after the injection was completed the cutting of the trap door in the bone was begun. Incision of the soft parts and bone and even the separation of the dura with the Braatz separator proceeded without expression of pain. Only when the freeing of the dura from the base of the skull with small sponges began did the patient start to complain. As soon as the second and third roots and the edge of the ganglion were exposed about eight drops were injected directly into the middle of the ganglion with a bent needle, so that it was filled up like a bladder. Immediately thereupon the patient fell into a deep sleep. The removal of the ganglion, the twisting out of the nerve trunks and the sewing down of the trap door of skin and bone could then be carried out completely without pain.

Härtel* has demonstrated a method of anesthetizing one side of the face by a single injection into the ganglion, which makes injection of the various facial roots unnecessary. The anesthesia begins immediately. Through the cheek a long, fine needle is introduced into the third division, and it is passed within its sheath through the foramen ovale and into the ganglion itself. In this way the third branch serves

*Zentral, f. Chir. 1912, No. 21.

as a path of conduction for the needle and prevents it from gliding off and puncturing any neighboring vessel. The introduction is made about 3 cm. external to the angle of the mouth. Without injuring the mucous membrane of the mouth, the needle is introduced between the lower jaw and the outer wall of the antrum as far as the infratemporal fossa. "Now one feels his way backward, observing the following important points concerning the direction of the needle: Observed exactly from in front, the needle should point to the pupil of the eye of the same side. Seen exactly from the side it should point toward the articular tubercle of the zygoma."* As soon as the nerve trunk is met by the point of the needle, the patient feels pain in the lower teeth. In this way one recognizes that the needle is in the right position so that the needle may be pushed along further until pain is felt in the upper teeth, then Härtel injects ½ to 1 c.c. of a 2 per cent. novocain-suprarenin solution. In nine cases in which he has used the method he has obtained complete anesthesia.

EXTREMITIES

For the various operations on the neck, thorax and abdomen which may be carried out under local anesthesia the special technique will be described in their respective chapters. We will consider here only local anesthesia of large sections of the body, particularly anesthesia of the entire limbs and extremities.

Kulenkampff† found that in order to break the conductivity of all the sensory tracks of the arm the proper place for the injection is above the clavicle, in the gap between the scalenus anticus and medius, where the brachial plexus runs to the outside of the subclavian artery. The artery may be easily recognized by its pulsation, and the clavicle is likewise readily palpable. The brachial plexus lies here in loose tissue, which is particularly suited to take up the solution. Ten c.c. of a 2 per cent. solution are injected. The danger of injuring the subclavian artery with the needle is slight; on the other hand, the needle may glide by the plexus and come up against the first rib. It is, therefore, advisable to inject the solution only after the patient has felt a radiating paresthesia in the fingers, which signifies that the needle is in contact with the plexus.

An injection wheal having been made in the skin over the place decided upon, a thin needle 4 cm. long is inserted in the direction of

*Härtel, l. c.

†Zentral. f. Chir. 1911, No. 40.

the second or third thoracic spine, that is to say, somewhat medially and posteriorly. As soon as the fascia is penetrated and sensations arise in the fingers, the syringe is emptied. Since the arm will become hyperemic in a short time, the application of the Esmarch method of inducing local anemia is requisite. Loss of sensibility appears in about twenty minutes and lasts for two or three hours. The method of Kulenkampff has been tried out without ill effect in twenty-five cases. In our experience, in the care of cases of accidental wounds of the hand, the procedure has several times proved inadequate, and in other cases the anesthesia did not appear until after a half hour.

The anesthetization of large sections in the lower extremities is even less dependable; a complete interruption of conduction such as that in the upper arm is not possible because the sensation is served by four nerve trunks which lie at a considerable distance from each other, the obturator, the anterior crural; the external cutaneous and the great sciatic. Circular subcutaneous injections about the extremities induce an anesthesia of the skin only, which suffices for skin-grafting. Nyström* states that the external cutaneous nerve which supplies the surface of the outer part of the upper thigh may be anesthetized through a subcutaneous and subfascial injection somewhat below the anterior spine of the ilium, and close to it. Braun anesthetized the whole foot satisfactorily by injecting the subcutaneous tissue around the leg above the ankle, for the terminal filaments of the external popliteal (peroneal) nerve spread subfascially over the anterior surface of the tibia and in the interosseous space, and injecting the two branches of the posterior tibial nerve behind under the Achilles tendon and near its medial edge. Anesthesia appeared in twenty-five minutes.

In order to carry out resections and amputations on the peripheral portions of the extremities Bier† developed a form of anesthesia which differs from the foregoing. The field of operation is limited by two torniquets, which are firmly applied above and below, and novocain, ½ per cent. in physiological salt solution without the addition of the suprarenin, is injected with considerable force into the veins. The fluid overcomes the valves and diffuses through the capillaries to the terminal filaments of the nerves. The field of insensibility which is obtained through this direct venous anesthesia spreads as the fluid finds its way into the larger nerve trunks, which Bier has already shown with indirect venous anesthesia.

*Zentral. f. Chir. 1901, Nr. 5.

†Verhand. d. Deutsch. Gesselleschft. f. Chir. 1908.

The success of this procedure depends upon the particular care which is given to the anemia which is previously induced and to the venous injection. To expel the blood the whole extremity is held up in the air and is bound from toe to groin with a soft elastic bandage, and at the upper end of the operative field a wide tourniquet is laid on to cause complete circulatory stasis. The expulsion bandage is then taken off, and at the lower end of the operative field another tourniquet is applied. Since the upper tourniquet cannot be borne for any length of time on account of the pain which it causes, Momburg directs that after the anesthesia has begun this one be removed after a second has been applied within the insensitive area just below it.

When the anemia and circulatory stasis is complete a vein, which has been marked before the operation, is exposed and tied off proximally, and in the peripheral end a cannula with a rib about its end is tied tight enough to stand considerable pressure without leakage of fluid. It is then connected with a strong and tight 100 c.c. syringe containing the novocain-salt solution, without bubbles. The injection should be made slowly, but under considerable pressure. The anesthesia appears between the two tourniquets immediately after the injection. The amount necessary for the thigh of an adult is 75 c.c. of the ½ per cent. solution; for the upper arm, 50 c.c.

All visible vessels must be seized and tied at the end of the operation. If the upper tourniquet is loosened a moment so that blood may enter the vessels, and then drawn tight again, it will enable one to find the lumen of the larger vessels as the blood spurts out, it will wash out the remnant of the novocain from the veins, and the anesthesia, nevertheless, will suffice to finish the operation. The instant that the upper tourniquet is completely removed the anesthesia disappears.

CHAPTER 3—ASEPSIS

Dry asepsis serves best to promote smooth healing of wounds. By asepsis we mean practically the exercise of the utmost care in depriving pathogenic bacteria of access to the wound, without injuring the tissues by the chemical agents which are employed for killing bacteria.

Antisepsis strove to attain this goal, but with the means which were at its disposal, the way was difficult. The principle of antiseptic wound healing consisted in overcoming bacteria through the employment of chemical poisons (Lister's carbolic spray) at the point where they were already in contact with the wound or were about to be. Various observers have demonstrated the inactivity of this method toward bacteria in an infected wound, but on the other hand have established the injurious effects which chemical agents exercise as cell poisons. Now efforts are made to keep all antiseptic agents from the wound and to free so far as possible from sources of infection beforehand everything which comes into contact directly or indirectly with the wound.

The ideal of absolute asepsis has not yet been wholly realized; it is not possible, for instance, to get rid of antiseptic poisons altogether in disinfection of the skin. And even after strong drugs are employed in the preparation, as strong as the skin will stand, it is not in a bacteriological sense absolutely free of bacteria. We can succeed in reaching a state of absolute freedom from bacteria only with instruments, linen and dressing material which have been sterilized in superheated steam or in boiling water.

Although the skin remains, from the purely bacteriological point of view, notwithstanding our efforts, a bacteria carrier, practical experience has taught us that the removal of all bacteria carrying material by one of the many disinfectant methods suffices to overcome the danger of infection from this source. Interference with healing is to be laid more to other faults, which are the more numerous the more complicated the method of disinfection is.

Air-borne infection is responsible for trouble still less frequently than the intelligently disinfected skin. Infection may occur through bacteria-laden dust, or through drops of water which are exhaled in

forced expiration, coughing, sneezing or talking. In order to avoid this possibility many surgeons wear a face mask or a gauze strip tied over the mouth. Some have given up this practice, because the masks are uncomfortable on the face, are hot and heavy, and particularly because, in spite of the mask, wound infection has still occurred. In quiet breathing no considerable danger threatens the wound from the water content of the air, but if one is in the habit of talking a great deal during the operation, or if one wears mustaches or a beard, one should cover the mouth while operating.

The significance of dust as regards wound infection cannot be overlooked. This danger may be lessened if everything in the operating room is avoided which may stir it up, and if one protects the open wound by a pad of gauze so that dust will not sink into it. In order to prevent the dispersion of infective material, it is sufficient to wipe up the operating room with a damp cloth. In hospitals that handle many septic cases it is necessary to operate upon the clean and the septic cases in separate rooms, in order to maintain the aseptic room as free from bacteria as possible. The filtration of air going to the operating room is of illusory benefit. The minor significance of air infection was shown in the time of strict antisepsis and the use of the carbolic spray was given up early.

A strict attainment of asepsis is the easier the more simply and intelligently it is carried out. Every complication in methods increases the possibility of failure, and the only improvements are those which increase the simplicity.

DISINFECTION OF THE SKIN

In order to destroy the bacteria which reside in the skin or to make them harmless to the wound many methods have been recommended, but they all possess the disadvantage that they are not complete. The ground for this lies in the anatomic structure of the skin, which, with its surface rich in hollows and ridges and with its innumerable glandular orifices, makes it very difficult for antiseptic agents to reach the bacteria. They may be removed from the surface through mechanical and chemical cleansing, but a large number remain in the depths, which gradually reach the surface during a lengthy operation.

Out of the great number of methods which have been employed, it may be said once for all that none of them will stand strict bacterio-

logical investigation. Without going into the methods of hand disinfection, we shall consider here only that which has served us for several years.

DISINFECTION OF THE HANDS

The hands and arms as far as the elbow are washed in running water for a quarter of an hour with soap and brush, and cleansed of all dirt. This opens up and cleanses of grease the superficial horny layer of the skin, and prepares it for the penetration of the antiseptic. Unirritating alkali soap is the best to use for washing, as soft soap in the long run is not well borne by the skin. If there is no running water at hand, the washing may be carried out with standing water in a basin, which must be frequently changed. The temperature of the water should be as high as possible, because hot water softens the horny layer much better than cold. The bacterial content of running water is so small that it practically may not be considered. For this reason hot sterile water may be mixed with cold running water without restriction.

Mechanical cleansing of the skin of the hands consists above all in scrubbing them continually during a whole quarter of an hour. The soap must be rubbed into all of the corners and wrinkles of the fingers and hand, and each part up to the elbow must be scrubbed separately. Then the suds are washed away and a new and just as careful cleansing is begun. The ordinary cheap hand brush is suitable for this mechanical cleansing. Several of these should be sterilized beforehand by boiling with water in a vessel without the addition of soda, and then placed into a sterile jar containing one to one thousand oxycyanate of mercury. Where an autoclave is at hand the sterilization of the brush may be carried out in superheated steam. They should be resterilized before each operation.

The soap and hot-water cleansing of the fingers is interrupted once at the beginning in order to clean the nails. The cake of soap during this procedure is laid upon a brush which is turned upside down, in order not to bring it into contact with the sink. Long nails make cleansing difficult, and they should be trimmed before the operation. Nail shears as well as orange stick should be sterilized before each operation. In using the nail cleaner one should not be so strenuous as to undermine the nail fold. It is best to remove only with the blunt stick the dirt and skurf which has been softened by the hot soap and water. It is wrong to clean the nails before washing, because it is

only through washing that the deep layers are opened up and the bacteria brought to the surface.

CHEMICAL CLEANSING

After the last remnants of the suds have been washed from the elbow and arm and hand under the faucet, the skin is scrubbed in a one-half or one to a thousand warm solution of oxycyanate of mercury. The soap should be completely removed from the skin, because the oxycyanate, like the sublimate, is destroyed by soap. In order to differentiate the oxycyanate solution from water and other fluids it is colored with a few drops of methylene blue. In washing as well as in rinsing off the arms and hands care must be taken that the sleeves, which have been rolled up to the middle of the upper arm, do not become wet, so that drops may run down the arm during the operation or reach the wound from the clothing. Naturally the mercury solution can only destroy the organisms which are on the surface and possibly those also which lie under the softened uppermost horny layer. Since the germicidal action does not penetrate into the ducts of the sweat and sebaceous glands and the rugæ of the skin, we repeat the washing in oxycyanate solution several times during the course of the operation, in order to render innocuous the bacteria which come to the surface as the result of the skin activity. In particular we should be careful that no blood dries upon the hands, as its albumen is precipitated by quicksilver, and when it has once dried on it is difficult to remove. The solutions in the basins which have become soiled by blood during the operation should be immediately renewed. After washing, the skin should be dried off with a sterile sponge in order that the solution does not drop into the wound.

Every hand which takes part in the operation should be subject to this same strict antiseptic preparation.

For a long time we employed sublimate in one-half or one to a thousand solution, but since it is not well borne by all skins we have given it up. The bacterial power of both agents is slight, but the oxycyanate does not exercise so intense a coagulating effect upon the albumen as the sublimate. Another advantage of the oxycyanate is that instruments may be allowed to remain for a considerable time in the solution without being corroded.

FURTHER RULES FOR ASEPSIS OF THE SKIN

Alcohol is not employed by us either as a disinfectant or to de-

hydrate the skin; it is impossible with it to remove the fat. Its advantage of fixing the bacteria in position in the skin so that they will not reach the surface is overcome by the disadvantage that many hands under its influence become cracked and chapped, and mechanical cleansing with soap and water is rendered difficult. Since a smooth, supple skin is one of the necessary conditions for washing and disinfection, we strive to keep the hands in as good a condition as possible. After the operation is over, they are carefully washed and glycerine or some skin lotion is applied. This is not washed off again, but is dried on a towel. The glycerine penetrates into the horny layer and prevents, on account of its hygroscopic action, drying out of the skin.

As a further precaution against carrying of bacteria by the hands one should most assiduously avoid all contact or soiling with septic material. This may be done, for instance, by the use of instruments in changing dressings, and by wearing rubber gloves in all septic procedures, as well as in making certain examinations. Care must be exercised wherever possible to prevent inadequate skin disinfection before septic procedures.

Soiling of the hands during operation requires a complete new disinfection with soap and water, as well as sterilization of all of the instruments which have been used, and changing the linen which protects the operating field. The washing off of a finger alone in the oxycyanate is not sufficient, and after opening the intestine, for instance, or a septic bladder or gall bladder, the sewing up of the abdominal wall should be completed by the assistant or the operation should be interrupted until the hands have been newly cleansed.

Since, in spite of all precautions, the skin of the fingers remains as the most important source of wound infection, they should not be brought into contact with the unprotected wound without reason. Instruments should be substituted for the fingers wherever it is possible, and also the dressing material and still more the suture material should be protected from the contact of many hands. Joint surfaces, muscle wounds and free plastic flaps as well as the meninges are particularly susceptible to infection through direct contact, while the peritoneum, for instance, will stand a good deal.

The best protection of the skin from contact with septic material is the impermeable rubber glove. We employ it for the protection of our own skin in all septic operations and in rectal and vaginal examinations; in clean operations many continental surgeons depend alone upon the disinfection of the hands, although this is not the common

practice in America. The gloves are to be sterilized before using in superheated steam after they have been powdered with talcum inside and out, and wrapped in gauze or placed in separate pockets in a glove holder, in order that their surfaces may not stick together. The hands must be perfectly dry to pull the gloves on readily. For ordinary examinations and wherever the autoclave is not at hand they may be boiled in soda bicarbonate solution and then put on after they have been filled with oxycyanate. They lose their elasticity rapidly with boiling. After use they should be thoroughly washed and cleaned of all dirt. Small tears and holes may be mended by sticking on small pieces from an old glove with cement.

Gloves fit the fingers and hands closely and comfortably so long as they are new and still elastic, and as soon as one becomes used to them they offer no hindrance, excepting to a certain extent in the palpation of fine differences; for instance, as in testing consistency. Since their smooth surface interferes with grasping and holding, one can put on over them a sterile cotton glove or else make use of a special glove with pebbled surface. Although the gloves themselves are perfectly sterilizable, they do not give complete protection to the wound from the bacteria of the skin, which stands in the way of their general employment, particularly for aseptic procedure. A small tear or prick in the glove suffices to bring the naked skin into contact with the wound. The advantages of a perfectly sterilizable skin covering are overcome by the circumstance that bacteria develop under the glove as actively as in a moist chamber. The gloves are readily torn on the corners of the instruments, on needles and thread, and on bony splinters, and frequently the damage is not immediately noticed. Even though all who favor gloves were united upon the principle that previous disinfection of the hands should never be slighted, nevertheless their general employment may increase the tendency to hurried and careless preparation. In this possibility of tearing or puncture exists a considerable danger to the patient, and if a tear is found the old gloves are to be removed, the hands redisinfected and new sterile gloves applied.

ASEPSIS OF THE OPERATIVE FIELD

The more or less complicated procedures which formerly were employed for sterilization of the operative field have been discontinued by most surgeons since Grossich confirmed tincture of iodine as the simplest and surest agent conceivable. Tincture of iodine was used

before his day for bactericidal and dehydrating properties, in tuberculous fistulæ, for instance, but to Grossich alone must be given the credit of the general introduction of the use of tincture of iodine for the sterilization of the operative field. The effect of the tincture depends upon the fact that the bacteria are killed on the surface and are fixed in the depths as the result of its inhibition by the crevices of the skin and the intercellular spaces. Since the method was first published* it has been tried in many clinics, and practically without exception the reports have been favorable. Its unconditional safety has given it preference since that time not only for celiotomies, joint and skull operations, but even in cases where the skin could not be satisfactorily disinfected by the methods which were earlier employed. Thus it demonstrated its particular advantages in laminectomies in the lower section of the spine where the skin for a long time had been soiled through contact with urine and feces, or where incisions had to be made in a close proximity to a bed sore.

Grossich at first recommended the use of the official tincture of iodine, and later advised against the unnecessary modifications of his technique which were being constantly proposed, such as diluted tincture and combinations or iodine and benzine. It is of great importance in order to get the full activity of the tincture that the skin does not come in contact beforehand with any sort of fluid, but that the tincture be applied to a dry skin. All previous cleansings of the skin with ether or benzine should be omitted, as well as washing with soap and water, or performed at a considerable interval before the iodine is applied, because all fluids make their way into the glandular openings and intercellular spaces and prevent the tincture from working. Shaving and the cleansing bath should be given on the day preceding the operation, but in emergency operations the bath is omitted and the patient is shaved dry. The superfluity of the removal of grease from the skin and its mechanical cleansing has often been showed in the treatment of accidental wounds, particularly those involving the badly soiled skin of laborers.

We complete the sterilization of the operative field in one application. A sterile sponge which is held by a sterile clamp is saturated with tincture of iodine and this is applied over a wide area. Any excess of tincture is sopped up from the skin by means of another sterile sponge. Neither before the incision nor after the operation is iodine reapplied. On the contrary, before the dressing is applied

*Zentral. f. Chir. 1908, Nr. 44.

such iodine as still remains on the skin is removed by a sponge which is soaked in ether, benzine or alcohol.

We have never seen any detrimental results when the Grossich technique is strictly followed. It appears as if wound healing was particularly smooth under the influence of the tincture of iodine. At any rate since its employment stitch abscesses which formerly were an infrequent occurrence, have completely vanished. In those portions of the skin which are naturally damp, and where the evaporation is hindered, or where the skin has previously been irritated by poultices or adhesive straps, signs of irritation may sometimes appear in the first days after the operation. Since we have adopted the practice of cleaning the skin of iodine after the operation, we rarely see either this mild inflammation or eczema. The removal of remnants of iodine should be done with particular care from the scrotum, vulva and anus as well as upon the posterior aspect of the body and in deep hollows of the skin. The irritation of the conjunctiva and the mucous membranes of the nose by the free iodine may sometimes be disagreeable for those engaged in the operation.

DISINFECTION OF THE MUCOUS MEMBRANES

For the disinfection of mucous membranes tincture of iodine cannot be used, because they are normally covered with a moist layer, and moisture interferes with the antiseptic action of the tincture. But wherever the epithelial surface of the mucous membrane is destroyed and ulcers are present, application of the tincture to these places will prevent infection from them of wounds in the neighborhood.

Absolute sterilization of mucous membrane cannot be obtained with any agent. Practically this has no great significance, since wounds in the mucous surfaces usually heal particularly well. Strong antiseptic solutions cannot properly be applied, since they cause inflammatory irritative symptoms and are readily absorbed. In operations involving the mucous membrane of the mouth we are satisfied with washing it out repeatedly the day before operation with hydrogen dioxid. Just preceding the operation we sponge off the mucous surfaces with 4 per cent. boric acid solution. The vagina similarly is washed out the day before operation with a mild antiseptic solution, and just preceding the operation it is douched with suds, followed by a rinsing with boric acid solution, lysol or alcohol. Mucous membranes of the stomach or intestines which have been opened during the course of an operation are not disinfected, but any blood and mucus

is wiped up with dry sponges. Whatever adheres to the line of union in intestinal anastomosis after suture of the mucous membrane or serosa is carefully removed by gauze which has been moistened with physiological salt solution.

STERILIZATION OF INSTRUMENTS, DRESSINGS AND SUTURE MATERIAL

The surest method of sterilizing instruments and dressings is steam under pressure or boiling water. All objects which are not destroyed or rendered useless by the influence of heat must, therefore, be prepared by this method.

STERILIZATION OF INSTRUMENTS

Metal objects should be boiled on account of the simplicity and greater assurance of this method. To prevent rust, soda bicarbonate is added to the water; a handful to about five quarts suffices to cover the instruments with a very fine precipitate. After the operation, the instruments should be laid in cold soda solution, scrubbed clean, and rubbed dry with a towel. The soda should not be allowed to remain for too long a time upon the metal, because its hygroscopic action finally causes the metal to rust. The addition of soft soap to the water will make it easier to polish off the cold instruments. Instruments should always be put away clean and dry.

Since heat radiates the most rapidly through a good conductor, the instruments should be made completely of metal and without wooden or composite handles. Wood splits in hot water and the heat does not penetrate to the deeply situated bacteria. So far as possible the instruments should be smooth and polished and of simple mechanism.

If these requirements are fulfilled, it is sufficient to leave the instruments for five minutes in boiling water. In order to make assurance doubly sure, we allow our instruments to remain ten minutes in water which is boiling hard. In the sterilizer they lie in order upon a perforated tray, which can be lifted out with sterile hooks. For use they are laid upon a dry, sterile sheet folded several times, or there should be a thick sterile pad next the table, because the moisture through capillary attraction sucks up bacteria from the lower layers. In order to keep the table covers dry, the water is allowed to drain off from the tray. They must naturally be protected from every contact with unclean objects. The instruments are used dry and should not be kept in salt solution, lysol or any other anti-

septic medium. They may be washed in sterile water during the operation when they have been soiled with blood.

Disinfection of instruments in antiseptic solutions has been given up, because it is not sure, and because remnants of the antiseptic fluid remain upon the instruments, and so come in contact with the wound surface and through irritation interfere with wound healing. Polished knives, in order that their edges do not suffer from boiling, may be laid for fifteen minutes in 70 per cent. alcohol; we prefer that the blade be wrapped with paper or laid in a perforated metal rack to protect it and boiled with the other instruments. Syringes with hard rubber parts or leather washers ready for use may be kept in one to two thousand oxycyanate solution, although this does not really sterilize them; glass syringes, and also those with metal tops, may be kept in alcohol, but when possible they should be sterilized by boiling before use.

Ordinarily metal and glass objects may be boiled together in soda solution; the boiling of rubber drains and soft rubber catheters should when possible be carried out by themselves, for the metal instruments are attacked by the sulphur contained in rubber, so that they lack precision in closing. Hard rubber catheters and bougies, and particularly silk lisle catheters, do not stand hot water. They may be well sterilized in the autoclave, but like gloves they must be kept from coming in contact with each other by being wrapped in blotting paper. But to be preferred is boiling in a saturated aqueous solution of magnesium sulphate, in concentrated salt solution, or in a 60 per cent. ammonium sulphate solution. Several forms of apparatus have been constructed for their disinfection in formalin vapor.

STERILIZATION OF DRESSINGS AND LINEN

All linens which are employed in the operation may be sterilized just as assuredly as the instruments. Sheets and gowns, sponges and towels are done up in packages and wrapped separately in two layers of sheeting and sterilized by steam under pressure for twenty to thirty minutes. This time is reckoned not from the moment when the packages are placed in the autoclave, but from the time the thermometer reaches 120 C. (248 F.). By this time the air has been forced out of the chamber and steam is present under at least one atmosphere (15 lbs.) pressure. In order that the steam may penetrate to all layers of their contents, the packages should be piled up loosely together. If metal containers are used for gauze, sponges and dress-

ings, they should be open during the sterilization and should be shut only after they have been taken out of the autoclave, when the sterilization is over. Through their heat the remnant of steam with which they are impregnated vaporizes and the linen and dressing material is just as dry to use as the instruments.

All sterilized sheets, gowns and dressings remain closed until just before the operation, and the metal drums and packages are opened just before use. The closed packages are dated with a rubber stamp after sterilization, and they should not be kept for a long time without resterilizing, since the moisture in the air and the fall of bacteria-laden dust upon the surfaces may result in penetration into the interior. It must be insisted that the most painstaking regulations for the destruction of bacteria remain useless if in putting on the gown or in draping the operative field with towels, non-sterile or questionable objects are touched. In operating only that narrowly limited area which the surgeon himself can continually oversee should be considered as unquestionably sterile. For that reason it is well never to lay instruments and sponges upon the sheet which drapes the patient.

IMPREGNATED GAUZE

Gauze which is saturated with antiseptic agents requires special preparation. While sublimate gauze and materials saturated with carbolic acid and other agents are no longer used, the use of iodoform gauze in wounds which are not aseptic has continued. It is employed to assist the asepsis, in that it absorbs the secretions and prevents them from breaking down, even if retained for a long time. The unirritating vioform possesses in the highest degree the property of drying out wound cavities, and for that reason we employ vioform gauze at times to shut off large wound cavities or bleeding surfaces and protect them against the entrance of bacteria. To iodoform is ascribed a specific influence in tuberculosis, which depends essentially upon the effect of the iodine. In the destructive processes which go on in a secreting wound, the iodoform splits, giving off free iodine. One must always be on the lookout, when iodoform is employed, for its toxic effects. They exhibit themselves in the appearance of a fire-red exanthem with numerous blebs, at the site of application or at some distant place, or even over the entire body, accompanied by fever, headache, and in particularly severe cases with hemorrhagic nephritis and psychic disturbances.

As the iodoform in itself possesses no antiseptic properties and may very readily carry virulent germs into the wound, the gauze which is to be impregnated must be previously sterilized. This procedure is carried out in the following manner: Ten selvaged bandages five yards long of any width up to three inches, after being unrolled and moistened with hot water, are dipped in the following solution:

Iodoform	50.
Glycerine	450.
Alcohol, 96 per cent.	500.

and are thoroughly impregnated with it. After being wrung out they are hung up in a dark room to dry and are finally cut into convenient lengths, rolled up and placed in a covered porcelain jar until used. If raw gauze or unselvaged bandage is used, the edges must be folded in. They must be kept protected from light before use, since the iodoform will otherwise be destroyed and turn blue.

To make vioform gauze, the material, loosely rolled up, is dipped in a suspension of vioform made as follows:

Vioform	10.0
Milk sugar	10.0
Glycerine	25.0
Alcohol (96 per cent.)	50.0
Distilled water	500.0

The gauze is allowed to dry for several days upon a porcelain plate, and it is then sterilized in the autoclave. In sterilizing it should not be placed in metal containers, as the vioform attacks the metal and colors it black.

STERILIZATION OF SUTURE MATERIAL

For tying and sewing up we require a tenacious thread which may be completely sterilized. But no material at our disposal, whether absorbable or permanent, fulfills all requirements well. Silk, linen, silkworm gut, horsehair and particularly wire may be freed from bacteria by boiling or in the autoclave, but the ties, and particularly the continuous sutures, remain as foreign bodies in the tissues, and do not always heal in without irritation, particularly if the knots have been tied by the naked finger. On the other hand, the absorbable catgut cannot be used after this form of safe sterilization, for as the result of heat it loses its tenacity and elasticity, so that it is readily

broken. In order to free catgut of bacteria it must be saturated for a long time with antiseptic agents, the remnants of which, contrary to the rules of pure asepsis, must be shut up with it in the tissues. Moreover, since the catgut knots, and particularly running sutures, do not absorb rapidly, and act for a considerable length of time as foreign bodies, the outlook for a smooth healing in of the chemical saturated material diminishes.

Accordingly the quarrel as to whether silk or catgut shall be preferred for buried sutures cannot be decided off-hand. But the idea that stitch abscesses or necrosis of tissue, which occasionally but not often disturb wound healing, unexpectedly and unwelcomely, depends on uncleanliness of the material is a mistaken one. The fault lies to a far greater degree in the insufficiency or inadequacy of the skin disinfection, and in the influence of the sutures as foreign bodies, and in the tissue irritation from antiseptic solutions. Bacteriological tests of suture material may persistently demonstrate its freedom from bacteria. It appears as if the bacteria which are rubbed into the material by the skin in tying the knot find a medium which, through the tissue reaction to the foreign bodies and the irritating effect of antiseptics, seems to be particularly fitted for their development. This is the only explanation that can be offered for the stitch abscess which first develops a week or ten days and sometimes even longer after the operation in a wound which up to that time has been satisfactorily aseptic.

EMPLOYMENT OF VARIOUS SUTURE MATERIALS

Since rapidly absorbable foreign bodies, if they only remain in the tissue with as little irritation as possible, form assuredly the poorest culture medium for the bacteria which are implanted with them, we accordingly recommend for deep suture and for tying the finer sizes of catgut. For instance, for mucous membrane and wounds of muscle and fascia, No. 0 or 1. Only for the peritoneum and for stomach and intestinal mucous membranes are running sutures employed, and everywhere else the interrupted, in order to limit as far as possible necrosis and the effect of a foreign body. Silk suture material should be preferred in the uniting of the serous coats of the stomach, intestines and bladder, because here the suture is not intended to be readily absorbed, and should be strong enough to hold under considerable tension, which would not be true of fine catgut. Upon the same ground silk must be given the preference over catgut in closing hernial

canals in the radical operation for hernia, and kangaroo tendon possesses advantages over catgut for this purpose, and is so used by many surgeons. Also linen which has been treated with celloidin (Pagenstecher), on account of its cheapness, fineness, strength and sterilizability, is excellently adapted for these sutures. For sewing up the skin nothing excels the readily sterilizable silkworm gut, or, for the face, horsehair.

To unite bones or to close hernial and other openings which are under strong tension, the best service may be procured from the absorbable and safely sterilizable aluminum bronze wire. The unirritative healing which follows the use of this material practically without exception can almost entirely be referred to the fact that the polished surface of the thread cannot carry bacteria. And no doubt the hands also have less occasion to touch the thread and to wipe off bacteria in holding on to it and while tying the knot, as on account of the smoothness and stiffness of the material this must ordinarily be done with instruments or gauze.

STERILIZATION OF CATGUT

In the preparation of catgut so far as possible a clean, raw product should be provided and the technique carefully followed. Bacteriological examinations show that pus organisms, tetanus and anthrax, which in previous experience might be met with in raw catgut, are never found in the raw material prepared according to Kuhn. For use the catgut is sterilized after the method of Claudius in an iodine-potassium iodide solution in the following way: In a sterile vessel the unrolled catgut is covered with the following solution:

Iodine crystals	2 c.c.
Potassium iodide	4 c.c.
Distilled water	1000 c.c.

and is allowed to remain for twenty-four hours. For size No. 3 and all larger sizes, which we personally never use, the treatment must be prolonged for twelve hours more. After this time is over the solution, which is sufficient for twenty-five strands five yards long, is poured off and replaced by 80 per cent. alcohol, which takes up the excess of iodine from the catgut. When the alcohol is colored dark it is renewed, but if the catgut is to be kept for a long time it should be thinned with water. When the strands have lain in the alcohol for some time they are removed and placed dry in a sterile glass. Catgut

thus prepared may be used, No. 00 for use on the dura, No. 0 for suturing the intestines and for ties, No. 1 for larger vessels and for sewing up, and far less frequently No. 2 or 3 if the tension of the tissues demands a stronger thread.

Surgeons who wish to save the bother of preparing their own catgut and who appreciate the convenience and cleanliness of using it in glass tubes may obtain catgut as well as other suture material prepared in various ways all ready to use. There are many excellent brands on the market, put up by manufacturers who have acquired considerable reputation for a sterile product. The better makers have a competent bacteriologist test samples from each batch and approve of it before it is sent out. Recently in the United States the method of preparing catgut originated by Bartlett of St. Louis, or some modification thereof, has been adopted by a considerable number of hospitals.

STERILIZATION OF SILK AND LINEN

While in the sterilization of catgut we cannot get along without antiseptics, the use of such agents is unnecessary in the sterilization of silk. Impregnation with salts of mercury should be done away with, because the silk may be sterilized with more assurance and with less injury by boiling or in steam under pressure. The opinion that as a result of impregnation with antiseptic the development of bacteria in the suture hole is hindered is negatived by the fact that the antiseptic, particularly the salts of mercury, goes immediately into union with the albumen of the cells, and bacteria from the hand may remain on the threads in spite of the antiseptic. The fact that coarse silk is not readily sterilized and may retain bacteria within itself has taught us not to bury thick threads in the tissue, but where a continuous or interrupted suture is necessary, such as in serous suture of the abdominal organs or in closing hernial openings, to use only the finest sizes, No. 1 and less frequently No. 2. The largest size used for skin sutures is No. 5, and only for the Heidenhain hemostatic suture, which will be described later, do we employ as large as No. 14, since we always remove it after the skin is sutured.

In the chapter on blood-vessel surgery we will take up the question of the paraffin silk specially prepared for this purpose.

In order to carry out the sterilization economically, the silk which is needed for an operation is rolled upon a card or glass bobbin and sterilized in a glass vessel in the autoclave. As soon as the glass is cold the silk is covered with 80 per cent. alcohol, in which it may remain

standing for any length of time necessary. A bobbin which had once been taken out of the vessel is not replaced until resterilized in boiling water (without soda). Many surgeons simply boil the silk with the instruments. Silk loses its strength if boiled too long.

Linen is sterilized in the same way as silk. It has a smoother surface, but is a little less strong than silk and possesses the advantage of greater economy. It is not fitted for impregnation with antiseptic agents.

FURTHER ASEPTIC REGULATIONS DURING OPERATION

DRAPING THE PATIENT

When all preparations are ended every one who is concerned in the operation puts on a sterile gown. This should be buttoned in the back and closed in front, to cover the body. The gown may have sleeves reaching below the wrist, the ends of which are gathered in under the gloves, or it may have elbow sleeves only, and the forearm be covered by separate close-fitting half sleeves, which are pinned on by the nurse with sterile safety pins. The operative field is painted with tincture of iodine and its surroundings are covered by four towels. Only enough space is allowed to remain uncovered as suffices for the length of the incision. In order that the towels be not shoved about over the wound, they may be pinned together, or fastened to the skin edges, with Backhaus clamps. A large celiotomy sheet with a small slit-like opening may be used to cover everything; its only disadvantage is that if an unexpected change becomes necessary during the operation it cannot be removed without some danger to the asepsis. In laying on the towels as well as in drawing on the gowns one must carefully observe that they touch nothing which is not sterile and so become a source of infection to the wound.

From the beginning of the operation only the region which is under the eye of the surgeon is to be considered sterile. Places at any distance, even when they are covered with sterile towels, are not to be considered sterile. It cannot be completely avoided, however, that as the operator or his assistant turns about to reach for instruments or for other purposes, the gown will come in contact with something which is not completely sterile and thus indirectly become a means of infection. When any break has happened in technique, even when it is no more than a suspicion, the whole procedure should be repeated,

otherwise the operating room personnel will become careless of minute detail. Towels and strips which have become soiled during an intestinal suture, for instance, or in opening up an unsterilized area, are removed before the wound is sewed up or before further clean regions are exposed, and replaced by clean ones, the gloves are removed and the hands are again carefully scrubbed in soap and water and oxycyanate solution, and the instruments are newly rinsed and disinfected for the rest of the operation, unless a new kit has previously been prepared.

Following the rule that the fewer fingers the less danger of infection, the number of assistants during an operation should be as few as possible. One assistant who renders the field of operation approachable by means of retractors, and a nurse to handle the instruments, are sufficient for practically all major operations. Both must wash off their hands in oxycyanate solution from time to time as well as the operator, and in every detail carry out without remission the rules of asepsis.

CARE OF THE WOUND

Since with all our precautions we cannot succeed with certainty in preventing all access of bacteria, in dressing the wound we attempt to make it as difficult as possible for the bacteria to develop.

Accordingly, we spare the wound surface of all contact with antiseptics. But if antiseptics are present for the purpose of destroying bacteria upon the uninjured surface of the skin, their bactericidal action in an open wound is reversed rather than otherwise. For antiseptic agents work upon fresh wound surfaces as cell poisons, which stimulate the tissues to secrete and lead to inflammatory changes or to necrosis, effects which prepare a favorable culture medium for the development of bacteria. For that reason all instruments and materials which are brought into contact with the wound should be dry and aseptic and not moist and covered with some antiseptic agent.

DRAINAGE

The difficulty of the proliferation of the bacteria will be increased if all the fluid which is secreted in a wound as well as the blood which oozes out after the operation can find an unimpeded exit. A wound which glues itself together rapidly offers no nutritive material either in the way of retained secretion or hematoma. Drainage of large wounds and the most careful hemostasis are therefore the best means

of protection. A strong transitory compression with gauze frequently suffices for a complete hemostasis. In order to prevent the formation of hematoma, spurting vessels are seized and tied. Those vessels which come to view in making the incision are best tied off before they are divided. Where blood seeps out from capillary wounds and in places where numerous lymph vessels are cut in sewing up, we leave an opening for a drainage tube, which is laid to the deepest part of the wound. Sometimes a counter-incision must be made for carrying off the secretions, while the wound itself is sewed up tight. An uneven wound floor which cannot be smoothly united in its depths, for instance after the removal of a tumor, is always drained. Two or three days later, or as soon as the wound surfaces adhere and give off no more secretion, the tube can be removed.

To reinforce hemostasis in oozing surfaces of considerable extent, and to suck up wound secretion, gauze drainage must be left in occasionally. For this purpose we employ, especially in the peritoneal cavity, folded gauze strips a yard long, of which one end is conducted out through a hole in the suture line. Such strips have the advantage that they can be lost only through gross carelessness. Plain sterile gauze is used for general purposes and for the drainage of the peritoneal cavity, and iodoform gauze is used only for the drainage of tuberculous foci. Vioform gauze has the advantage over sterile gauze that it dries out large cavities more effectively without irritating the wound or exercising a toxic effect. It may, therefore, be employed in extensive and strongly secreting wound cavities, for instance after extirpation of the rectum, and in small but deep wounds where one is not sure of the asepsis.

If packing is employed to control venous or parenchymatous oozing, sterile strips are effective. Such oozing ceases from the pressure of the gauze, because this rapidly adheres to the vessel wounds. After five days at the latest the vessels are closed through a permanent thrombosis and the strip can then be removed, although it may remain longer if there is urgent need. Arterial bleeding should not be controlled by means of packing.

Gauze left in the abdomen should always be wrapped in rubber dam where it comes through the wound (cigarette drain), because skin and gauze stick together rapidly and in that way the secretion is dammed back. For the gauze, whether it is plain or impregnated, is always a source of irritation to the cut surface.

Suprarenin is used at times for provisional hemostasis. To allow

one to work in a deep lying field undisturbed by bleeding, physiological salt solution is employed, to 100 parts of which 20 drops of the one to a thousand suprarenin solution are added. Gauze sponges or strips are soaked in this solution. For hemostasis over deep wounds where the vision is interfered with and in operations upon the skull where it is impossible to tie off and the field is too narrow to allow of packing with gauze strips, sponges soaked with suprarenin may be used to advantage.

For the drainage of wounds of the superficies, such as amputation stumps and after removal of the breast, and particularly where the cosmetic result is a factor, narrow strips of rubber dam are very effective. They do not adhere to the wound edges, nor do they promote inspissation of the secretions and in that way plug up the incision. For this reason rubber has largely supplanted gauze in septic wounds.

In addition to hemostasis and to the carrying off of wound secretions, gauze strips serve particularly well also in shutting off a clean field from infected areas. In this way we protect the free peritoneal cavity, the meningeal space, the pleural and other cavities from infection in that we create a dam around about the infected focus. As a result of the irritation which the protective walling off exercises upon the tissues, adhesions form which at first are loose, but later make up an extensive wall against the penetration of infected material. Gauze impregnated with iodoform irritates the tissues more to the formation of adhesions than does sterile gauze.

CARE OF THE WOUND EDGES

Next in importance as a preventative against the development of bacteria to the removal of wound fluids is the avoidance of every mechanical injury. A smooth division of the tissues with a sharp knife is better as regards healing than dull tearing apart or bruising of the tissues by blunt dissection. The sharply cut soft parts adhere again rapidly. In irregular wound surfaces with hollows and pockets, foreign bodies and necrotic shreds, this adhesion is hindered and bacteria find opportunity to develop and proliferate in the exudate which immediately fills the dead spaces. The incision which runs in the direction of the fibres is the most advantageous for every tissue. In the depths tearing and bruising of the tissues may be avoided if one does not make too short an incision; a long carefully handled wound heals with more assurance than a short and badly damaged incision.

In the course of the operation everything should be avoided which might increase the mechanical irritation of the wound. Unnecessary contact should be avoided by covering the wound surfaces with gauze sponges. Ties should include when possible only the bleeding vessel, and should avoid neighboring tissues, in order to cause no necrosis in the wound. Mass ligatures, if possible, should be done away with altogether. In the same way in aseptic operations the thermocautery should never be used for the separation of tissues. Bits of tissue lying loose in the wound, such as splinters of bone or little tabs of fat, should be removed before sewing up, as well as tabs of hanging muscle and fascia.

CHAPTER 4—AFTER-TREATMENT

DRESSING

At the close of the operation the skin in the neighborhood of the wound, the line of suture being protected, is wiped clean of remaining iodine and dried blood with a sponge soaked in ether, benzine or alcohol.

The dressing consists of sterile gauze next the skin, covered with absorbent cotton or sheet wadding. The gauze when laid on flat serves as a compress, or if opened it serves to absorb any blood or wound secretions, as well as the moisture of the skin. The cotton protects the wound from harmful pressure, reinforces the capillary action of the gauze, and, so long as it remains dry, acts as a filter against bacteria entering from without. If the cotton is damp it loses these properties and the wound dressing must be changed. If, as in certain operations, such as those on the brain and spinal cord and on the chest and abdomen, one must reckon upon an early and marked infiltration of the entire dressing, which will offer favorable circumstances for the development of bacteria, we complete the dressing by adding an outer layer of sterilized iodoform gauze. This forms an efficient protection against the danger of invasion of the moist gauze by foreign bacteria.

Even in infected wounds the lower layer of the dressing should consist of plain gauze, in order that no irritation of the skin should occur as the result of antiseptic agents.

The dressing is fastened on with a gauze bandage or by adhesive straps. Either should be so applied that the dressing material and the wound edges are lightly compressed and that a complete occlusion of the wound is obtained. For wounds which secrete freely, and which have to be covered with a thick layer of dressing material, and in places where the hair grows rapidly, appropriate methods must be employed for keeping on the bandage. The dressing when complete must be applied so as to allow no foreign bodies, for instance, remnants of food, or even the hands of the patient, to get under it and reach the wound. Wherever the dressing stands away from the skin it should be stuck down by means of a strip of zinc oxide adhesive plaster.

Generally speaking, wounds on the limbs should have a dressing applied to include both of the neighboring joints. In wounds of joints, segments of the limb above and below should be included in the bandage. For the head and face the classical methods of bandaging are the best. Celiotomy dressings should include one or both thighs, and extensive chest and shoulder bandages should include the head and neck. In applying the dressing the patient should assume the position which he later will maintain in bed, in order that the edge of the bandage shall not cut in or stand away when he changes his position.

Where it is available, the best method of holding on dressing material is adhesive plaster, which may be bought in every width. But plaster strips must not be applied overlapping each other clapboard-wise, but between them small spaces must be left in order that the evaporation of the skin moisture be not restricted. Where excessive and persistent secretion is expected, such as after the creation of intestinal or bladder fistulæ, or in extensive infected wounds, the dressing should be held on by means of a swathe or many-tailed bandage, under which the dressing can be renewed without difficulty.

To immobilize movable portions of the body, it suffices to incorporate strips of splint wood in the dressing, or to apply a splint. Where wood projects and touches the skin it should be carefully padded with cotton, particularly when bony processes lie just under the skin. For the limbs one may use any sort of ready-made splint of wood, wire or tin. For the lower extremity the Volkmann T splint is an advantageous support. When anywhere in the body one wishes to guard against the least possible motion, a Plaster of Paris bandage is applied over the dressing. To facilitate the change of dressing a window is cut in the hardened plaster at the proper place. Less resistant, but simpler to apply, and lighter in weight than the plaster bandage, are the starch or silicate (water glass) bandages. The impregnated bandage is before use placed in water, wrung out and applied about the dressing. Since these become stiff when they are dry, their edges must be padded to prevent them from cutting into the skin.

CHANGING THE DRESSING

The healing of an aseptic wound follows, as a rule, under a single dressing. The dressing is first changed when the sutures or the skin clamps are to be removed, usually after a week. A soft sterile pad

or an ointment dressing is then applied for protection over the fresh scar. Wherever the wound is liable to tension or where sudden pressure might open up the line of suture, some or all of the stitches may remain without danger for fourteen days, three weeks or even longer. An abdominal incision may thus be exposed to danger in attacks of coughing, vomiting or in difficult defecation. The sutures remain throughout this period without arousing any reaction or they gradually cut their way through the skin, but usually a strong epithelial scar has formed by this time between the stitch holes. A mild reddening of the stitch holes does not demand immediate removal of the stitches, since after the passage of the first few days wound infection does not arise from the skin or from the open stitch holes, under aseptic conditions.

The appearance of fever and acute pain in the wound in the first few days after the operation signify an interference with healing, which may be caused through infection or through secondary bleeding. If only insignificant swelling or inflammation of the stitch holes is evident, it is sufficient to remove one or another suture and in that way allow the wound edges to gap without danger of complete separation. If in spite of this the temperature ascends and general symptoms as well as the appearance of the wound leads one to make the diagnosis of retained secretion or infection of the deeper layers of wound, all stitches must be removed, and the open wound must be packed lightly in all of its recesses with rubber dam. The temperature rise from an uninfected hematoma disappears twenty-four hours to forty-eight hours after this operation.

The time to dress drained wounds depends upon whether the wound is clean or infected. Packing which serves only to protect a large cavity from hematoma or infection can be allowed to remain for a considerable time, particularly if it is impregnated with iodoform and so protects the absorbed secretion from dissolution. Bleeding from venous vessels occurs, as a rule, immediately, or at the latest not after five days, so that packing to stop the vascular ooze can then be removed. When a drainage wick of gauze is removed, a small rubber dam wick should be left in the wound a few days longer, in order to anticipate all retention of wound secretion. Persistent adhesions do not occur until after a considerable time. Accordingly, in order to protect against the extrusion of coils of intestine, for instance, the packing which is removed at the first dressing must be replaced by a new one. If a strip sticks too tightly to the wound edges, it may be

loosened by the use of hydrogen dioxid, or by allowing warm boric acid solution to trickle upon it.

In infected wounds and those which secrete freely, the dressing must be changed early, at least on the second or third day after the operation. Gauze or tube drainage even in this length of time may become saturated with material which dries and inspissates, the dressing sticks to the skin, drainage is blocked, and retention of pus is induced. In the renewal of the dressing of infected wounds the same principles apply as at the first dressing after the operation. Through adequate drainage the wounds must be held open until the pockets have rid themselves of all secretion, necrotic tabs have come away and fresh red granulations appear.

Protracted healing in infected wounds may be helped out by stimulants such as balsam of Peru, glycerine, or tincture of myrrh in 10 per cent. solution. As soon as an infected wound cavity appears clean, it may be closed by secondary suture. A small rubber wick is usually left in, to avoid retention of secretions, and is removed in a few days if the wound surfaces have adhered without any rise in temperature. As soon as deep wound cavities, after several changes of drains, have been converted into extensive granulating surfaces, scar formation may be promoted by secondary suture after mobilization of the wound edges. If the granulated surface appears so extensive that a secondary suture is not possible, it may be shrunk gradually by striping it with the silver nitrate pencil from the skin edge outward. An ointment made of scarlet red serves excellently to promote epithelialization. The best means to hasten scar formation with the minimum of contraction is the transplantation of epidermis after the method of Reverdin or Thiersch.

SPECIAL COMPLICATIONS

CARDIAC WEAKNESS

Cardiac weakness after the operation as a result of the anesthesia or the loss of blood is combated by means of camphor, caffeine, or the intravenous injection of digalen. A subcutaneous injection of 10 per cent. camphor oil may be repeated as often as the heart requires stimulation, for its effect rapidly vanishes. In weak patients and those who have lost a great deal of blood, injections which are given one after the other are usually without effect, and are not without danger. If the heart begins to flag, the caffeine sodiobenzoate in 30 per cent. solution gives good service; an injection of about 1 c.c.

may be repeated every hour. In addition to being a cardiac stimulant, caffein acts also as a stimulant to respiration and renal activity. While these two agents have an immediate effect, which rapidly disappears, digalen possesses a slower but more persistent action upon the heart muscle. It may ordinarily be administered subcutaneously up to 4 c.c. per day. Given intravenously, it works more rapidly than by subcutaneous injection; in urgent cases we repeat an injection of 1 c.c. four times in the twenty-four hours. In patients with arteriosclerosis and those with an apoplectic tendency care must be exercised on account of the sudden increase in blood pressure which results.

The loss of a large amount of blood during the operation may be compensated for by a subcutaneous or better *intravenous infusion* of physiological salt solution, which may be repeated several times in the day. In threatening cardiac weakness as the result of anemia we add twenty-five drops of one to a thousand suprarenin solution to the quart. In less threatening cases the subcutaneous infusion or rectal instillation by the drop method gives good service. In addition to the treatment of acute hemorrhage, a washing out of the body is indicated in peritoneal sepsis and in toxic conditions; moreover, the subcutaneous rectal or intravenous infusion is the only means of satisfying the fluid requirements of the body after celiotomies, when the stomach and intestines are to be protected, and particularly after operations upon these organs.

Further means to combat weakness from loss of blood we possess in the artificial restriction of the circulation. For this purpose we bind the legs from the toes to the groin with an elastic bandage (*autotransfusion*). At the same time the foot of the bed is raised and the head is lowered to prevent a long-continued anemia of the brain. It is very important in these conditions of weakness that care should be taken to keep the body warm by means of hot water bags, warmed or electric blankets or heating pads, used carefully on account of the danger of burning.

Although the *transfusion of blood* from one man to another or from animals to man was given up several times in the past five hundred years on account of the danger which was connected with it, recently, under the influence of Carrel and Hotz, it has been taken up again as the final method for combating a sudden and serious loss of blood. The old method of intravenous infusion of defibrinated blood has been replaced by direct transfusion between two persons. The procedure commonly advocated is the connection of the radial

artery of the donor to the median cephalic vein of the recipient; some men, however, favor the use of an arm vein in place of the brachial artery of the donor. The connection is made by direct suture, by means of a cannula, such as that of Crile, of Elsberg or of Soresi, or by glass tubes or containers lined with paraffin.

For direct transfusion the donor should be a young and healthy individual preferably from the same family as the patient, to avoid the possibility of intolerance and hemoglobinemia. The flow should not be allowed to continue more than thirty or forty minutes; the indication for disconnection of the anastomosis is faintness on the part of the donor or a drop in blood pressure from 125 mm. to 100 mm.

PAIN IN THE WOUND

Just after the operation we frequently give morphine to overcome pain in the wound. In grown-up persons we begin with an injection of 1/4 grain, in order to obtain a definite effect at once. If the patient has been accustomed to morphine, we do not hesitate to give considerably larger doses, with the purpose of overcoming the pain at the beginning, and particularly through the first night. If morphine alone causes vomiting, the patient may get morphine with atropin, or pantopon, the latter in a dose double that of morphine. As soon as the pain has disappeared, we cease injections; at night any ordinary narcotic is given when necessary to induce sleep. For the psychic disturbances which not infrequently occur in nervous patients, in the first few days, the bromids are of service.

Pain in the wound and the restlessness which goes with it should be overcome as far as possible after the operation, because it may have a considerable influence upon the healing. Apart from the administration of drugs, much may be done to lighten distressing conditions. All disturbing agents should be kept from the patient, and his position in bed may be rendered more comfortable by the use of pillows, foot supports or knee rolls.

THROMBOSIS, EMBOLUS AND PNEUMONIA

Since physical rest has much significance for the healing of wounds, and early movement increases the danger of embolus, we keep our patients with extensive wounds of the bones or soft parts of the lower extremity in bed as a rule several weeks; those who have had celiotomies and operations upon the brain and spinal cord, fourteen days; after procedures on the upper extremities, the thorax, neck and

face, we allow patients to get up early, sometimes even on the day after operation. Old persons with bronchitis or a tendency to pneumonia and cardiac weakness are always sat up on the day following the operation. This we accomplish by the use of a back support in bed or by placing them in a reclining chair, in order to stimulate them to deep breathing and to better ventilation of the lungs.

Ries of Chicago and Kümmell recommend that celiotomies should regularly be allowed to get up the day after operation, and they see the chief recommendation for this in the stimulation of circulation, decrease in the formation of thrombi and danger of emoblism, and in the favorable effect upon the general well being of the patient. In accordance with their theory, we attempted for some time to carry out early rising in fresh celiotomies, but in a large proportion of cases we found stubborn resistance. And in spite of it we still had thrombosis, and several patients complained greatly in the second or third week of a feeling of weakness and were put back to bed, so that they received no benefit as regards the length of the convalescence. Nevertheless, early rising after operations has real advantages in operative gynecology, since the proportion of thrombosis and embolism after the adoption of this procedure has definitely fallen. The advantages have been evident also in a great number of appendix patients, who have been operated on during the acute stage or in the interval. The great development of the technique of this operation, particularly the small incision, seems to make a two weeks' rest in bed superfluous, since the scar suffers nothing in security from standing up.

The threatened danger of lung inflammation and of thrombosis and embolism can be met with almost the same advantage by the employment of less radical means. Weak and elderly patients are assisted every day in ventilating the air passages. Some form of respiratory gymnastics not only prevents the alveoli from sticking together, but also markedly stimulates the circulation in the lungs. In the same way celiotomy patients should move their legs early. Henle advises that "taking a walk" in bed should be reinforced by massage of the lower legs beginning the very first day, which instruction we have practically always followed in women and old persons.

GASTRIC AND INTESTINAL DISTURBANCES

Disturbances of the gastro-intestinal track oftentimes cause extreme inconvenience in convalescence. Vomiting after the anesthesia has become less frequent with expert etherization, but has not dis-

appeared; usually it does not begin until after twenty-four hours. The best way to overcome recurring attacks of nausea consists in absolute denial of nourishment and fluid. The torturing thirst may be assuaged by moistening the lips and tongue, washing out the mouth, allowing pills of ice with or without peppermint to melt in the mouth, or the administration of cold tea or coffee by the teaspoonful or by subcutaneous infusion. Of considerable help in this regard is the rectal injection of a half-pint of luke-warm water by the drop method, to be repeated several times in the day. Nurslings and young children, on the other hand, receive the bottle immediately after the end of anesthesia. Since the appetite of the operative patient usually disappears, it is best not to offer solid food in the first days after the operation. But an exception to this is made in children; if they have not vomited, we give them solid food early. After chloroform anesthesia in particular in adults it is not unusual to see catarrhal conditions of the stomach as the result of too early attempts at feeding. If one does not succeed forthwith in overcoming these disturbances by a strongly restricted diet, there may result a long-continued under-nourishment with loss of strength.

ARTIFICIAL FEEDING

In case of necessity we try to supply nourishment through the rectum by means of *nutritive enemas.* It is not possible for any length of time to induce the absorption of a sufficient amount of albumin or carbohydrates even to maintain the existing state of nourishment, and in addition frequently, after a short period, a mucous colitis occurs. Ewald recommends the following nutritive enema: 4 drams of grape sugar, two or three eggs, as much as can be taken up on the point of a knife of malted milk or some similar prepared food, one wine glass of red wine, and half a glass of water or milk. This mixture should be allowed to run into the upper rectum at the temperature of the body. In the morning a cleansing enema must precede the nutritive enema. In order to avoid causing irritation of the lower segment of the colon when the enemas have to be repeated for any length of time, fifteen drops of tincture of opium are added.

Du Mesnil de Rochemont attempted to introduce nourishment by means of the subcutaneous *injection of sterile oil.* He injected up to two ounces and never saw any injury at the site of injection. Friedrich also injected from one to three ounces of sterile oil slowly under

the skin, giving twice a day as an auxiliary grape sugar-salt solution in which the sterilizable albumin of Siegfried, pepsinfibrinpeptone, was dissolved. He recommends the following: In the morning, ½ dram salt, 10 drams grape sugar and 4 drams albumin in 1 quart of water, in the evening the same with half the quantity of the albumin preparation.

INSTITUTION OF PERISTALSIS

The patient may experience severe annoyance as a result of persistent interference with intestinal peristalsis. This is particularly the case after celiotomies and procedures on the spinal cord. If the difficulty is the result of an inflation of the large colon, the introduction of a rectal tube and the passing off of the gas will usually suffice to give relief. Later, peppermint tea will oftentimes prove of service. If the bowels have not moved spontaneously on the second day after the operation, they must be cared for by enemas or cathartics. Most patients as a result of constipation complain of headache, loss of appetite and loss of sleep, none of which serve in the least to promote healing. The best agent to induce defecation is castor oil, but one may choose between salts and cascara on the one hand and enemas of water, glycerine or oil on the other. About three ounces each of honey or molasses and milk makes an excellent and unirritating enema.

In complete paresis of the intestine such as occurs as the result of a purulent peritonitis or after severe intraperitoneal hemorrhage, results may frequently be obtained by a subcutaneous injection of 1/64 grain *physostigmine salicylate.* If no result is obtained in a quarter of an hour the injection must be repeated, but when this agent is employed one must be on the watch for the possibility of cardiac collapse.

One may employ with some assurance the organic preparation introduced by Zülzer, *hormonal*, which is injected intravenously in a dose of 4 to 6 drams. While it is acting, the administration of morphine should be avoided, for it interferes with the specific effect of the hormonal. As a lubricator, castor oil is given after the injection. The action of hormonal, in contra-distinction to physostigmin, is a physiological one; it gives rise to a peristaltic wave without spasm and its influence is long continued. In case of threatening acute intestinal paresis, we have had favorable results with it in the majority of cases; we have never observed injurious effects of any account.

DISTURBANCES OF THE BLADDER

Retention of urine after operation is observed less frequently than interference with intestinal activity. The chief cause of this disturbance lies in the fear of pain which, particularly after celiotomies and gynecological operations in women, is connected with the evacuation of urine. After the radical operation for hernia, hemorrhoids and in some degree after procedures on the brain and spinal cord, weakness or paresis of the bladder may be mistaken for hematoma, or intestinal paresis from peritonitis.

If urination does not occur spontaneously one may first make use of ordinary means of assistance, such as hot towels or hot water bags laid on over the region of the bladder, or the patient, if permissible, may be lifted into a sitting posture or allowed to stand up. These methods are at least less dangerous than catheterization, for no matter with what cleanliness it is carried out, if frequently repeated it readily results in a cystitis. Women are apt to become accustomed to catheterization. Ordinarily we wait before trying this procedure until twenty-four hours have passed after the operation.

PART II. SURGERY OF THE HEAD

CHAPTER 5—TREATMENT OF WOUNDS OF THE HEAD

WOUNDS OF THE SOFT PARTS

All wounds of the soft parts on the head may be considered infected unless they have been received under aseptic circumstances. This holds particularly for wounds received from accidental injuries. On the scalp they require particular care in handling, because wound infection and its developments involve a considerable danger not only for the coverings of the skull, but also for the brain and its envelop. Favorable opportunity exists in the richly developed blood and lymph vessels which bind together the soft parts and the bone for sources of inflammation to pass from without inward. Purulent meningitis and inflammation of the brain may be the fatal result of a superficial infection.

For this reason fresh accidental wounds of the head of any extent should not, as a rule, be immediately sewed up, but should be treated openly. First the surroundings of the wound over a considerable area are dry shaved and painted with benzine followed by tincture of iodine, or with iodine alone, then the torn tissues are freed of dirt and blood clots with sterile forceps and gauze and every spurting vessel is tied. In order, so far as possible, to transform the whole wound into a smooth-walled cavity, crushed portions of the wound, edges and tabs of tissue, are removed by knife and scissors, and when necessary the external skin wound is enlarged. Bridges of tissue which separate small pockets from each other are split, and finally the wound cavity is packed in all of its recesses with sterile iodoform gauze.

In the open treatment retention of blood and of wound secretions are diminished, and in that way the danger that bacteria find favorable conditions for forcing their way into the depths is lessened. If after three days the wound surfaces show no evidences of infection, the packing is removed and the wound sewed up.

Sometimes exception must be made to this principle of the open treatment of wounds of the soft parts on the head. If as the result of

powerful trauma in a tangental direction a considerable flap of skin is torn from the cranium, this must be replaced on account of the danger of necrosis of the exposed bone, and held in its original position by several stitches. In the deepest point of the wound pocket a drainage tube is placed and sewed in, to carry off wound secretion and blood. A longitudinal incision made at the root of the flap ordinarily does not endanger its nutrition. The drainage lessens the danger of infection since, as a result, the wound surfaces remain dry and rapidly adhere to each other.

Primary closure of wounds of the face may be requisite if cosmetic results are to be considered, for with secondary suture one never obtains so fine a scar as with primary suture. But freshly sutured wounds contain within their depths hidden sources of infection. Therefore, as soon as signs of inflammation appear in any sutured wound, stitches must be removed and the wound opened up.

TREATMENT OF COMPOUND FRACTURES OF THE SKULL

The treatment of compound fractures of the skull is carried out on similar principles. No matter what the origin of the wound, one can never determine whether or not it is infected, and even though the majority of compound fractures of the skull heal without difficulty, nevertheless, this always remains an insecure probability. The usual treatment is limited to cleaning up and disinfecting the surroundings, applying a sterile dressing, and waiting. Without doubt this method of procedure in the majority of cases gives good results, but one should never judge without a close examination of the wound whether matter has been forced in deep which may lead to infection of the wound.

For example, a young man of twenty-one years was brought into the hospital four days after an apparently slight wound of the scalp, which had been treated in the above manner; he presented definite symptoms of meningitis and after a few days died. Under the edges of the skin wound, which had already adhered, was found a fissure fracture of the parietal bone, a slight splintering of the lamina vitrea and an extensive tear in the dura; on the surface of the crushed brain substance were found several hairs. No symptoms referable to the cortex were aroused by the trauma, which in an injury of the right parietal lobe, a mute region, is not to be wondered at. One such unfavorable result counterbalances a hundred good ones, when one considers that this patient might have been saved by a slight procedure

carried out immediately after the injury. If there is the least suspicion that the scalp wound has been contaminated by septic material, it should under every circumstance be opened up wide. One should not stop even at trephining.

In addition to the danger of infection, one may often look for later disturbances on the part of the brain from a splintering of the internal table, which occurs with the fracture. In irresponsive regions, which taken altogether make up the largest part of the superficial area of the brain, such a splinter, even if it perforated the dura mater, might lie for some time without causing irritation, and only arouse symptoms after the course of weeks, months or years. Such splinters may, as experience has taught us, heal in and smooth over without causing epilepsy; and moreover, this is not the only cause of this brain affliction; it may come also as the result of a severe shaking up or local contusion of the brain after uncomplicated fractures. But in open fractures the possibility of its occurring must always be considered in addition to the danger of infection.

The following represents our experience in a similar case: A thirty-seven-year-old army officer met with a severe automobile accident at night, so that he had to be carried unconscious to a hospital. There several insignificant wounds from splinters of glass and a wound on the forehead were found, and the patient gradually recovered consciousness. After the application of an aseptic dressing he was sent home alone. In the next few days the dressing was changed several times by a consulting surgeon, but beyond that nothing was done. The injured man felt fairly well except on the first two days, when he complained of a headache and occasional delirium. The temperature on these two evenings was 100.5, but it then fell to normal. According to the report of the house physician, the pulse was always subnormal, but at times it fell as low as 52 beats to the minute.

Eight days after the injury, after the patient had eaten a considerable dinner at three o'clock in the afternoon, he was taken with severe cramps and convulsions, which developed into a deep coma; the cramps lasted at least five minutes and the unconsciousness for half an hour. Examination at the beginning of recovery, when we were called in, showed normal fundus and pupillary reactions and no sensory or motor disturbances anywhere over the body, but, on the other hand, there was a severe headache in the frontal region, which lasted until anesthesia was started at 7.30 that night. The X-ray

showed several depressed splinters in the middle of the frontal bone.

In the middle of the forehead there was found an oblique fresh scar 4 cm. long. This scar was excised, whereupon it appeared that to the right side the periosteum was loosened by granulations, so that the bone was exposed and the surface was pallid. After this observation a trap-door of skin and bone with its base to the right was made. The two drill holes were bored in the middle line where the scar had been excised. The lower drill hole opened into the frontal sinus, and after the anterior bony plate was penetrated the posterior plate had to be drilled. From the upper drill hole there appeared a turbid seropurulent fluid followed by blood. The bony incision was made in the ordinary manner with the Dahlgren forceps.

Immediately on turning back the flap two large bony splinters and one small one were discovered projecting into the dura. In addition a fissure ran to the right for some distance, and between the dura and the bone was found a thick, somewhat decomposed blood clot. About 1 cm. more of bone had to be removed at the right in order to allow the removal of the clot. In the direction of the root of the nose we found a large and a small splinter of bone projecting. The frontal bone below was cracked over a considerable area; a large splinter of bone, which included the entire glabella, was allowed to remain, because it was attached to the skin. Above, two loose flakes of bone were found between the dura and the lamina vitrea and removed. No further fragments could be felt. Finally the right temporal lobe and the left in its median fourth were exposed, both naturally covered with dura, as well as the longitudinal sinus in the entire extent of the wound, over 5 cm.

There now appeared in the dura near the longitudinal sinus a tear which had already superficially adhered. In order not to meet the sinus a dural flap was made over the right frontal lobe, so that its base was directed toward the sinus, that is to say medial. On opening this flap it was apparent that the tear of the dura had just encountered a large arachnoidal vein, as a result of which the whole visible portion of the brain was saturated with blood. The vein was double tied and divided. Careful palpation of the entire lobe showed nowhere either splinters of bone or other foreign bodies. It was carried out by introducing the index finger near the falx cerebri, while the other index finger palpated correspondingly on the outer side. Finally the whole subdural space was packed with vioform gauze, as the wound, which

was eight days old, did not seem to be free of the possibility of infection, and the skin and bone flap was sewn down.

Healing was uninterrupted. The temperature just after the operation rose to 101.2, pulse 96, but it fell that night to 98.8, pulse 76, and on the second evening it reached 100.4, pulse 92. When on the sixth day the drainage was removed a few drops of turbid fluid followed. From that on the temperature varied between 97.6 and 98.8 and the pulse between 66 and 76. On the eleventh day the stitches were taken out, the wound being healed, and on the fifteenth day the patient left his bed and two days later the hospital. He is now completely well.

According to our opinion, the treatment even of small external wounds should not be limited to the application of antiseptic or aseptic dressings, but the skin wound should be enlarged, so that no pockets or recesses remain, and all foreign bodies, such as hair, sand, etc., as well as clot should be removed, splinters of bone pulled out and crushed portions of the brain substance and lacerated tissue trimmed away. In order to prevent necrosis of the bone and later injury of the brain, sharp projecting points in the bony edges of the wound should be smoothed off with rongeurs. When the necessity arises, the wound in the dura should be enlarged in order that there should be no retention of blood or secretion, and in that way further destruction encouraged. When the bleeding has been carefully controlled, the entire wound cavity cleaned by sponging with sterile gauze and exposed through wide retraction, it should be packed with sterile iodoform gauze to the very bottom. If handled in this manner, even very dirty and complicated wounds run a favorable course. It is most advantageous to employ the gauze in the form of strips or tape, as it is more conveniently removed through the wide apertures which are left in closing the wound, after five or six days, or later, as the case may be. Through partially sewing up the skin wound one lessens the possibility of prolapse of the brain, which occurs more readily if the pia is also torn over any considerable extent. To be sure, one must usually, by means of a plastic flap, with or without periosteum, attempt later to create a covering for a large hernia of the brain.

The further treatment of wounds of the brain as a result of pressure of bony splinters, particularly fresh injuries of the centres which lie in the cortex, will be considered in the chapter dealing with this special region.

BULLET WOUNDS OF THE SKULL

Military practice has taught us that perforating bullet wounds heal best if only the surrounding portions of the skin are cleaned and an aseptic dressing applied. Every attempt to locate the bullet, and particularly early probing, should be rejected entirely, since it increases the danger of infection, which in the first place is slight. The bullets in many cases heal in without irritation, and may remain in situ in soft parts or in the brain itself for the span of a lifetime without causing symptoms.

An indication for operative interference, according to these principles, appears when bleeding, either from a sinus or a large vein in the pia mater, or from the middle meningeal artery or one of its branches, or finally from the carotid canal, gives rise to evidences of brain compression and focal symptoms; and an examination of the course of the bullet must be made, if the bullet, which is itself ordinarily sterile, has presumably carried with it into the depths septic particles, such as bits of clothing.

Fresh bullet wounds of the skull only seldom indicate surgical interference; nevertheless, the removal of a bullet, or at least the opening up of its path so far as this is possible, may be indicated after several years. Difficulties may arise referable to splinters or depressions of bone, to the dura, or to the site of the bullet. Also a number of late complications find their explanation in the property of the bullet to wander. This wandering may take place without symptoms when areas of minor significance or portions of the brain already destroyed by the bullet are encountered, then only repeated X-ray examinations will give the necessary information concerning its changes in position. But it is possible, and this is particularly true in those with a neuropathic tendency or when an inherited taint is present, for a general epilepsy to develop. In other cases more or less severe symptoms develop from the wandering of the bullet, which may be differentiated according to the sections of the brain which are involved. At times also, infrequently, the basal nerves of the brain are compressed, a circumstance which is apt to give very definite symptoms.

The subject of the removal of bullets and other foreign bodies from the brain will be taken up later.

TREATMENT OF INFECTED WOUNDS AND SEPTIC PROCESSES. INCISION OF PHLEGMON

Infected wounds, abscesses and all spreading purulent inflamma-

tions on the head demand deep incision of the infiltrated tissue, on account of the danger of extension of infection into the cranium. The incision should be made beyond the boundaries of the inflammatory infiltration in depth as well as in superficial extent, so that the tissue will spread open and the secretions flow off unhindered. Absorption of the wound secretions is promoted by light packing, drainage and moist dressings. One should not hesitate to open wide by counter incisions the deepest pockets of the infected wound.

All phlegmonous processes, whether they originate from diseased teeth, glandular abscesses, infected wounds on the face, mouth, or from within the nose, should be laid wide open in a similar manner.

Although in the first place the incision must open up the infiltrated area to its entire extent, at the same time regard must be paid to the facial nerve, since the division of its branches may result in permanent paralysis. One may avoid cutting the facial nerve with assurance by keeping outside of a triangle, the apex of which lies at a point where the lobe of the ear meets the skin of the cheek and the base lies on a line between the outer end of the eyebrow and the corner of the mouth. If an incision has to be made within this triangle, its direction should be in a line radiating from the apex. The supra-maxillary branch for the lower lip is not always easily avoided; as a rule it runs just behind and parallel to the margin of the jaw, but its position is irregular. Even in deep cellulitis of the face, developing from carious teeth or other foci which lie deep, which creeps forward upon the masseter and spreads out under the strong temporal fascia, the necessary incision may be made so that no injury to the facial nerve results.

TREATMENT OF FURUNCLES

The treatment of furuncles on the head and face depends upon their position, the condition of their development, whether they are single or multiple, and particularly whether the symptoms are local or general.

Ordinarily the treatment of ripe furuncles is simple and well understood. They are recognized by a complete or nearly complete necrosis of a hair follicle and a softening down of the neighboring tissue within the limits of a small reddened and swollen area. At the most a portion of the lymph nodes of the region may be indurated and tender. Such a furuncle heals as soon as the slough and crust which covers it have been removed by forceps and the softened or liquefied tissue has been

allowed exit by a crucial incision. The further the softening has gone, the smaller may be the incision and as a result the less the scar. Healing follows under soothing ointment dressings or, if the skin will stand it, a moist mildly antiseptic dressing.

If one is scrupulous about the scar which results from incision in inflamed tissues, the removal of the slough and the emptying of the fluid portions of the infected focus may be undertaken with a suction cup after the method of Klapp. For a half hour several times a day it is applied for five minutes at a time with a pause of three minutes. The edge of the suction cup, as well as the vicinity of the furuncle, must be well greased. In this way the sliding off of the glass and the injurious pressure of its edges will be prevented, and the surrounding tissue be protected from exposure to further infection through the pus evacuated. The negative pressure in the glass should never be so strong as to cause pain. The hyperemia which is obtained by suction exerts a painless and healing influence upon the course of inflammation.

Unsoftened fresh furuncles may be healed without pus formation by the application of an unirritating ointment spread over the surface of the hyperemia induced by the suction cup; or a moist 90 per cent. alcohol dressing covered with some impermeable material with holes cut in it exercises a favorable influence. If under this treatment healing does not result, the application works as a poultice, which hastens local softening.

One should discontinue the bloodless treatment as soon as an extending thrombosis is apparent in the neighborhood of a furuncle. If hard and sensitive cords may be felt by careful palpation of the skin, the infected tissues must be deeply and widely opened in order to prevent transportation of purulent particles into the circulation, and a pyemic intoxication. For the same reason squeezing and pressure upon the infiltration region about the furuncle should be guarded against.

The ordinarily harmless but protracted multiple furunculosis should also be treated after the foregoing principles. They extend their chronic course over the limbs, over the hair line on the neck and over the entire body. In conjunction we have the formation of all manner of furunculous nodes, which vary in size, painfulness and in the stage of inflammation. The furunculosis of nurslings, which spreads all over the body, is particularly prone to abscess formation. It heals up most rapidly when each single abscess is opened by incision

under proper precautions. In this way sometimes we have to make 150 to 200 incisions in the course of several weeks in infants before it is finally overcome. We have never seen the slightest result either therapeutically or prophylactically from the use of yeast. Vaccine therapy sometimes acts well in chronic cases.

Furuncles of the upper lip and cheek follow in the majority of cases the same clinical course as isolated furuncles in other portions of the body. They may, however, be very virulent, and they are particularly disposed to induce pyemia and purulent meningitis. For that reason they should always be considered and treated as a dangerous affection. The severity of the symptoms does not give indication of their possibilities. The ordinary malaise, fever and local changes are exhibited to a greater extent in the face than in other locations. The inflammatory edema usually extends to the upper portion of the face, so that one or both eyes may be closed by swelling of the lid. In furuncle of the lip the entire lip may project like a proboscis, and on the nose the soft parts may exhibit so great a swelling that the nasal passages are closed.

The particular danger in lip and cheek furuncles consists in the tendency for the infection to extend to the facial vein and its branches. By this means masses may be carried off to the most remote places. In pyemia after furuncles of the face, the joints of the lower extremities and the pararenal tissue are particularly involved. Less favorable even than pyemia is the course of an extensive putrid thrombosis of the face. This may involve the sinus cavernosus and other vessels of the base of the skull. It may include the veins of the eye or may even induce a purulent meningitis.

Since the course of a lip or cheek furuncle cannot be foreseen and since it may lead to a fatal termination, one is justified in making early and extensive incisions in order to open up the infiltrated tissue. Such a radical procedure is particularly indicated if the development of the inflammatory changes does not remain limited to the neighborhood of the furuncle, but if in the course of the disease a hard cord painful to pressure appears at the site of the facial vein.

While early incision of the furuncle has been demanded in every case by the majority of surgeons, recently efforts have been made along the line of conservative and bloodless treatment. This point of view has its justification in the fact that uncomplicated lip and cheek furuncles run a benign course in the majority of cases if they are protected from all mechanical insult. Particularly all palpation

and squeezing of the affected area must be avoided in order not to force bits of necrosed tissue or bacteria themselves into the rich lymphatic and blood circulation. Chewing and talking should be limited as far as possible for the same reason. The patient should be kept in bed and treatment should otherwise be limited to covering the furuncle with a piece of compress thickly smeared with ointment, to protect it and to overcome the feeling of tension. In the clinic of Bier a light hyperemia with the rubber bandage about the neck for twenty to twenty-two hours is employed. We can obtain a definite result with the suction cup, as in other furuncles, only when a necrotic slough has been already formed in the centre.

TREATMENT OF CARBUNCLE

The same principles are employed in the treatment of carbuncle as for furuncle of the face. Since the purulent infiltration includes several hair follicles, it is clear that the danger increases with the circumference of the focus.

Carbuncles, like furuncles, are particularly malignant on the lip. They demand, on account of the danger of metastasis, an early and broad incision along the border of the mucous membrane of the upper lip. This incision divides the mass in a line which will give a scar of passable cosmetic appearance. If such a splitting of the infiltrated area does not suffice, another incision is made at right angles to it directly across the infiltrated tissue. This sometimes exposes the facial vein, which must be tied off. In contrast to this radical procedure, Bier recommends treatment with passive hyperemia just as for furuncles.

The danger of metastasis of purulent material to the other parts of the body is more safely avoided by excision of the carbuncle. This radical procedure is to be considered on the face only in severe cases. But according to Riedel, all neck and back carbuncles, without regard to their circumference, should be extirpated just as a malignant growth, a procedure which we have followed as a rule, and which may be typified by the following observation:

A thirty-year-old man had a carbuncle the size of a baby's fist on the right side of the neck. In order to excise it entirely, the skin was divided at a distance of several mm. from the border of the infiltrated zone. An elliptical incision being made on each side, so that the ends met above and below (Fig. 2, Plate 1), the carbuncle was seized by double hooks and was extirpated by incision through

Excision of a Carbuncle.

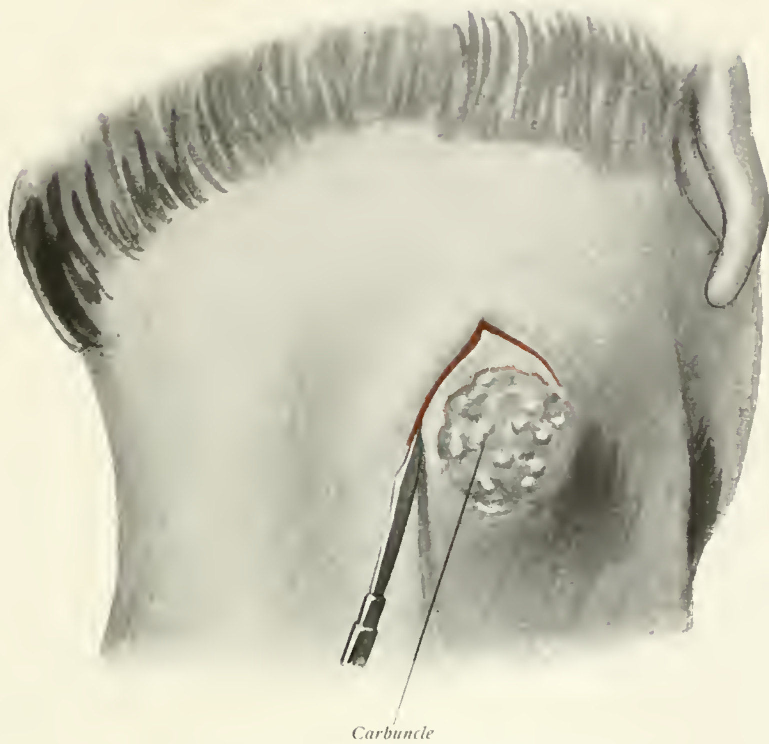

Fig. 2. Elliptiform incision of the skin.

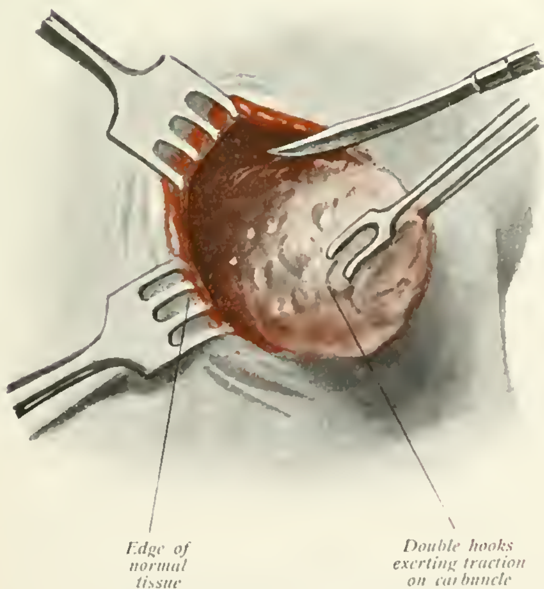

Fig. 3. Deep dissection.

Fig. 4. Wound after extirpation.

normal tissue just like a tumor. To be sure that it was entirely removed, the wound edges were held apart with retractors under considerable tension (Fig. 3, Plate 1). It became necessary to remove at the same time the infiltrated fascia of the neck, as well as the superficial layer of muscle, so that after the complete extirpation a clean wound remained (Fig. 4, Plate 1). The entire wound cavity was packed with iodoform gauze and a moist dressing applied.

Two days later the dressing was removed, the wound appeared clean and showed only a few purulent points. Eight days after the extirpation it was covered by fresh granulations, after which the light antiseptic dressing was changed every day. On the same day the entire defect, after undermining the skin edges, was closed by secondary suture, and the patient was discharged a week later.

Small carbuncles, if the infiltration does not go very deep, or the discoloration of the skin does not extend far beyond the purulent points on the surface, may be split open by crucial incisions. As soon as all slough has come away and the inflammation has disappeared, the four corners of skin formed by the incision come together over the granulations. To avoid a disfiguring scar, secondary suture may be employed in this case also. But if, as occurs in diabetes, a deep, woody infiltration is present over the entire neck from one ear to the other, and the skin on the elevated portions shows a gray-red to whitish color and a disposition to necrosis, the crucial incision is useless and extirpation alone can put an end to extension and the dangerous possibilities of general infection. In diabetics the larger portion of the discolored skin in carbuncle of the neck becomes necrotic; since the crucial incision cannot open up all the infiltrated region under the flaps, radical removal of the infected tissue stands, as a matter of course, as the most suitable method of treatment.

In extensive carbuncle of the neck, excised with a knife in a fashion similar to that shown in Plate 1, it is advisable to begin the incision at the lower edge of the carbuncle, so that the blood flowing down from above does not interfere with the field. The wound edges are held apart under considerable tension in order to see how far the purulent softening extends into the depths. The strongest venous or arterial bleeding may be controlled by pressure of gauze sponges on the wound surface during the few seconds which are needed from the beginning of the upper incision until its removal. As a rule, it is

not necessary to seize the vessels, which at the beginning bleed rather severely.

After the extirpation of a carbuncle, the edges of the open wound are apt to fall together rapidly, and after a week all the necrosed material has separated and the inflammatory edema has so far disappeared that a practically flat surface remains. Sometimes, to be sure, this process lasts longer. During this stage nothing does better than a salt and citrate dressing. As soon as the wound has become clean the defect may be closed by mobilization of the skin edges and secondary suture, or less advantageously by means of Reverdin or Thiersch skin grafts. If such a secondary operation is deemed inadvisable for any reason, excellent results may be obtained by the use of scarlet red or fuchsin ointments.

Excision of a cystic Endothelioma.

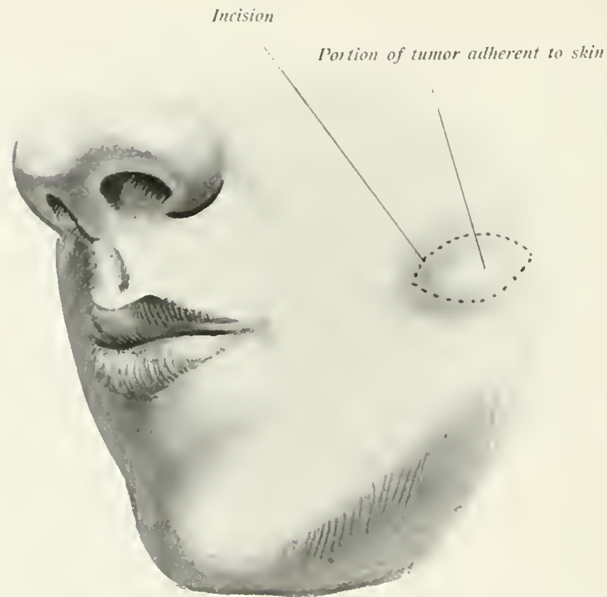

Fig. 5. Elliptiform incision through skin.

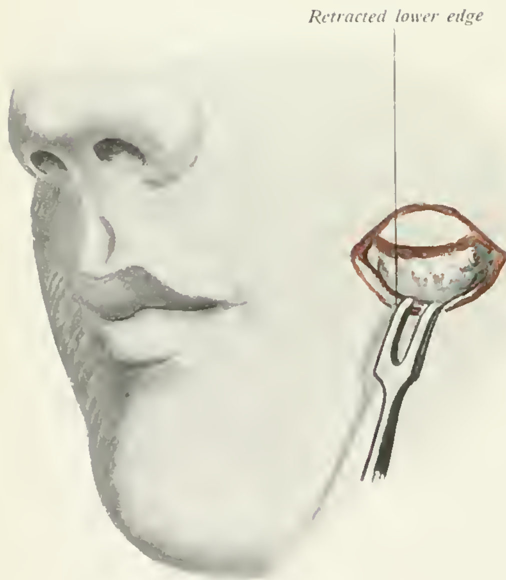

Fig. 6. Dissection of fat of cheek.

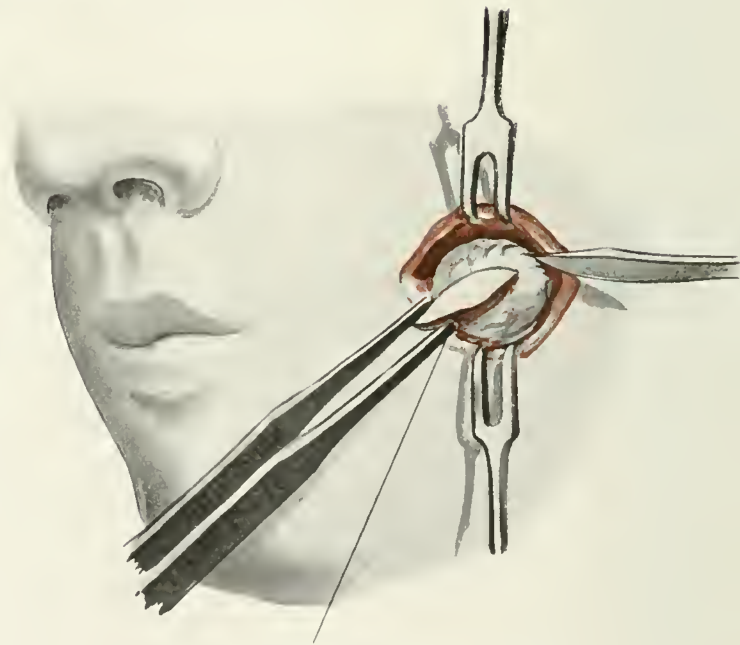

Fig. 7. Completion of the extirpation.

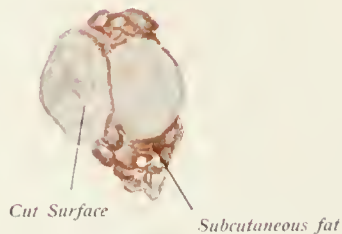

Fig. 8. Tumor, split after removal.

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CHAPTER 6—EXTIRPATION OF TUMORS IN THE TISSUES OF THE FACE

SMALL AND BENIGN GROWTHS: LIPOMA, FIBROMA, SEBACEOUS CYSTS, FIBRO-EPITHELIAL TUMORS

The removal of small benign tumors or tumor-like formations on the soft parts of the face can, as long as the skin is not adherent to them, be carried out subcutaneously through a linear incision. If the skin has become adherent to the tumor or has been partly destroyed, the tumor must be shelled out after an oval incision.

Injuries of the branches of the facial nerve may be avoided in most cases in the manner described under purulent infiltrations. The incisions should run in radiating fashion forward from the root of the lobe of the ear, and so long as one continues parallel to the line of incision and divides the deep layers carefully, danger of cutting across the nerve is not great. This is diminished if the tumor in growing to the surface has pushed the nerve fibres to one side.

As an example of the removal of a tumor from a cheek the following observation may serve: A tumor the size of a cherry was apparent upon the left cheek of a young woman just in front of the edge of the parotid and on the level of the lower teeth. It was very slightly movable upon the deep tissues; the skin had become adherent to it. Since it was probably a case of cystic adenoma, the extirpation was carried out in a short ether "rausch."

The skin, which had grown to the tumor, had to be incised in the form of an oval (Fig. 5, Plate 2) until the wound edges above and below could be retracted with sharp hooks (Fig. 6, Plate 2) and the whole tumor could be cut out with a wide margin of normal tissue (Fig. 7, Plate 2). Since all the incisions were made in the direction of the branches of the facial nerve and the separation of the subcutaneous tissue was carried out carefully, injury to the nerves was avoided. After ligation of the spurting vessels, the oval incision was sewed up in a straight line.

Out of the removed tumor (Fig. 8, Plate 2) there poured a thin, seromucous content. The inner wall of the cyst was thin, smooth, white and shiny. It lay everywhere embedded in fat except on the outside, where it had grown to the epidermis. No connection with the parotid could be made out.

HEMANGIOMA OF THE FACE: HEMANGIOMA SIMPLEX

In the new-born or in children in the first months of life, on the skin of the face more frequently than in other parts of the body, a tiny, level, fiery red birth mark may appear. On close examination one can recognize at the edge of the affected area individual ectactic blood vessels, of which the entire mass of the formation is composed. Such hemangioma may grow rapidly and in the course of months and years spread to include the lips, nose, lids and ears. On account of this it is advisable to remove small red birth marks which lie near the orifices of the face as soon as they show a disposition to extend. This is best carried out in the first weeks of life with a Paquelin cautery, carbon dioxide snow, or liquid air. Larger hemangioma must be excised and the skin defect closed by suture or, if necessary, covered by epidermal transplantation.

ANGIOMA CAVERNOSUM

Cavernous angioma, just as the simple isolated angioma, is usually congenital or arises in the first few years of life. It is composed of a crowded throng of blood sinuses, which contain venous blood. If these, in their growth, press through to the surface of the skin, they appear as blue knots or varicosities through the skin of the cheek and the margin of the lip. On the other hand, they may grow deep into the fatty pad of the cheek, so that, after Virchow, they have been also named lipogenous angioma. As an example of the appearance and treatment of these tumors, the following observation may serve:

A nine-months-old child was born with an angioma on the scalp the size of the head of a pin and a varix on the cheek the size of a grape seed. Gradually the tumor of the cheek grew, and while it was still about the size of a quarter an attempt had been made to destroy it with alcohol injections. As a result the tumor and the skin which covered it became gangrenous. In a short time erysipelas set in, starting from the wound of the cheek and spreading over the entire body of the child, which put an end to further treatment. After the erysipelas and a series of posterysipelatous abscesses in various portions of the body were healed, the tumor, which had been destroyed in its centre, had attained the size of a small apple (Fig. 9, Plate 3).

For the extirpation of the scars and the skin of the cheek, which had become adherent to the tumor, an oblique oval incision was made (Fig. 10, Plate 4), directed downwards and inwards, because it was apparent that in this way distortion of the eyelids and of the corner

Angioma cavernosum of the cheek. I.

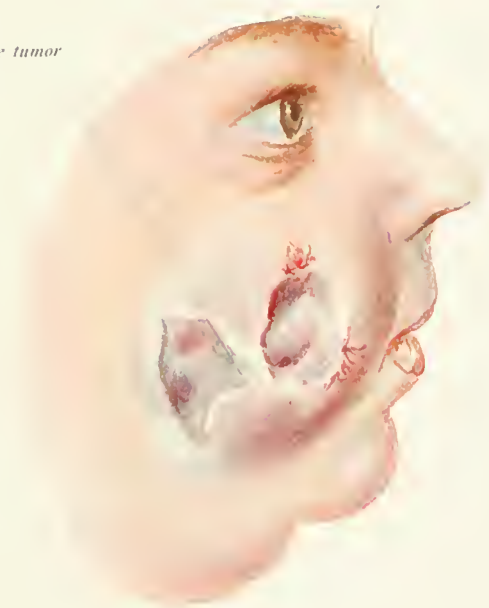

Fig. 9. The skin has been destroyed as a result of alcohol injections.

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Extirpation of an Angioma of the cheek. II.

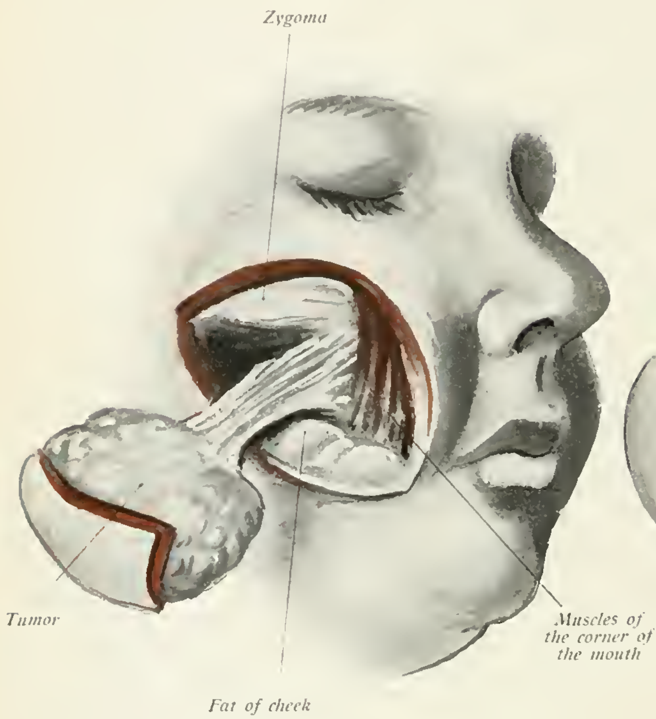

Fig. 10. The tumor which has been dissected remains attached only by a strip of connective tissue

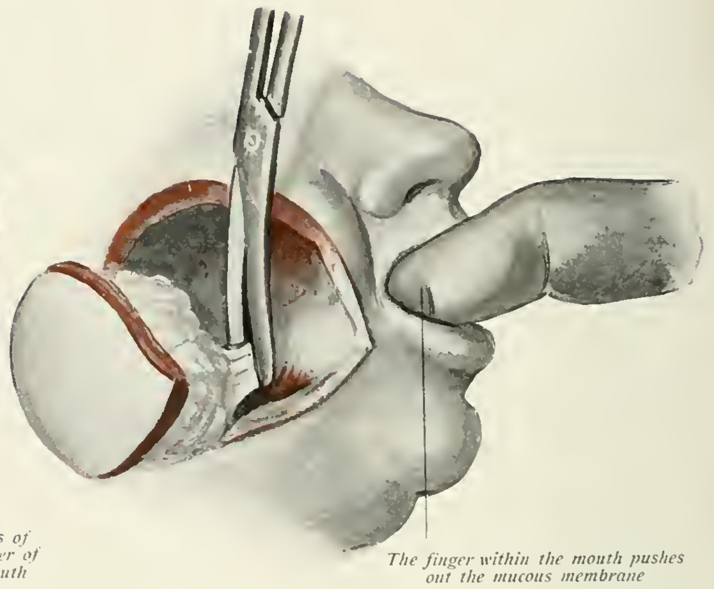

Fig. 11. Completion of the Extirpation.

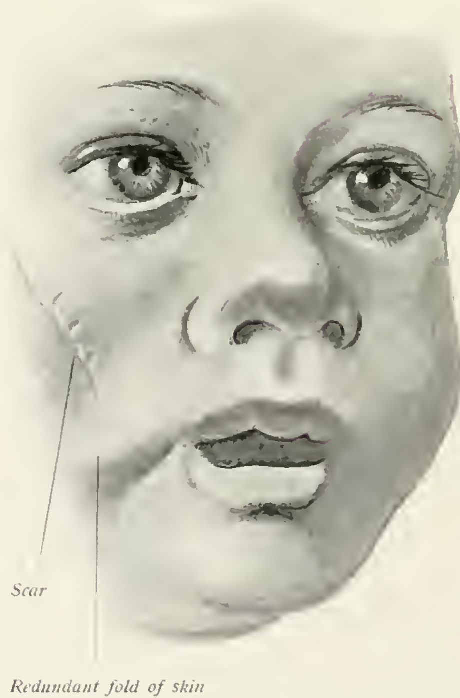

Fig. 12. The face healed without distortion of the features.

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of the mouth would be kept at a minimum. The incision first separated only the skin about the tumor. At the forward edge the dissection was carried on until the base of the tumor was perfectly free; every spurting vessel was seized and tied off. The same was done in the lower border and in the neighborhood of the corner of the mouth. The tumor here went into the depths as far as the mucous membrane of the mouth, but it was not adherent to this. In order not to destroy this and in that way favor infection of the wound, the little finger of the right hand was placed in the mouth and with this the mucous membrane was pressed forward so that the tumor might be separated from the submucosa piecemeal with scissors (Fig. 11, Plate 4). Here likewise all spurting vessels were immediately seized and tied.

After freeing the skin of the cheek behind, the tumor could be exposed down to the fat pad of the cheek and the zygoma. Out of regard for the later cosmetic effect the fat of the cheek was preserved so far as possible.

When the tumor was freed from its bed and removed, the muscles which run to the corner of the mouth were exposed as well as the zygoma and the fat pad of the cheek. Finally the skin was sewn up with interrupted sutures without causing any deformity or displacement of the lid or corner of the mouth.

After completion of the suture the small angioma on the scalp was excised by an oval incision. In such an excision all bleeding may be prevented if an assistant presses upon the bony substructure with the fingers on either side of the designed incision and a continuous buttonhole stitch is placed while the compression is continued.

At first the right corner of the mouth was paralyzed so that in crying and laughing the mouth was drawn strongly to the left, but this improved within the next ten days and upon discharge, fourteen days after the operation, only a very slight paresis persisted.

The wound healed smoothly, so that on the seventh day the stitches could be removed. At the lower corner of the mouth a little fold of skin had resulted from the suture, which at first projected considerably, but by the day of discharge it had flattened out to a small elevation. The linear wound of the cheek was only noticeable on account of its redness (Fig. 12, Plate 4). The scar on the head was hardly visible.

RACEMOSE ARTERIAL HEMANGIOMA

Much less frequent than simple and cavernous tumors on the face and the head is the arterial angioma. It is apt to develop as a "creep-

ing" angioma in the neighborhood of the ear, and it then stands in relation to the superficial arteries. Its recognition depends upon palpation and upon pulsation, which is usually visible. Although the skin lies over it only in a thin bluish layer, the single vessels as a rule are not visible. The following case cited by H. Berger* is representative:

A nine-year-old boy had since birth, according to his father, a tumor on the right side of the head, which at times showed an increase in size and at other times was stationary. Several weeks before his admittance to the hospital the tumor had begun to grow rapidly, and the right eye, which had previously not been involved, had begun to swell. There was no pain. According to the parents, he at times complained of headache but not of roaring, buzzing or similar manifestations.

On the right side of the head was a broad tumor for the most part movable under and with the skin over the bone, made up of numerous coils of vessels, which pulsated synchronously with the heartbeat. With the pulsation one could feel and hear in the tumor a definite thrill. The temporal artery, which was the size of a lead pencil, showed marked pulsation, and unusual pulsation was also to be seen in the neighborhood of the tumor and even in the neck and clavicular fossa. The extent of the tumor was as follows: The lower border, beginning at the right tragus, ran obliquely upwards to the outer corner of the eye and through the upper lid as far as the glabella. From here it went, following the sagittal suture, upwards to the middle of the frontal bone. Only in the region of the anterior edge of the scalp did it pass beyond the middle line. From the middle of the temporal bone, the posterior border of the tumor returned to the right ear and from the concha of the ear back to the tragus. The pulsation in the tumor could not be decreased either by compression of the common carotid artery or at any point between that and the tumor. The right upper lid was a dark bluish red and swollen, but the lobe was not pushed forward and the fundus as well as the vision was normal.

At the operation, through a skin incision which ran obliquely from the outer corner of the eye downward, in the direction of the facial branches, to the tragus, the temporal artery and numerous other arteries the size of a lead pencil, which were exposed, were double tied and divided. This tying off affected only that part of the tumor which

*Bruns Beiträge z. klin. Chir. XXII.

lay just in front of the ear, otherwise the pulsation continued. From a second skin incision above the glabella the hemorrhage was just as strong as in the first. Here the skin vessels were compressed between two fingers and the incision carried down to the periosteum. The supra-orbital artery was exposed as a thick cord and between double ligatures it was divided. The second incision was then carried obliquely through the upper lid until it met the first, and down through the entire tumor mass, so that the cut vessels could easily be seized and tied. Only a few of the larger and more easily exposed vessels were tied before cutting.

After completion of the skin incision and most of the ties, the entire tumor along the lower oblique incision from the upper lid down, together with skin, muscle and fascia, was freed from the healthy under layer with the help of raspatory, which made more tying off necessary. In several places the periosteum had to be taken away because in and and under it further arteries were present. Repeatedly vessels spurted directly out of bone and could only be stopped by boring in with a pointed clamp. The bone itself was everywhere intact. After about one-half of the tumor was freed from its base in this manner, the operation had to be interrupted on account of the condition of the patient. The wound was packed with 5 per cent. iodoform gauze and a light pressure dressing applied. All told up to this time 113 ties had been necessary. For this reason the loss of blood had been small; for either the vessels were exposed by the incision and tied or the separation of the skin and tumor mass was accomplished between the compressing fingers of the assistant and the cut lumina seized before a drop of blood was lost.

After three days, during which no disturbing symptoms such as hemorrhage or fever appeared, the patient being in good condition, the extirpation of the tumor was completed. It appeared, where the skin had not been severed, generally edematous. It was possible to free the tumor after extending the skin incision upward from the glabella along the sagittal line close to the pericranium, partly by blunt dissection and partly with the scissors. All of the numerous vessels were seized, in the periosteum as well as the vessels of the tumor itself, which continued to bleed copiously. The bone was not in the least eroded. After the entire tumor together with the skin for a finger's breadth around its border had been turned up, he created a flap of skin the pedicle of which lay between the tragus and the frontal protuberance. In order to remove the tumor from the skin and in

this manner to extirpate it, all the vessels supplying the tumor through the pedicle of the flap were divided and the tumor mass removed from the inner surface of the skin. Even in this manœuvre several good-sized vessels spurted and had to be tied. In some places the mass was so closely attached to the skin that the skin was buttonholed. After all traces of the tumor substance had been removed, the skin flap was laid back over the wound surface and sewed loosely around the periphery. In three places small fine drains held the line open to avoid possibilities of danger. In the second operation, which completed the extirpation, 76 ties were necessary, so that the total number of ties was 189.

The operation was again over without any pronounced loss of blood. A slight tendency to fever, caused by partial necrosis of the flap, disappeared within a few days. After a week, the portion of the flap which survived had healed in place. The necrosis involved an area the size of a nickel upon the right forehead, as well as the entire eyebrow and the loosened portion of the right upper lid. After two weeks the patient was out of bed. With the further advance of the scar formation on the regions not covered with skin, distortion soon became apparent. The upper eyelid was pulled up so far above the superciliary ridge—about one inch—that he could close the eye only by pulling the lower lid up to meet it. This defect was covered in by a plastic operation and skin transplantation after the method of Krause, and the eyebrow was replaced by skin from the scalp (see p. 152). After this, complete recovery occurred. Abnormal pulsation could not be made out either in the former tumor region, in the immediate neighborhood or at some distance. The entire treatment took three months.

EXTIRPATION OF LARGE OR MALIGNANT TUMORS ON THE FACE

The wounds which result from the removal of benign tumors usually allow of easy closure by drawing the edges together by direct suture. This is the most successful, in so far as one is as sparing as possible of the normal tissue, because the skin defects which result are usually smaller than the subcutaneous pocket from which the tumor is removed.

Since malignant tumors possess the property of growing through the infiltrated tissue, in every case a portion of the neighboring tissue which does not appear involved must be also removed; for the borders of the tumor and their transition into normal tissue are not recogniz-

able by the naked eye. In order not to leave behind any suspicious tissue, the extirpation of the tumor must always include the tissues a half inch or so beyond its apparent boundary. Moreover, the zone of inflammatory infiltration, for instance, which surrounds practically all carcinomata, particularly those of the skin, should never extend beyond the line of incision. No regard should be paid for the preservation of neighboring organs, nerves and vessels, particularly if doubt exists as to how far the tumor has proceeded.

Naturally with every radical removal of a malignant tumor there results a tissue defect of considerable size. Since the tumor may destroy portions of the face over a considerable extent, so the defect after extirpation may extend considerably. Such wounds cannot be closed by suture alone without serious mutilation, as after the removal of most benign tumors which can be shelled out, but the loss must so far as possible be replaced by the aid of plastic methods. The worst cosmetic effect and the most severe functional difficulties are suffered after the destruction of the bony framework of the face and the skin which covers it. In the replacing of both these structures lies the chief indication for plastic operations on the face.

CHAPTER 7—PLASTIC OPERATIONS ON THE FACE

SIMPLE METHODS OF DERMOPLASTY

The simplest method for covering surface defects on the face is by undermining the skin edges and sewing them together in a straight line. This method is adapted only for small defects. In larger wound surfaces one must make tension incisions at either side and mobilize the wound edges. Various methods for doing this are shown in the following sketches, which are taken from Hochenegg's "Lehrbuch der speziellen Chirurgie."

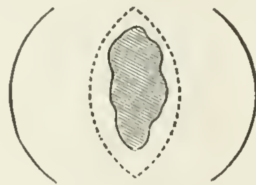

Fig. 13

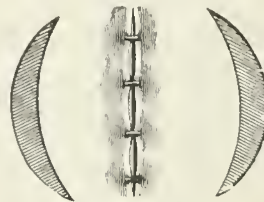

Fig. 14

A wound with irregular edges is transformed into an oval wound by trimming the edges, and two parallel tension incisions are made (Fig. 13); after mobilization of the flaps the wound edges are sewed together (Fig. 14).

Fig. 15

Fig. 16

A small rectangular surface (Fig. 15) is covered by a mobilized flap (Fig. 16), which has been formed between incisions continuing two parallel edges of the wound. (Celsus.)

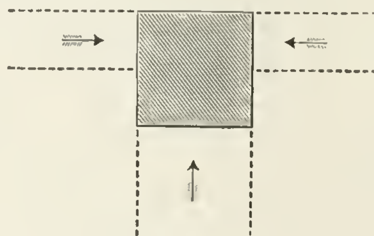

Fig. 17

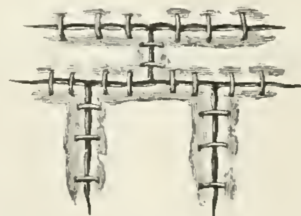

Fig. 18

Large rectangular defects (Fig. 17) may be covered by several flaps taken similarly from two or more sides (Fig. 18).

Three-cornered defects (Fig. 19) are covered by a flap which is formed by a crescentic incision in a line continuing the base of the triangle (Fig. 20).

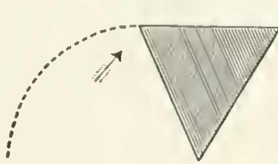

Fig. 19

Fig. 20

Large triangular defects (Fig. 21) may be covered by a mobilization of the wound edges upon both sides (Fig. 22).

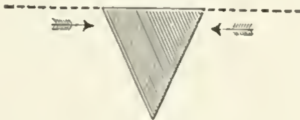

Fig. 21

Fig. 22

Burow's modification (Fig. 23) of this procedure is as follows: One edge (A B) of the isosceles triangular surface is lengthened (A B B A). The proximal edge (B C) is mobilized to a considerable distance and

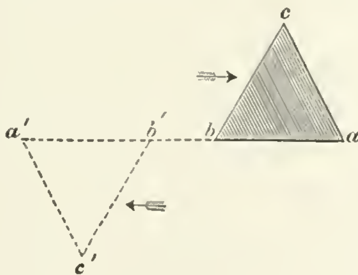

Fig. 23

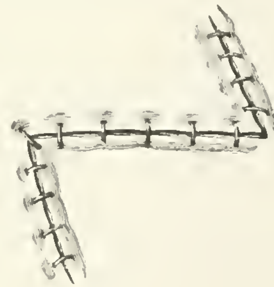

Fig. 24

the skin is drawn in the direction of the arrow. In order to allow the skin to slide over, a new triangle (A B C) is excised analogous to the first, but reversed, and the suture is completed (Fig. 24).

Burow's modification for covering rectangular defects consists in the mobilization of the flap and skin sliding after the excision of two triangles (Fig. 25 and Fig. 26).

After these methods all sorts of superficial wounds may be covered with skin. Numerous opportunities not limited to the face will present themselves, in which these simplest of all plastic methods may be used to practical purpose. Their unlimited employment in the face is not permissible; for instance, the angles of the eyes and mouth should never be dragged or displaced, as tension may result in functional as well as cosmetic disturbances. But these may follow direct suture of a wound which is pulled to a straight line, as well as after undermining and plastic mobilization of wound edges. On the other

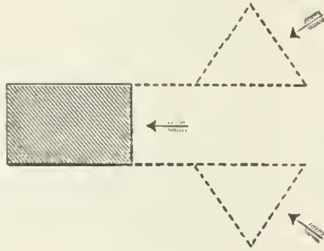

Fig. 25

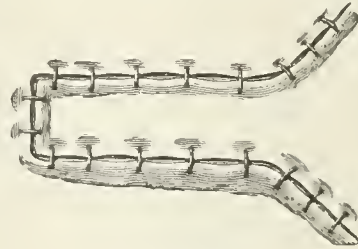

Fig. 26

hand, on the large surfaces of the forehead and scalp these methods may be employed with or without variation.

Naturally all large wounds of the soft parts on the head and face as well as those which have resulted from the extirpation of malignant tumors may be covered by plastic flaps, such as wounds from trauma, after burns, and destruction of the skin as a result of tuberculosis, syphilis or noma. Before plastic procedures such wound surfaces must be completely free of all diseased and necrotic areas and the wound edges trimmed.

FLAP GRAFTS

Before application of the foregoing methods it is necessary that the wound surface should have an oval, triangular or rectangular shape. If these conditions cannot be fulfilled, we have at our disposal another form of plastic operation, which consists in cutting out a flap in the immediate neighborhood and turning it in on a pedicle over the raw surface. In order to lay the flap in evenly and without constraint, various conditions must be fulfilled.

First, the flap must be similar in shape to the wound surface. But since skin which is freed from its bed shrinks considerably, allowance must be made in all directions in outlining the flap. In the second

place, one must leave the pedicle of the flap so wide that not only the arterial inflow, but the venous outflow will not be in the least restricted. For this reason unnecessary cutting of vessels must be avoided when the flap is being made. This may be carried out if one edge of the new formed flap is the same as one edge of the original wound (Fig. 27), and the skin incision for the other edge of the flap made in the direction of the vessels and not across them. Moreover, in turning in the flap on its nutritional bridge the pedicle should not be twisted so much as to compress the lumina of the vessels (Fig. 28).

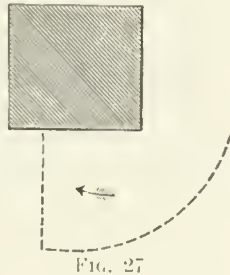

Fig. 27

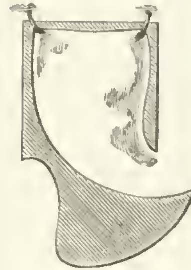

Fig. 28

Finally, the stitches which fix the flap should be limited in number in order to avoid danger of necrosis of the edge of the flap from sutures.

The secondary wound surface is covered over with the aid of tension sutures, after undermining the wound edges, or by epidermal grafts after the method of Thiersch.

INDIAN METHOD

The modern flap graft corresponds substantially to the old Indian technique. This method consisted in making a flap on the forehead, with its nutritional bridge at the glabella, which resembled in form the superficial tissues of the nose. After separation from its bed and turning on the broad pedicle the flap was employed to reform a nose which had been cut off. At the present time the technique of nose formation in this original form has been given up because skin alone is not sufficient to insure a lasting result. Noses which are made of skin alone shrink in a short time and in the place of the originally successful feature there shortly appears a shapeless, disfigured nubble.

The pediculated flap made out of the neighboring tissues and resembling the wound in its form finds its most favorable application in the covering of large defects on the head and face. Particularly the irregular wounds which result after extirpation of epithelioma in

the neighborhood of the facial clefts may be covered by this method. As an example we cite the following case:

A seventy-year-old man had been blind in the right eye since his twentieth year, as a result of injury with a steel splinter. The nasal half of the left upper lid extending to the glabella and upward over the region of the eyebrow was destroyed by an epithelioma the size of a quarter. The conjunctiva and the eyeball were intact and the outer two-thirds of the lid were not affected. The patient had noticed it first one year before.

In order to remove the new growth an incision was made through normal tissue about ½ cm. from its boundary and it was freed up from its bed (Fig. 29, Plate 5). At the inner corner of the eye it was in such close relation to the bone that the bone-scraper had to be used to separate it. During this procedure the eyeball was protected by the index finger (Fig. 30, Plate 5). At the inner corner of the orbit considerable tissue had to be removed on account of the extension of the epithelioma, to insure that no remnants were left behind.

After the removal of the ulcer about two-thirds of the skin of the upper lid was missing and about one-third of the conjunctiva. In order to hold the lid in its proper position during the rest of the operation and to protect the eyeball in the subsequent manipulations, the lids were sewed together at the corner by a provisional stitch (Fig. 31, Plate 5). The conjunctiva of the upper lid could be easily drawn inward, and was attached to the medial edge of the orbit with three catgut sutures; by this means the defect of the conjunctiva was completely overcome and a good base supplied for the flap.

The large defect which resulted could be covered by a flap taken from the forehead with a pedicle over the glabella. The flap was made rather large so that the inner corner of the eye might be covered without tension. In order to fit it in, the spur of skin which projected from the upper medial edge of the defect, as the result of the outlining of the flap, had to be freed from its base (Fig. 32, Plate 5). The medial edge of the flap was then sewed down, covering in the lateral wall of the nose, the inner corner of the lid, and the mucous membrane of the upper lid.

After undermining the skin on the right half of the forehead and the spur of the skin already mentioned, the entire wound surface which resulted from the removal of the flap could be closed with the help of three tension sutures, leaving only a small fissure (Fig. 33, Plate 6). Finally, what was formerly the right lateral edge of the flap was

Cutting and implantation of a pediculated flap. I.

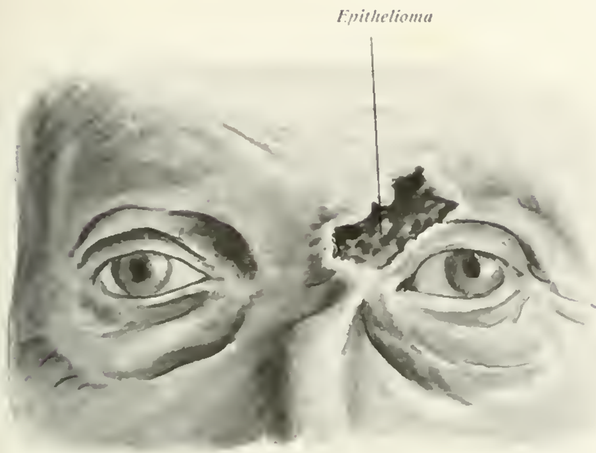

Fig. 29. Epithelioma at the inner canthus.

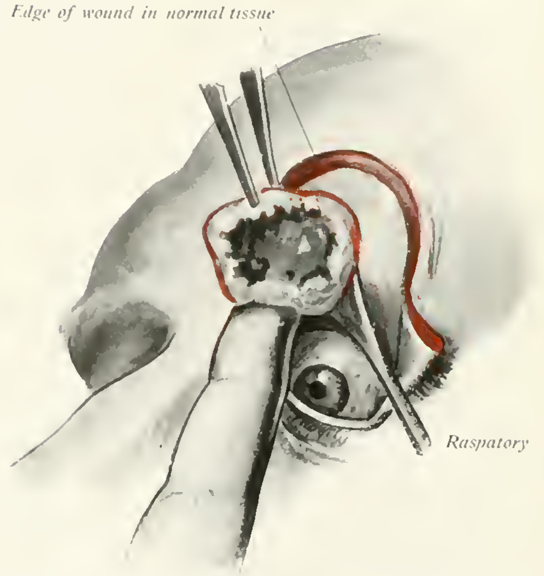

Fig. 30. Freeing the malignant tissue from the bone.

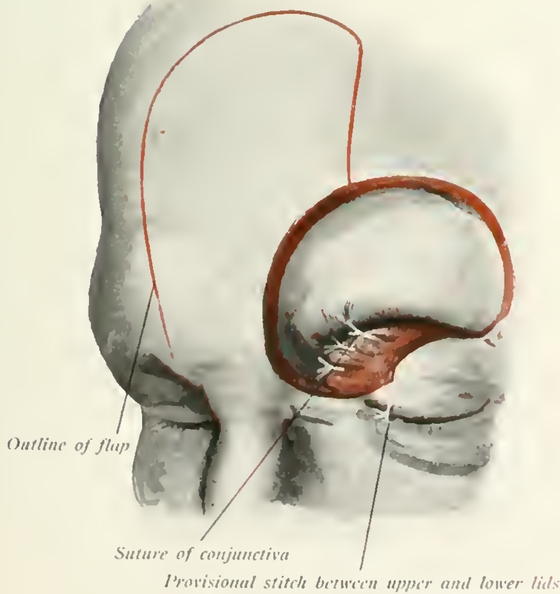

Fig. 31. Showing extent of wound surface to be covered, and outline of flap.

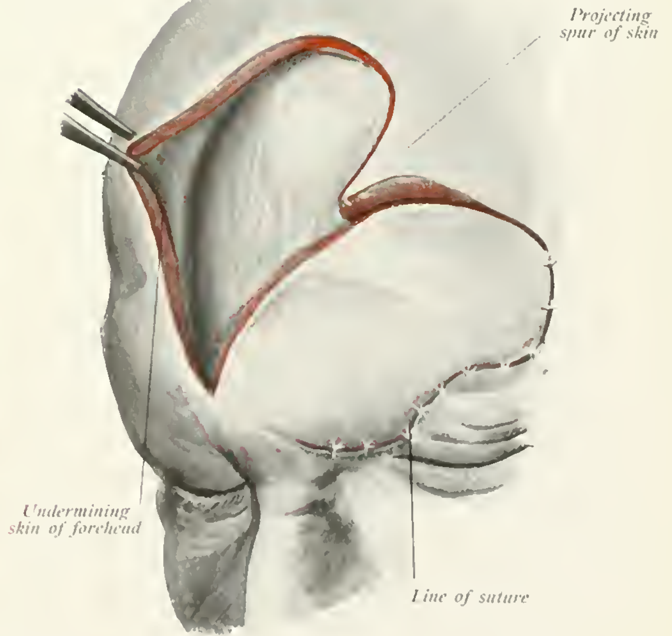

Fig. 32. The freed up flap has been turned and partly sewn in place.

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Cutting and implantation of a pediculated flap. II.

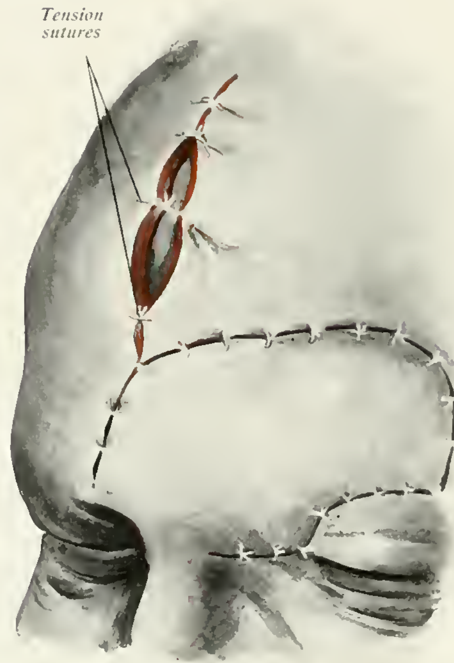

Fig. 33. The undermined skin of the right side of the forehead and the projecting spur have been sewed together with 3 tension sutures.

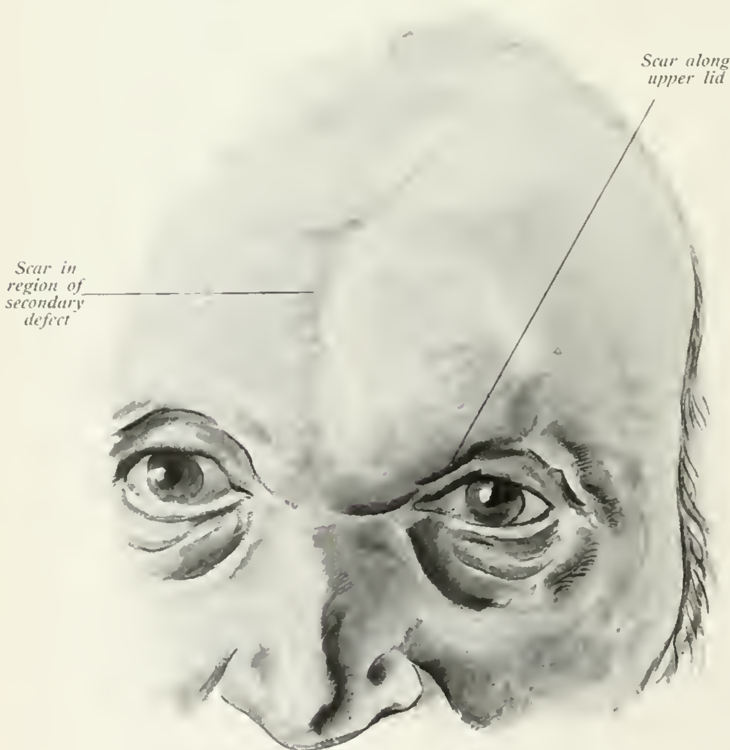

Fig. 34. Condition after 4 weeks, eyelids open.

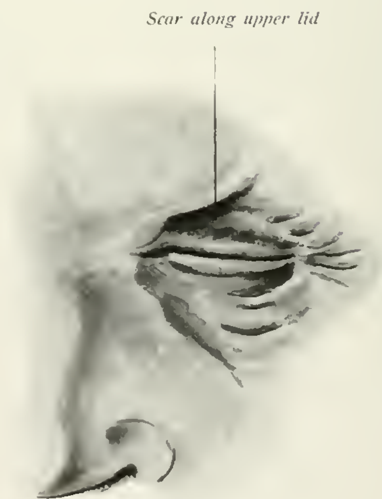

Fig 35. Eyelids closed.

united to the lower edge of the loosened spur, and, likewise without tension, the right lateral edge of the defect to the right corner of the flap. The suture which held the upper and lower lid together was removed and a monocular bandage was applied.

The flap from the forehead held satisfactorily without necrosis of the edge and after ten days all stitches were removed. The tension suture placed obliquely over the root of the nose had cut through the skin somewhat, but the fissure which remained had filled in with granulations.

Four weeks after the operation the patient could fully open and close the lid (Fig. 34, and Fig. 35, Plate 6), the skin of which in its inner third was formed of the flap, and the wound of the forehead was completely closed and covered with skin.

In this case the eye had to be preserved under any circumstance, because the patient was blind on the other side. Even if this necessity did not exist, its preservation was well justified, for the epithelioma had nowhere invaded the conjunctiva. V. Graefe stated that in epithelioma of the inner corner of the eye which invaded the conjunctiva the eye must be sacrificed. Our patient suffered no recurrence up to two and one-half years after the operation, and the cosmetic results have remained good.

FLAP GRAFTS IN OTHER PORTIONS OF THE BODY

Since flap grafts find their chief application in plastic operations on other portions of the body, it should be stated that they do not show the same disposition to heal in as well everywhere as on the face. Flaps taken from the arms and legs heal fairly well, but the skin of the shoulder, thorax and abdomen is more likely to become necrotic after transplantation, particularly about the edges. The reason for this probably exists in the fact that the skin of the face is the most richly provided with vessels, while the arms and legs possess fewer superficial vessels, and the skin of the buttocks is still more poorly provided in this regard.

For this reason it is important in such places not to lay out too narrow a pedicle, and not to interfere with the nutrition by sutures which are placed too closely together. At the same time the loosened flap should never be twisted so far about its pedicle that the skin is blanched as a result of the tension.

In a seventy-year-old man, after the extirpation of a recurrent glandular carcinoma, the wound surface on the right side of the neck

was covered by laying on a broad pediculated flap from the shoulder. The primary tumor was situated on the upper part of the shell of the ear and had been removed a year and a half before. In the meantime glands had been twice removed.

At the last operation, a considerable area of skin and the upper half of the sternomastoid muscle had to be removed at the same time with the infected glands. The tip of the mastoid was chiseled off, and the internal jugular vein as well as the common carotid artery was exposed for some distance. On account of rather profuse venous hemorrhage, which could not be controlled by continued compression, the wound was packed with vioform gauze and the plastic operation postponed for five days.

The flap was taken from below in the neck and shoulder region, since here there were no scars to endanger nutrition, and because in addition the secondary wound, on account of the movability of the skin in this region, could be readily closed by direct suture. Accordingly, a flap was outlined with a broad anterior inferior pedicle (Fig. 36, Plate 7) and with a thick layer of subcutaneous tissue was loosened up from the soft parts beneath (Fig. 37, Plate 7). It was then brought upwards and forwards onto the defect (Fig. 38, Plate 7) and sewed in place without tension or distortion. The secondary defect, after undermining the wound edges, was closed in a horizontal line by direct suture (Fig. 39, Plate 7).

At the point where three lines of suture came together, and accordingly considerable danger of necrosis existed, only the epidermis and the uppermost layer of the corium were sewed together by superficial stitches. After the suture was completed, no folds were apparent in the skin. Four weeks later the flap had healed in completely without necrosis. A few of the stitches between the edges of the secondary wounds had cut through, but the flap closed in rapidly with an application of silver nitrate. Immediately after discharge, in spite of the wide extirpation, new glands appeared in the region of the upper wound edge, and the patient died a year later from extensive metastases.

THE ITALIAN METHOD

If for cosmetic or practical reasons the formation of a flap from the forehead does not appear feasible, the Italian or Tagliacotian method may find application. This consists in dissecting up a piece of skin on the arm corresponding in size to the wound, which remains

Pediculated flap in the region of shoulder and neck.

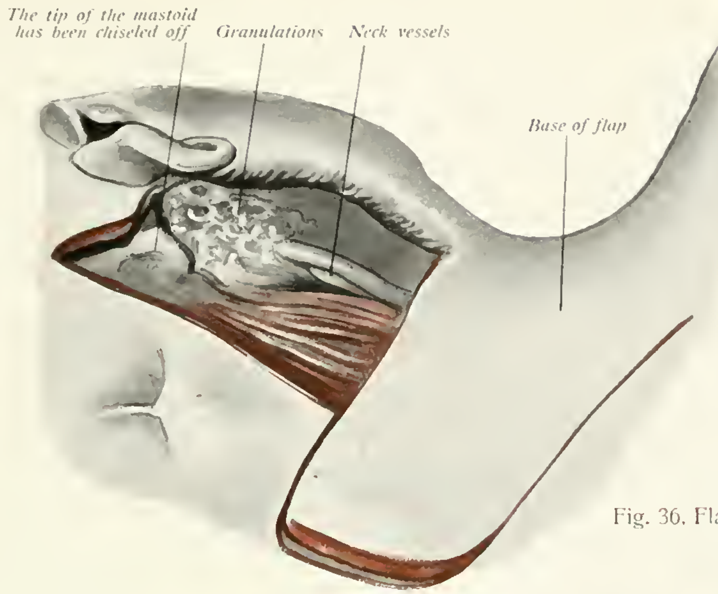

Fig. 36. Flap outlined, with base below.

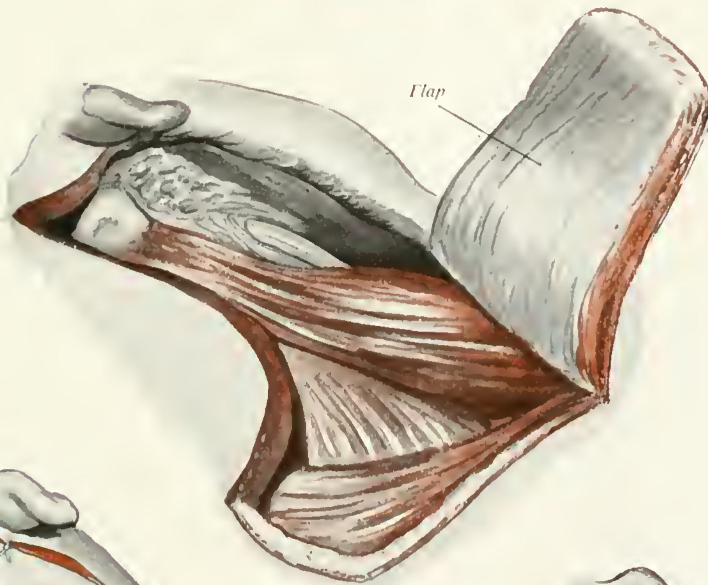

Fig. 37. Flap being applied

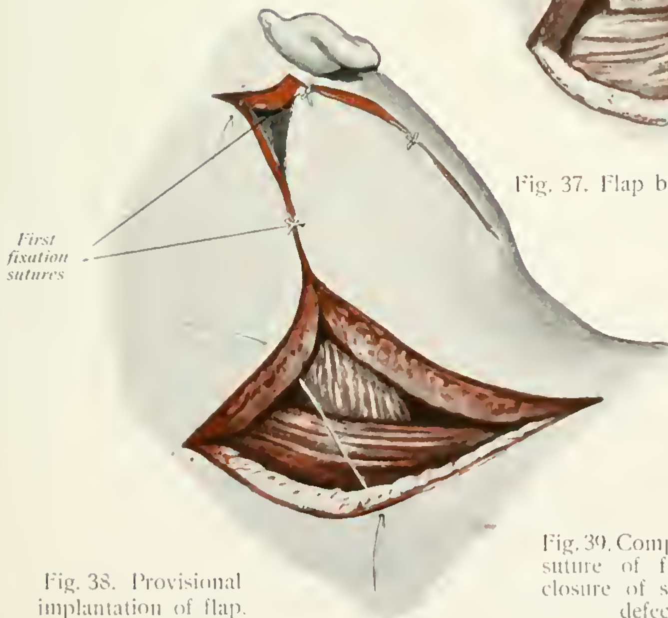

Fig. 38. Provisional implantation of flap.

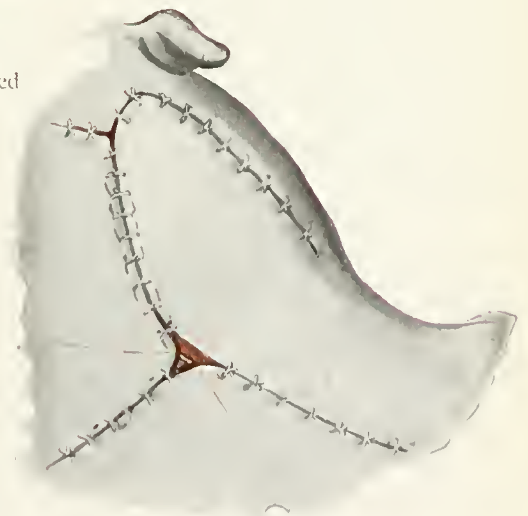

Fig. 39. Completion of suture of flap, and closure of secondary defect.

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Italian method of rhinoplasty I.

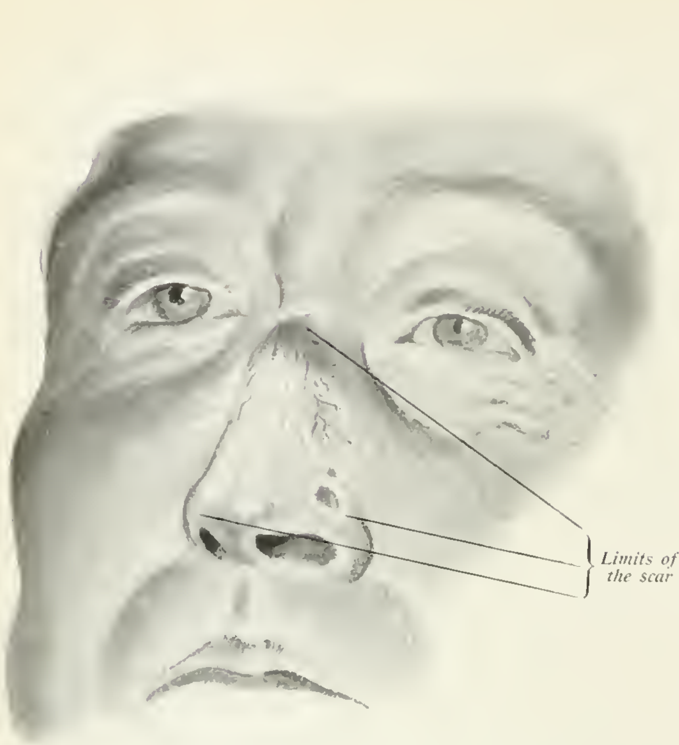

Fig. 40. Scar on nose, following burn.

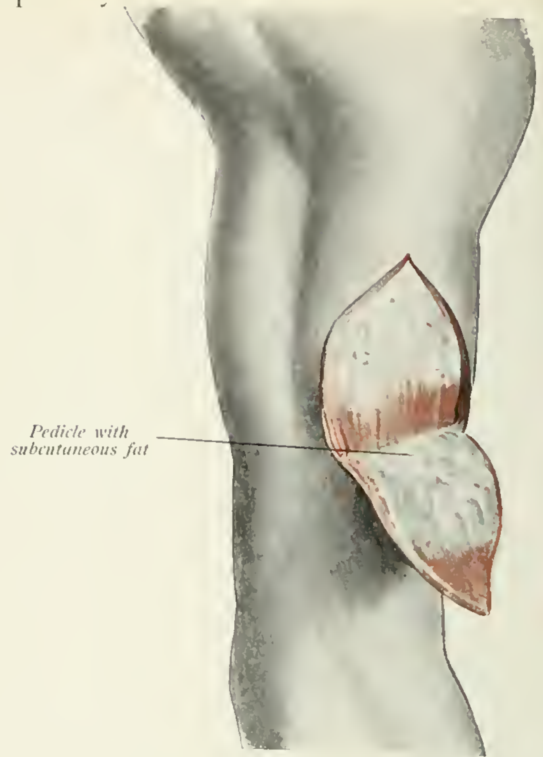

Fig. 41. Flap from upper arm.

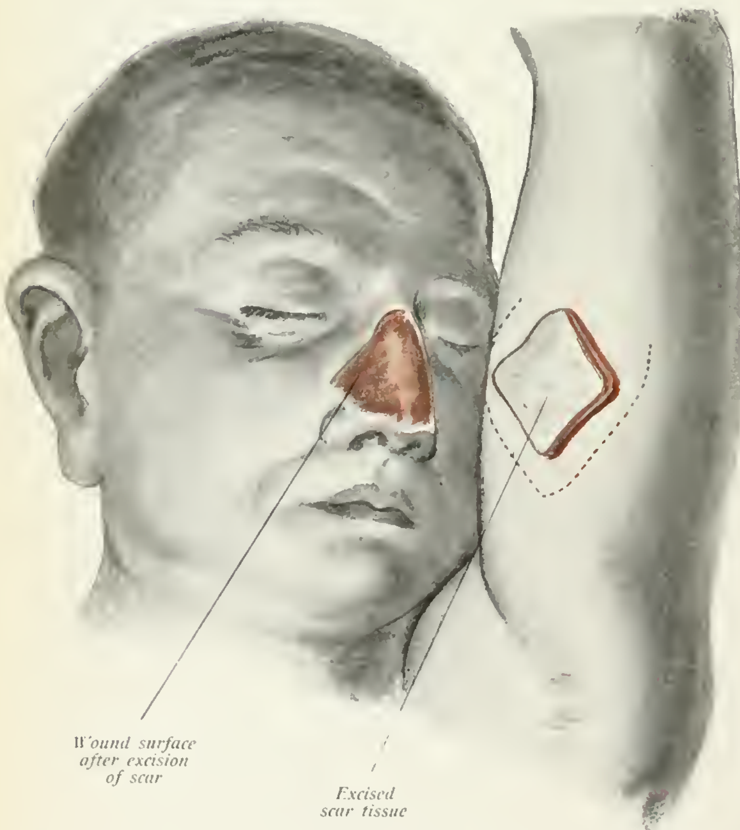

Fig. 42. The excised scar serves as pattern for outlining flap

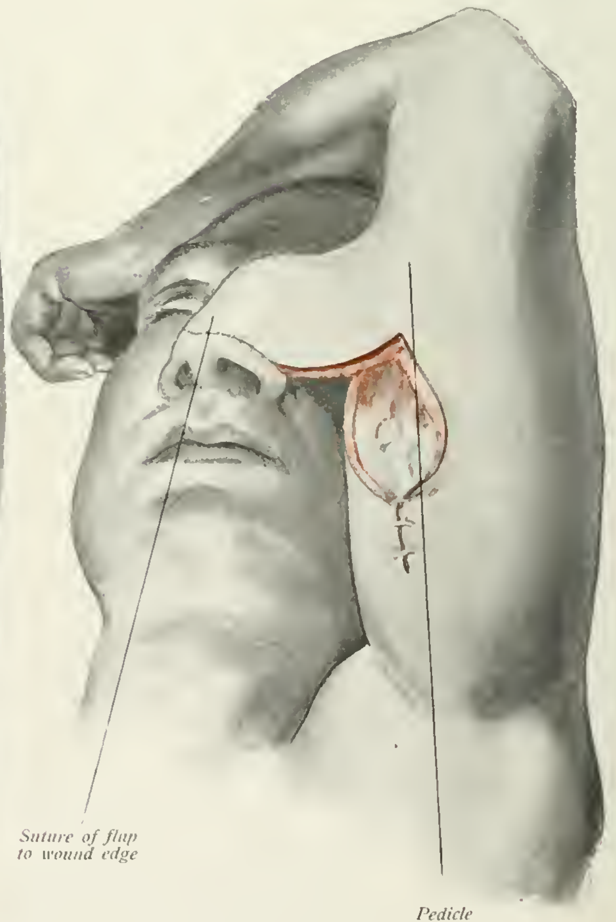

Fig. 43. Implantation of flap upon the nose.

in connection with its original surroundings by a wide pedicle, and sewing it in by its other three edges. In a week or ten days the flap has usually healed in about the edges, and the young vessels which have grown into the transplanted flap suffice to care for its nutrition. The pedicle can then be cut through, and the arm, which had been bandaged up to the head during this time, can be freed from its constrained position.

The disadvantage of this procedure, in addition to the discomfort to the patient during the first ten days, consists particularly in the difference between the color of the skin of the face and of the skin of the flap. The skin of the flap, previously covered by clothes, is usually to be readily differentiated by its pallor from its new surroundings. Moreover, this lack of agreement is compensated very slightly in the course of time, and the lack of pigmentation of the transplanted flap is never completely made up.

The advantage of the Italian method consists in the fact that the flap can be made of any desired thickness so far as the subcutaneous tissue goes. Also before transplantation bits of bone or cartilage may be allowed to heal in under the flap, if it is deemed advisable that the new piece of skin on the face shall have some support.

Originally the Italian method, like the Indian, was applied wholly to rhinoplasty. Both had the same disadvantage, that the new nose, which was composed entirely of skin, began to shrink immediately after it had healed in. For this reason both methods are no longer used for this purpose without modification. But in their simplicity they still serve as valuable methods for replacing skin defects.

The following is the history of a case of transplantation after the Italian method:

A forty-year-old sanitary officer, after a long sojourn in the tropics, developed extensive telangiectases on the bridge of his nose. Several exposures to the X-ray had resulted in a burning of the entire skin of the nose three years before. The scar (Fig. 40, Plate 8) consisted of shiny tissue under strong tension showing a rich development of vessels about the edge, and in addition to the cosmetic disadvantages it involved a series of rather severe symptoms. Under the influence of the slightest psychic disturbances and as a reaction to the influence of sunlight, cold or heat, the transparent scar epidermis became colored intensely red or blue, so that the patient suffered extreme anguish. Also from time to time new islands of telangiectasis appeared in several places. For six months the patient could not be persuaded to

undergo an operation, but gradually the depression increased, and this in conjunction with the limited outlook for improvement of the local symptoms seemed to justify operation.

The skin of the entire nose except for a narrow margin had to be removed. The forehead or other portions of the face could not be used for plastic purposes because the new scar might give rise to a similar condition of psychic depression. The employment of a free flap from the arm was considered, but by this method not infrequently irregularities of pigmentation occur, which strongly interfere with the cosmetic result. There remained, therefore, only the Italian method. The patient himself had made the trial for one day to see whether fixation of the left arm would be bearable, with the flap taken from the medial side of the upper arm.

The entire scar was excised within the normal skin, so that the incision ran about 1 or 2 mm. from the boundaries of the scar. The outlined scar was removed in one piece in order to hold it as an exact model for the flap. The cut edges of the skin of the nose, which remained, were undermined for about 1 mm. in order that the plastic flap (Fig. 41, Plate 8) could be sewed in exactly. Naturally the flap had to be outlined in a considerably larger size than the pattern, since the skin separated from its surroundings always shrinks. The size of the excised scar, which when spread out had the shape of a trapezium, were on the parallel sides 33 and 40 mm. and on the other sides 33 and 38 mm. The flap was made about one-third larger and the pedicle (Fig. 42, Plate 8) was to the outer side of the arm, and after division was to be sewed down to the left edge of the defect.

In its upper half the flap was taken away practically without fat, because this portion was to replace the thin part of the skin of the nose, and the skin of the upper arm contains more fat than is desirable. On the other hand, the lower part of the flap was made thicker, and close to the pedicle all the fat and subcutaneous tissue were allowed to remain. After outlining the flap, the arm was lifted high and flexed over the head. It was apparent that the flap could be laid in place and sewed in without twisting the pedicle.

The flap was approximated carefully by sutures to the right, the upper and the lower edges of the defect (Fig. 43, Plate 8). On the left margin the suture naturally could not take place because this corresponded to the pedicle. The defect which remained in the upper arm was diminished in size by three interrupted sutures. Finally the arm was fixed in its place by a plaster of Paris dressing, enclosing the

Italian method of rhinoplasty. II.

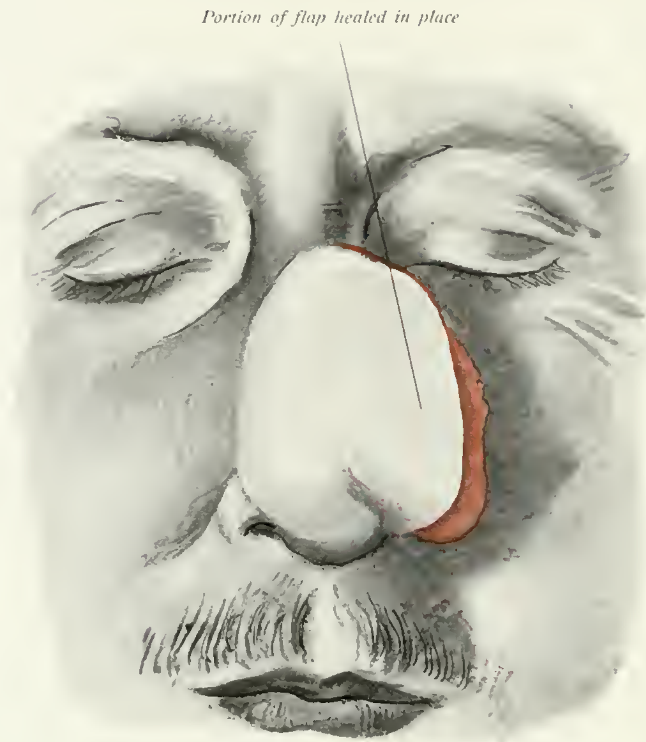

Fig. 44. The pedicle is divided after ten days.

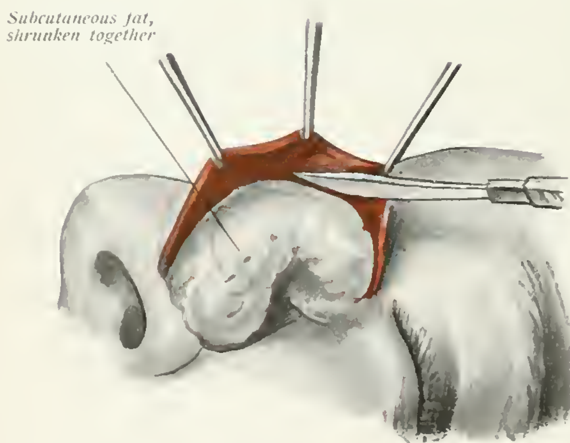

Fig. 45. The flap is made thinner by removal of the fat layer.

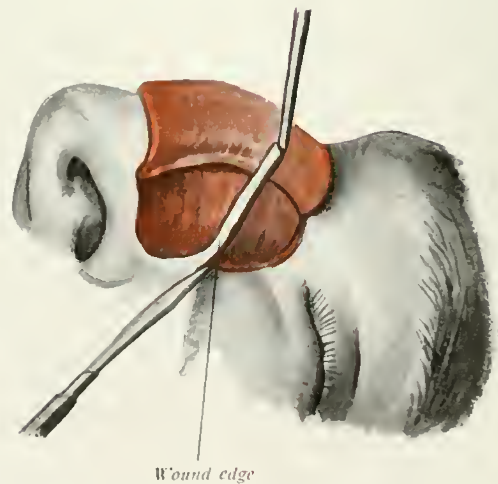

Fig. 46. The wound edge is again freshened up.

Italian method of rhinoplasty. III.

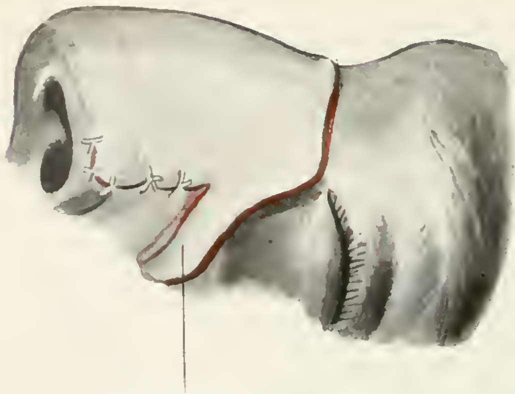

Fig. 47. The divided pedicle is sewed to wound margin.

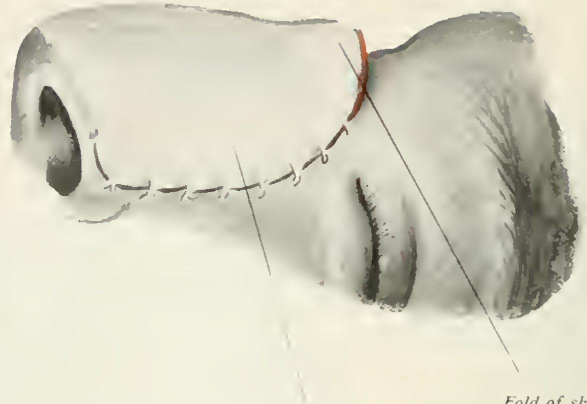

Fig. 48. Nose after completion of suture.

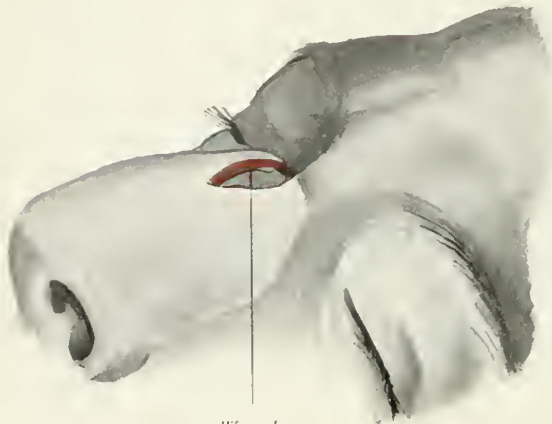

Fig. 49. Excision of the fold.

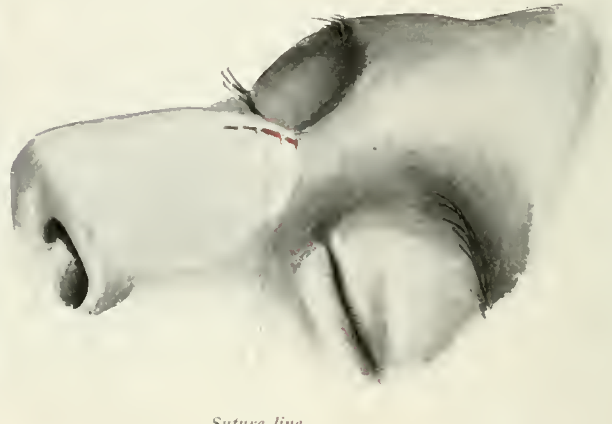

Fig. 50. Suture after excision.

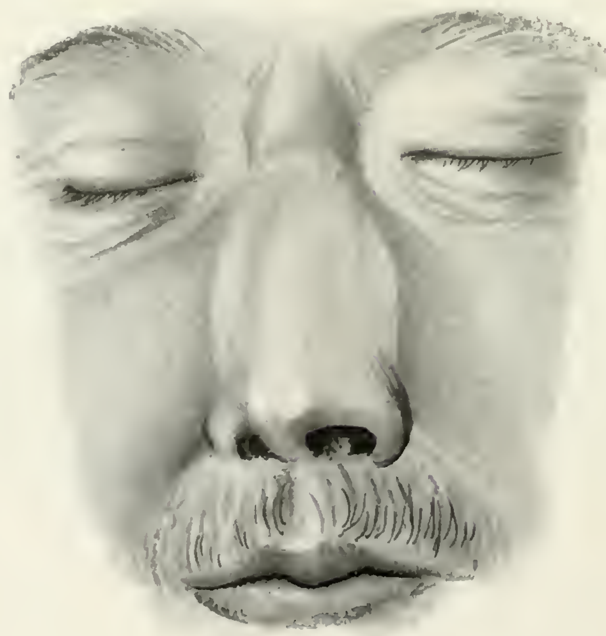

Fig. 51. Appearance after six weeks.

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head, chest and arm. In order to prevent any pressure between areas of skin laying next to each other, and maturation as the result of perspiration, a considerable number of sterile pads made of absorbent cotton enclosed in gauze were laid between the arm and the face, and the forearm was bent so that its volar side rested over the forehead. In this way the flap was held approximated without tension.

Twelve days later the plaster of Paris was removed without anesthesia. The transplanted skin had healed in well without the least necrosis at the site of the stitches. In the young scar there appeared small injected areas which marked the entrance of vessels from the surroundings. Accordingly, the pedicle was divided, so that the flap from now on had to be nourished entirely by the vessels of the nose (Fig. 44, Plate 9). When the pedicle was cut several hardly visible vessels bled: the hemorrhage ceased under light compression. Sewing in of the new edge to the left margin of the defect was delayed in order to determine whether or not there would be any necrosis as the result of the separation of the flap from the arm. A light sterile dressing was applied and the patient was put back to bed.

After ten days, it being apparent that the flap was well nourished, the wound on the left wing of the nose was closed. In order to attain the same favorable cosmetic result as had been obtained upon the right side, most of the thick fatty layer of the flap had to be trimmed away before it was sewed in (Fig. 45, Plate 9). This could be done without restraint, because during the ten days which had passed, new vessels had grown in from the under layers. The flap was put on the stretch and a knife was wielded so that no injury to the flap could result. It was found that there was plenty of skin to cover in the defect. In order to make as fine a scar as possible, the left margin of the nasal wound, which had grown in somewhat, as well as the edge of the flap itself, were freshened up again (Fig. 46, Plate 9).

Then followed the suture; it was carried out with the finest needles and silk, so that the stitch holes lay as close to the edge as possible. A small superfluity of skin of the flap was removed (Fig. 47, Plate 10). The suture was completed as far as the bridge of the nose. Here a fold stood up which had not been sewed down, to see whether the very thick flap would heal down along the entire line of suture, and to have a piece of skin in connection with the right side of the nose (Fig. 48, Plate 10) in case of any necessary patch work later. Healing followed so satisfactorily from a cosmetic point of view that the small fold was removed after a fortnight. It was excised by means

of an elipsoid incision and the skin was united by means of four stitches (Figs. 49 and 50, Plate 10).

Six weeks after the operation the patient was discharged. The end result was thoroughly satisfactory (Fig. 51, Plate 10). The implanted portion of skin on the nose could be clearly differentiated in color from the surroundings, but it was expected that the pallor might darken under the influence of sunlight and exposure.

TRANSPLANTATION OF FREE FLAPS

If a surface wound in the face or on the head cannot be covered over by the methods described, the desired result may be obtained by means of the transplantation of free flaps. This can be done using only the uppermost layer, the epidermis, or all the layers which make up the skin. In either way a lasting and durable result may be obtained on any part of the body as well as the face.

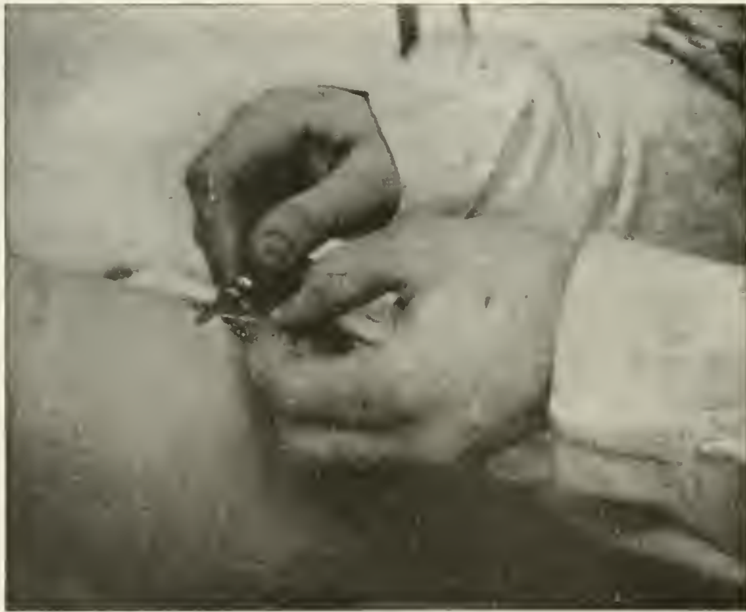

Fig. 52
Method of taking Reverdin grafts from front of thigh (Ehrenfried).

EPIDERMAL TRANSPLANTATION

Transplantation of the epidermis was originated by Reverdin, who established the method of "pin-point" grafting. According to this method small islets of epidermis are raised on the point of a needle and cut off by a see-sawing motion with a sharp knife (Fig. 52).

These are immediately transplanted to the area to be covered, which may be fresh or granulating. They should be distributed over the wound at the distance of about 1/4 inch from each other, the grafts

Fig. 53
Reverdin grafts planted on raw surface (2/3 natural size) (Ehrenfried).

themselves being about 1/8 inch in diameter (Fig. 53). The basal or malpighian layer adheres to the underlying surface and proliferates

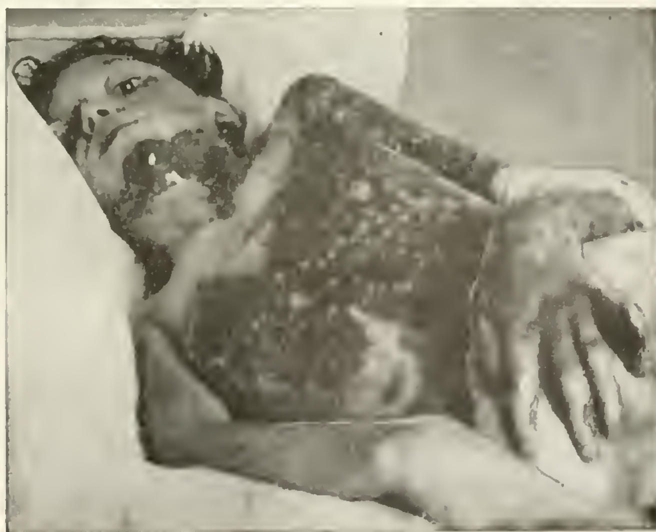

Fig. 54
Extensive third degree burn of neck, chest, arm and axilla, with serious and protracted secondary symptoms, shows proliferating islands from Reverdin grafts 14 days after their application. (From Ehrenfried and Cotton, op. cit.).

in all directions, until the growing islands from each transplant meet to cover in the surface with a thin bluish epithelium. This delicate epithelial covering under proper treatment is soon converted into a durable skin with relatively slight contraction. This method is applicable to fresh burns of large area and to secreting granulating surfaces (Figs. 54 and 55). Skin enough to cover the entire front of

Fig. 55

Same case as Fig. 54, photo taken 12 days later. Chest, neck and axilla nearly covered with sound skin. Secondary graft necessary on arm. All areas solid 9 weeks after burn received. (From Ehrenfried and Cotton, op. cit.).

the chest may be taken from the front of one thigh and leave only insignificant scars. Inasmuch as the material is always taken from the patient himself, the grafts usually "take."*

A method of transplanting epidermis in larger segments was originated by Ollier and developed by Thiersch. It heals on with less assurance than the Reverdin graft, particularly as the material frequently has to be taken from other persons than the patient, but even when a portion of the transplanted layer fails to survive, small islets of epithelium remain behind and proliferate in similar fashion to the Reverdin grafts.

To carry out the Thiersch method, so called, a razor or any wide knife made for this purpose is employed. The knife should be sharp.

*For a fuller discussion of this method see Ehrenfried and Cotton: Reverdin and other methods of skin-grafting. Boston Med. and Surg. Jour., 1909, clxi, pp. 911-927.

Before taking the grafts it is moistened in sterile salt solution in order to prevent the grafts from adhering to the blade. The front of the thigh usually is employed. Before taking the grafts the skin is disinfected by means of half-strength tincture of iodine.

The area itself is flattened and stretched between the volar edges of two hands, the assistant's above and the left hand of the surgeon below, or two small sterile boards may be used. The knife is laid on flat and carried through the uppermost layer by means of long oblique strokes. With practice one can pick up grafts of considerable size, but if this is not successfully done a number of smaller ones will serve the same purpose, without in any way influencing the result of the transplantation.

The strips of epidermis are drawn carefully off the blade by fixing one corner on the wound with a blunt probe and then carefully drawing away the knife from under it. In so far as they are inclined to curl up if they become dry, it is advisable to place them immediately on cutting.

If after the transplantation several grafts lap over each other or the neighboring skin, it is unnecessary to trim the projecting portion, for portions of the grafts which do not adhere to the prepared surface dry up and fall off of themselves.

After being laid in place the strips of epidermis are pressed onto the surface lightly with gauze in order that they may adhere at once and without formation of bubbles. If the floor is completely aseptic or the granulating surface dry and firm, the grafts adhere so much the better. If the granulations are exuberant and are secreting profusely they should be previously curetted or otherwise treated.

To cover in and protect the transplanted area a single layer of gauze is spread smoothly over it and small sponges of gauze are laid in clapboard fashion over this. In this way the wound secretion is absorbed and at the same time light compression is exerted upon the transplanted portions. Both Reverdin and Thiersch grafts may be held in place to advantage by a single layer of coarse mull which has been waterproofed in celloidin, as first advised by Kuhn, with the edges stuck down at some distance from the wound by collodion or adhesive strips, and a gauze dressing is applied over this. In changing the dressing only the gauze is removed and the mull is allowed to remain. This protects the grafts and prevents them from being torn away from their bed before they have permanently adhered.

The entire operation may be carried out with little pain and in

some cases without anesthesia. But sensitive patients should be anesthetized or the region from which the grafts are to be taken should be cocainized. The wound occasioned by the removal of the grafts is covered over with boric ointment. After about ten days the grafts are usually well adherent. Particularly suitable for epidermal grafting are flat surfaces which cannot be closed in by means of suture of the wound edges, and the method may be applied with complete success even where the wound lies directly upon a bony surface, such as the scalp or forehead.

This procedure, however, always leaves an epithelial scar which possesses the property of contraction common to all scars. This limits the applicability of the method; in the face, for instance, contraction will produce distortion of the features and a cosmetic failure.

THE WOLFE-KRAUSE METHOD

This method, originated by Wolfe for ophthalmic purposes and developed by Krause, consists, in contradistinction to the epidermal graft, in the employment of the whole thickness of the skin, including the fat. Since skin which has been freed from its surroundings shows a strong disposition to shrink, the new flaps must be outlined larger in all directions than the primary wound surface. Each piece of skin shrinks somewhat after it has been removed, but it has no tendency to shrink after it is healed on; wounds which have been covered by whole thickness grafts do not contract, in contradistinction to epidermal grafts. Such grafts when healed in are permanently elastic and are movable upon the underlying layer, accordingly they are more durable and are better able to resist pressure and injury. In this lies the advantage over the technique of Thiersch: the epidermal methods are applicable to superficial repair, while the whole thickness grafts of Krause are to be preferred for deeper loss of substance.

The flap is dissected up without the underlying fat. But small bits of fat which still adhere do not have to be removed with scissors, but may be allowed to remain. Care is taken to avoid the fatty layer because without it the skin adheres much more evenly and more rapidly.

The healing in of the flap depends largely upon its early adhesion to the underlying surface. The cosmetic result will be more satisfactory if the newly transplanted skin does not project from the wound surface from the presence of a thick fatty layer, but lies even with the level of the surrounding skin. The fat never entirely pre-

vents healing in, and after the transplantation it persists just like other parts of the skin, the hair, the glands and the elastic tissue.

Sometimes at the beginning or the end of the second week small blebs appear in the epidermal layer of the flap, which otherwise is well adherent to the wound. If these are incised one will see that the epidermis is raised; usually only local necrosis results, but large shreds may be loosened up so that the entire flap looks like a weeping eczema. Later the epithelium is restored, without endangering the vitality of the flap, as the result of the proliferation of the islands which remain behind in the neighborhood of the sweat and sebaceous glands. Differences in color bleach out in the first few weeks after the transplantation, but nevertheless the flap can be differentiated through its stronger pigmentation from the surrounding skin even in after years.

The persistence of differences in color is the only disadvantage of this method of replacing the skin of the face with skin from other parts of the body. Infrequently the transplanted area will later puff out and form a projecting pad; this finds its explanation in an irregular trimming of fat from the flap, or in an insufficient preparation of the wound surface. Of particular offence in this regard are insufficient hemostasis and scar contraction of the wound surface beneath the transplant.

To assure the healing in of free flaps according to Krause one requires absolute asepsis, a dry technique and complete hemostasis. The second requirement can be accomplished surely and with little difficulty now by the employment of tincture of iodine. In order to fulfill the third condition the wound must first be freed of all granulations and scar tissue formation on the floor and about the edges, and must then be compressed with gauze until on the removal of the gauze not the slightest clot formation occurs. Ligatures should be completely avoided if possible.

In excising the flap the danger of infection may be limited if, after making the first incision, the epidermis is seized by the thumb and forefinger, and folded upon itself, so that in lifting it wound surface is brought in contact with wound surface. In this way the loosened piece of skin is protected from too rapid drying. All mechanical injury of the edges of the flap, such as might be caused by the pressure of forceps, is avoided by holding it considerately between the fingers. In dissecting off the skin the knife blade is directed toward the skin and not toward the substratum, in order to free the flap evenly and with-

out any morsels of fat remaining. As in the Thiersch method, any part of the body may properly be submitted to this form of transplantation. However, flaps from the thigh or upper arm, particularly upon the flexor aspect, show a stronger disposition to heal on than skin from the buttock.

The free flap is unfolded and lightly pressed against the floor of the previously prepared wound until it adheres throughout. Only exceptionally, for instance in portions of the face which are very movable, is the application of a holding suture at the edge necessary. Ordinarily a well-applied dressing is sufficient to hold the rapidly adhering flap fast in its new situation without suture.

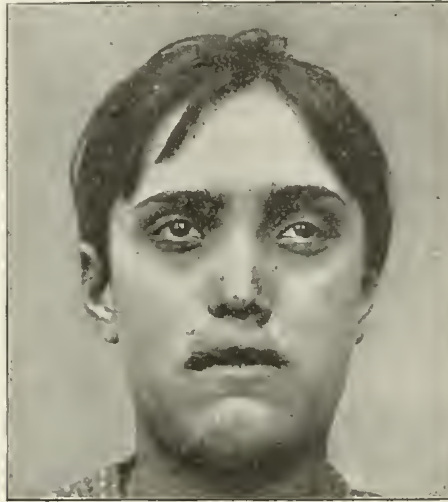

Fig. 56

Upper lip, restored by transplantation of a free flap from the flexor surface of the upper arm; photograph, 8 months after operation.

The secondary skin wound, from which the graft is taken, is sewed up directly, or if the tension is too great, after undermining the wound edges and extirpation of the fatty layer. Any surface which remains uncovered can be covered in with epidermal grafts.

We employ free flaps by preference upon fresh operative wounds in the face, such, for example, as those which result from the removal of malignant tumors or tuberculous disease, as may be shown by the following case cited by Krause:

"A fourteen-year-old girl was repeatedly operated on by my predecessors for ulcerative lupus, which had involved the greater part of the upper lip. She returned to the hospital with a recurrence; there existed a very offensive scar ectropion of the upper lip. On July 8,

1892, I removed all of the infected portion, which included practically the entire thickness of the lip down to the mucous membrane, and restored the defect by a free flap taken from the flexor side of the left upper arm, which after it had shrunk measured 6 cm. long by 2 cm. wide. Since patients coming out of the anesthetic continually move the lip, the flap was made fast by means of four silk sutures—this was the only case in which I had been induced to insert stitches. Healing followed without incident, the cosmetic result was very good, as is shown by a photograph (Fig. 56), taken March 30, 1893, that is nine months after the plastic operation. The flap had not shrunk; it was thick and soft."

Fig. 57
Photograph before operation, showing extensive lupus.

The following is another example of skin transplantation after deep-lying and widespread destruction of the skin of the face as the result of tuberculosis, taken also from Krause:

A thirty-four-year-old seamstress suffered since her seventh year from lupus of the face. In spite of continuous treatment, the lupus had extended until it involved the greater part of the face. The tip and alae of the nose were wanting, and no normal skin was at hand for plastic restoration (Fig. 57). The entire bridge of the nose which was affected with lupus was extirpated down to the pericondrium and periosteum, as well as the neighboring sections of the cheek. The defect was immediately covered in with two flaps taken from the volar

side of the right and left upper arms. Four weeks later the skin of the lip and in addition most of the affected skin of the right side of the cheek up to the ear and down to the neck was extirpated; the external maxillary artery was destroyed and the bleeding controlled by torsion. A flap from the left thigh was planted over the defect. Finally, after a fortnight the rest of the infected skin on the left cheek was extirpated, and since here the new skin could not be turned to

Fig. 58
Intermediate stage; photograph.

account for further plastic purposes, the surface was covered with Thiersch grafts (Fig. 58).

The free flap which covered in the entire nose up to the inner corner of the eye and the upper part of the cheek at that time was still recognizable from the scar about its periphery. This new skin was everywhere normal in appearance and possessed normal movability upon the underlying stratum; it was accordingly employed four months later in the form of two pediculated flaps to restore the wings and tip of the nose, while the new defects which resulted on the bridge of the nose and the cheeks were covered in by Thiersch grafts. The end result of this plastic operation was unusually satisfactory in every respect, the entire treatment consuming two and one-half years (Fig. 59). Nowhere did lupus nodules appear in the trans-

planted flaps, but four small nodules appeared in different places in the contiguous sound skin, and were burned out with the actual cautery.

Radical excision and restoration of the defect by free flaps is, of course, necessary for stubborn and recurring cases. Otherwise all superficial and still apparently young cases of lupus are first curetted, and the floor as well as the region of transition into apparently healthy

Fig. 59
Appearance 9 months after transplantation; photograph.

skin is burned out with the Paquelin cautery. Particular attention should be paid to the pale nodular thickenings in the deeper layers of the corium. If they are not radically removed with the curette, recurrences occur from these foci. Hemorrhage which does not stop of itself is controlled by compression with a pad of gauze, which may be smeared with boric ointment. It is wonderful how quickly even extensive surfaces which have been treated by the curette and the cautery heal over after the scab drops off.

TRANSPLANTATION OF FREE FLAPS AFTER EXTIRPATION OF MALIGNANT GROWTHS

Free flaps are also employed for covering in wounds of the face resulting from the removal of malignant tumors. Since these demand the most radical excision of all suspicious tissue, at times extensive portions of the face without regard to position are included in the

wound surface, so that it may extend over an entire cheek, or include the entire upper lip or chin.

Cancer of the face, of the extirpation of which such wounds are usually the result, comes under our observation in two forms: the flat ulcer-like skin cancer or epithelioma, and the true carcinoma, which proliferates in the depths. While both these forms are similar in histological characteristics, the flat skin cancer as well as the carcinoma of the skin taking their origin from the flat epithelium which is in transition to become horny, clinically they differ in many characteristics. The true carcinoma of the face, the location of which by choice is at the line of junction of mucous membrane and skin, for example on the lower lip, manifests all the malignant properties of other cancers; on the other hand the superficial epithelioma grows very slowly and lasts for many years, often for ten or more, in the same layer of the skin and shows in rare cases only a tendency to extend to the regional lymph nodes, or other metastases. In its centre the new-formed tissue in both forms is likely to become necrotic on account of the poverty of circulation, so that ulcers are formed which extend slowly and steadily over the surface, with a margin made up of an elevated wall of carcinoma. In the true carcinoma a rapid extension into the deep tissues goes hand in hand with the necrotic ulceration, while the flat epithelioma usually undergoes shrinkage and scar formation on the floor of the ulcer, as well as of one or more edges.

The superficial and clinically benign epithelioma may develop on any portion of the face, but particularly on the nose in the vicinity of the inner eyelid, and in places where the folds of facial expression are particularly impressed. With the extension of the ulcer in the course of years considerable surfaces of skin are destroyed without the deep tissue becoming involved. On the other hand this form of ulcer, which is the result of the activity of the proliferating epidermal carcinoma cells, tends to scar formation and covering over with epithelium, if all the necrosed tissue has fallen away and it has been protected from mechanical injury. This process is such as to deceive one into the belief that the ulcer has healed, while in fact the cells of the new growth are continuing their development under the surface and proliferating actively. Similarly the result of X-ray or radium treatment, of antiseptic and lightly cauterant applications, as well as heliotherapy and cauterization in the most cases is a temporary and apparent healing only.

A wide removal of an epithelioma by an incision in normal tissue

Transplantation of a free flap to the chin.

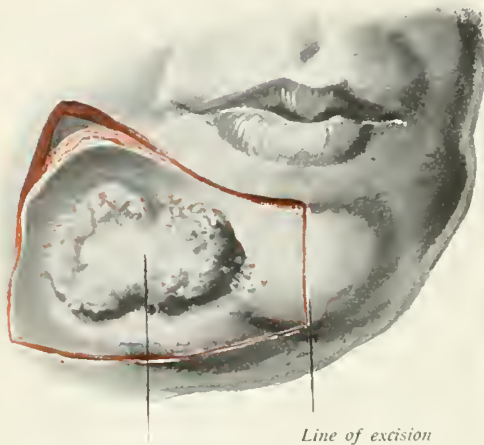

Fig. 60. Extirpation of an epithelioma.

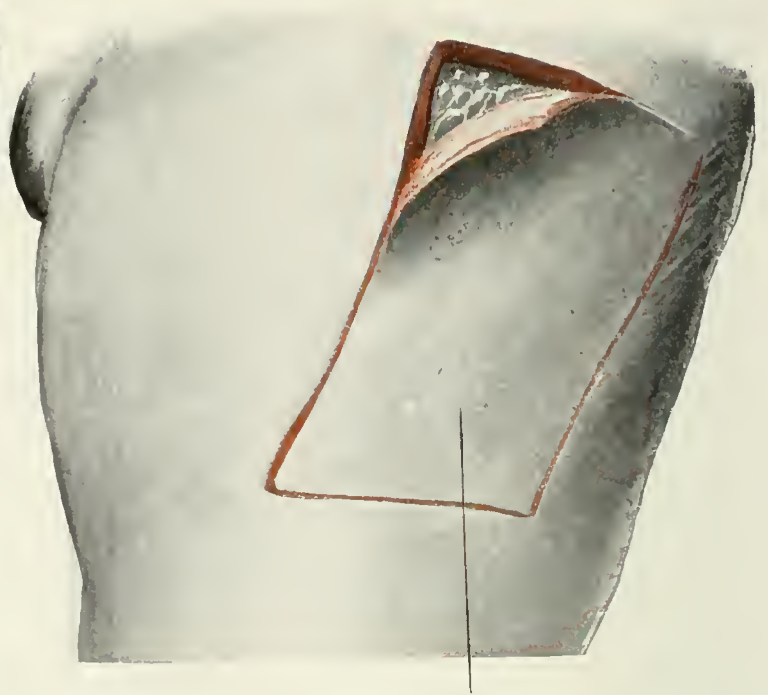

Fig. 61. Free flap from front of the thigh.

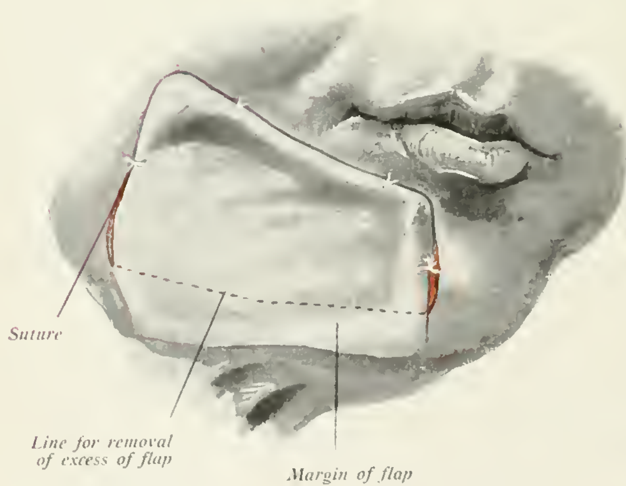

Fig. 62. Suture of flap in place.

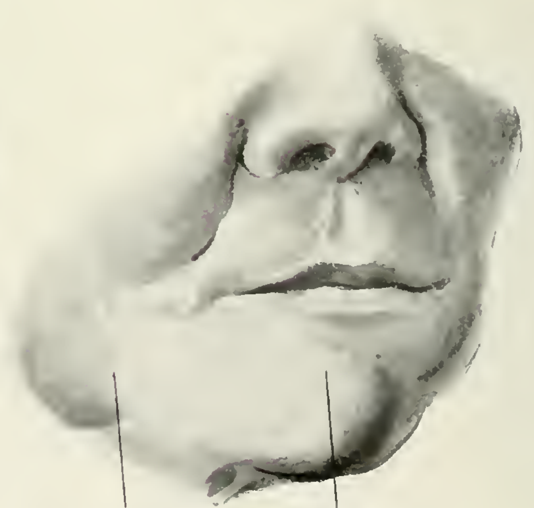

Fig. 63. Condition 1½ years after operation.

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and painstaking cleaning out of all suspicious tissue in the depths can alone guarantee a cure of this malignant disease, as with other malignant conditions. The following observation will serve to show how the loss of tissue may be provided for by means of a free flap:

In a forty-nine-year-old school teacher a tumor the size of a silver dollar had developed during three years upon the right chin furrow. In the middle the tumor was scarred over (Fig. 60, Plate 11). At the periphery it consisted of numerous readily bleeding tubercles and ulcerous excavations. The slowly growing tumor had never caused symptoms. Microscopic examination of a small portion of the margin which was readily removed with forceps showed epithelioma.

Under general anesthesia, the tumor was removed by a rhomboid incision, which included about 1 cm. of normal tissue (Fig. 60, Plate 11). The skin was seized with two toothed clamps at the upper corner after the incision had been carried down to muscle, and the entire new growth with the underlying fascia was removed. Nowhere was suspicion aroused that the epithelioma had penetrated the fascia. Several layers of gauze were laid upon the wound surface and the bleeding was controlled through strong pressure while the flap was being cut. The defect was not covered by Thiersch grafts because the upper edge of the wound reached close to the corner of the mouth and there was danger that as a result of scar contraction ectropion of the lower lip would ensue. In order to prevent this a flap of practically twice the size of the defect was cut from the anterior thigh (Fig. 61, Plate 11). During its removal the flap was held carefully with the fingers by its epidermal surface so that the wound surface came in contact only with the knife, and with the same care it was carried over to the primary wound on the chin and unfolded, after the bleeding had been stopped satisfactorily by the compression.

As the generous sized flap shrunk to a marked degree, it fitted satisfactorily the wound defect as far as the upper edge and two sides were concerned; but below it overlapped the wound edge for several mm., and this superfluous skin was removed with scissors. With regard for the continuous activity of the jaw in chewing, talking, etc., it seemed wise that, in exception to the general rule, the flap should be maintained in position by a few sutures (Fig. 62, Plate 11). In order to obtain rapid adhesion of the new skin to the base, light pressure was exerted from the middle outward toward the edge by means of small sponges. The wound of the thigh after undermining and mobilization of the surrounding skin could be satisfactorily closed by suture.

Six days later the flap was everywhere adherent to its bed and the sutures were removed. It had assumed a waxy white color, but it was warm and dry to the touch. At later dressings this pallor gradually was replaced by a bluish red shade. Part of the uppermost layer of the epidermis became elevated in the form of blebs and could be removed, after incision with a knife, in several places. Three weeks after the operation this shedding of epidermis was over and the flap had healed in solidly, so that the patient was discharged. A year and a half later the boundary line between chin and flap could hardly be recognized and the skin was movable upon its entire bed (Fig. 63, Plate 11). No recurrence had appeared within five years.

CHAPTER 8—SPECIAL PLASTIC PROCEDURES

There is a great deal of surgical satisfaction in the fact that other tissues as well as the skin allow of transplantation and remain viable in their new abode. Such transplantation may be free, in that for example a piece of bone or fascia, a bit of fat, or a slice of cartilage may be freed entirely from its original surroundings and brought into new relations with tissue in other places. This free transplantation stands in opposition to the older method by which, for instance, sections of muscle, bits of bone with periosteum attached, or flaps of mucous membrane remained in relation to their original site through nutritional bridges which carried the circulation. Also a combination of the free and of the pediculated grafts, such as the Müller-König method, by which a sliver of bone removed in connection with a flap of skin is nourished by the pedicle of the skin flap, finds extensive application in plastic surgery of the face. For this purpose it makes no difference whether these combined flaps are taken from the immediate neighborhood of the wound or from other portions of the body after the Italian method.

By the aid of the methods already described, not only broad and flat surfaces of the face may be covered, but prominent features may be artificially restored, if destroyed by disease or injury. By suitable choice of methods and judicious employment of the material at hand portions of the face of complicated structure, such as the nose, eyelid, mouth and ear may be built up in satisfactory fashion from a cosmetic point of view, and a total or partial loss may be agreeably restored.

Among the causes of the extensive mutilations which demand plastic repair, wounds made in the course of operative removal of malignant tumors stand in the first rank. Next come injuries, among which are particularly to be considered loss of tissue by burns and freezing, gunshot wounds and crushing injuries, which are very likely to carry in their train the loss of prominent features. In the third rank stand congenital deformities of the face, particularly of the lips and palate, which demand plastic treatment for the closure of clefts which result from incomplete fetal union of tissue.

The essential function of plastic surgery of the face consists in restoring a mouth bordered by lips, building up a nose with its proper

support, restoring form to the shell of the ear, and in palliating acceptably the loss of an eye or one of its lids. Of the most important surgical diseases and the operations which are necessary in their treatment we shall in what follows give illustrative cases; but it is impracticable to relate here all the methods which have been described and recommended, particularly as each case necessitates variations, and in no instance can a described procedure be strictly followed.

PLASTIC OPERATIONS ON THE LIPS: EXTIRPATION OF CANCER OF THE LIP

Carcinoma of the lower lip develops by predilection at the point of transition from skin to mucous membrane. It appears first as small tubercles or palpable nodules, which after a time develop into clusters of scabby and rapidly growing ulcers with irregularly raised margins. A considerable portion of the lip and of the skin of the cheek may be destroyed by its growth, and usually with the extension of the infiltration and of the ulcerous necrosis, carcinomatous infiltration of the submental as well as of the lateral glands of the neck appears.

So long as the carcinoma is reasonably small and does not include more than two-thirds of the lip, radical operation by means of a wedge-shaped excision with direct union of the remnants of the lip suffices, as the following case shows. Cleaning out of all submental nodes should always be carried out after the extirpation, in carcinoma of the lip which has existed for some time.

A landed proprietor nearly eighty years old had had removed, eight years before entering the hospital, an ulcer of the lower lip with a hard margin about the size of a penny. During the course of a year or more a raw surface had developed again in the region of the scar, which extended rather rapidly. Upon entrance practically the entire lower lip was destroyed by a carcinoma, which was 3 cm. wide and almost 2 cm. high; only a small segment of the lower lip remained intact at each corner (Fig. 64, Plate 12). In addition, on either side could be palpated small and hard submental nodes. In spite of the extent of the carcinoma, wedge-shaped excision was carried out, since because of the emaciation, the small remnants of the lower lip were readily movable and serviceable; and on account of extreme age the patient seemed too weak to be submitted to an extensive plastic operation.

As soon as the patient was placed upon the operating table severe collapse developed. For that reason the excision was carried out with-

Wedge excision of cancer of the lip.

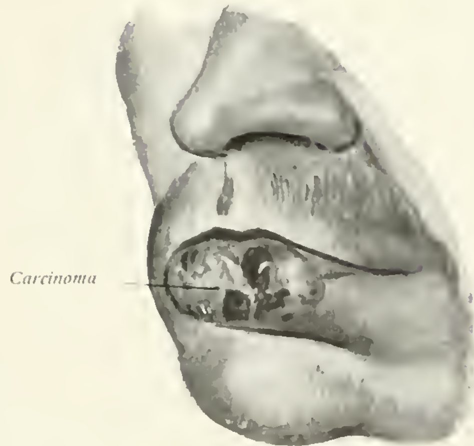

Fig. 64. Carcinoma in the middle of the lower lip.

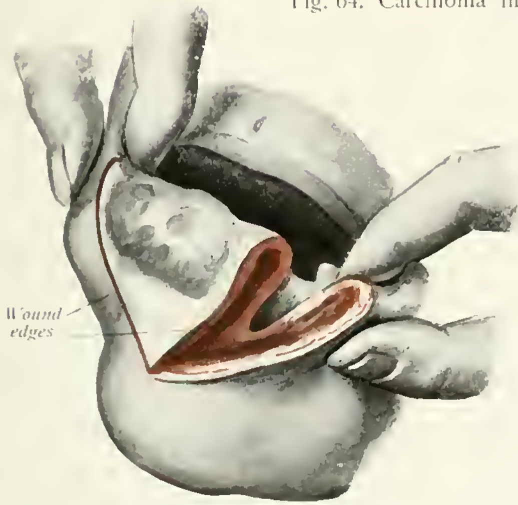

Fig. 65. Wedge excision, arteries being compressed by fingers.

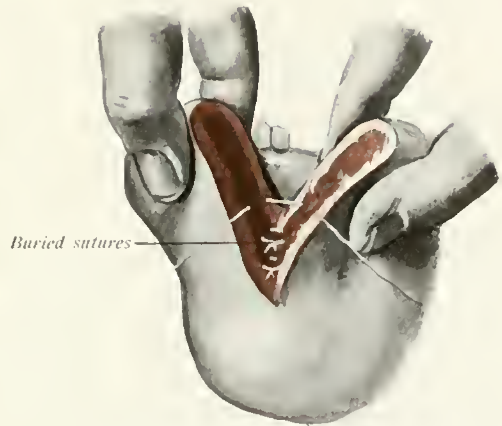

Fig. 66. Suture of mucous membrane.

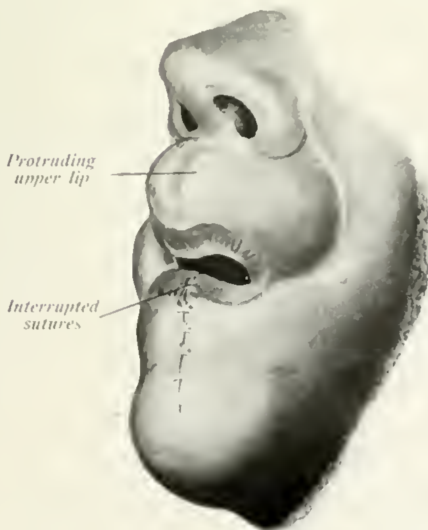

Fig. 67. Skin suture, showing lack of correspondence between upper and lower lips.

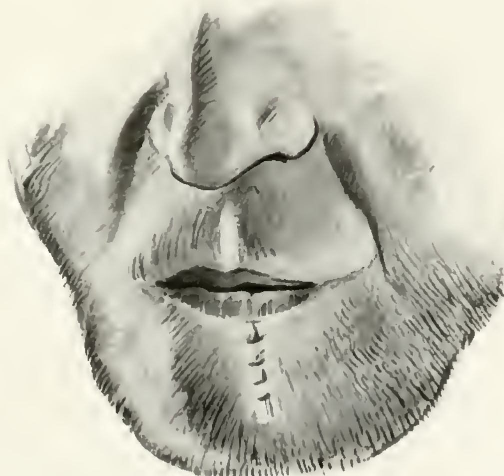

Fig. 68. The distortion of the corners of the mouth and the protuberence of the upper lip have completely disappeared after four weeks.

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out anesthesia. The lower lip was seized between the thumb and the forefinger at right and left, in this way compressing the coronary artery of each side at the corner of the mouth (Fig. 65, Plate 12). The operator could do this with his left hand at the right side himself, while the assistant compressed the left corner of the mouth. The lower lip was excised in wedge-shaped fashion with the knife down to the chin without loss of blood and without necessity for the tying of a single vessel. The mucous membrane of the mouth and lip was united by seven buried sutures of fine catgut in such fashion that the needle did not perforate the mucous membrane, but penetrated the tissues just within it (Fig. 66, Plate 12). This was followed by an exact approximation of the skin of the chin with interrupted silk. The external wound was finally covered with airol paste.

As the greater part of the lower lip was gone, the two corners of the mouth were pulled tightly together when the remnants of the lip were sewed up. As a result the upper lip was puffed out so that it projected like a tumor (Fig. 67, Plate 12). But within two weeks this lack of conformity between the wide upper lip and the narrow lower lip had gradually equalized itself, and a month after the operation the patient was discharged with the wound healed and a good functional result (Fig. 68, Plate 12).

The state of collapse sufficed to carry out the excision without pain; it did not seem expedient to start local anesthesia for finishing up the operation. Moreover, local anesthesia was renounced in advance, because it ordinarily renders difficult the judgment as to whether tissue is suspicious of carcinoma or normal. No other operative procedure could be considered in this frail old man, while in other cases cleaning out of the submental glands would have followed excision of the tumor.

PLASTIC RESTORATION OF THE LIP FROM THE CHEEK (DIEFFENBACH)

Wedge-shaped excision of the tumor and direct suture of the remnants of the lip leads to a useless result if the lip in entire or practically entire extent is destroyed by the disease. By direct suture of a large defect the orifice of the mouth becomes too narrow, and motion of the jaw is restricted as well by scar contraction; besides the exposure of the lower teeth and gum is cosmetically unsightly. By the help of various operative procedures these disadvantages may be avoided and a lower lip created which, without being too unattractive, gives a good functional result.

If the remnants which remain after excision of the tumor do not suffice for the formation of a useful lip, the method of Dieffenbach, which creates a new lip out of skin of the cheek, lined with mucous membrane, practical and of good appearance, really answers every purpose. By dissecting off a small flap of mucous membrane from the upper lip and drawing it down to meet the skin flap, one is in a position to prevent any considerable scar contraction of the orifice of the mouth from the corners. Also the lip which is newly made out of the whole thickness of the cheek remains mobile, so that solid and liquid food and saliva will not be spilled. A scar distortion of the flap into a small, tightly stretched bridge of skin which does not reach the level of the lower teeth may be avoided if the whole-thickness flap taken from the cheek is cut sufficiently high. The following observation will serve as an example of an individual case:

In a seventy-three-year-old letter-carrier the lower lip was practically completely destroyed by carcinoma. The left corner of the mouth was also involved by the tumor, but on the right side a portion 1 cm. wide remained healthy. Within, the tumor extended in the middle line as far as the point of transition of mucous membrane of the lip to gum. Outside it extended 2½ cm. below the border of the lip and down to the dimple of the chin. It had been present more than a year. The patient had been accustomed to smoke a pipe a good deal.

Since a row of enlarged lymph nodes were palpable, these were extirpated first, and for this purpose, with the head strongly bent backward, an incision was made in the neck, through skin, platysma and fascia in a line joining the two angles of the jaw. The flap was dissected up in the direction of the chin, exposing on each side the edge of the sternomastoid muscle and the vessels in their sheath. All the fat of the neck, that surrounding the submaxillary glands and the masses along the vessels which included the lymph nodes, could be removed easily through this incision up to the level of the larynx. After the extirpation of all suspicious tissue the wound of the neck was sutured.

The plan decided upon was to excise the carcinoma in the form of a wedge cut in the normal tissue of the lip and cheek, and to form a new lip by means of skin sliding from the neck. For this purpose the thumb and forefinger of the assistant seized and compressed the inferior coronary artery of the lip at each side in the pouch of the cheek. The entire tumor could then be excised, in addition to the

Plastic restoration of lip from the cheek (Dieffenbach).

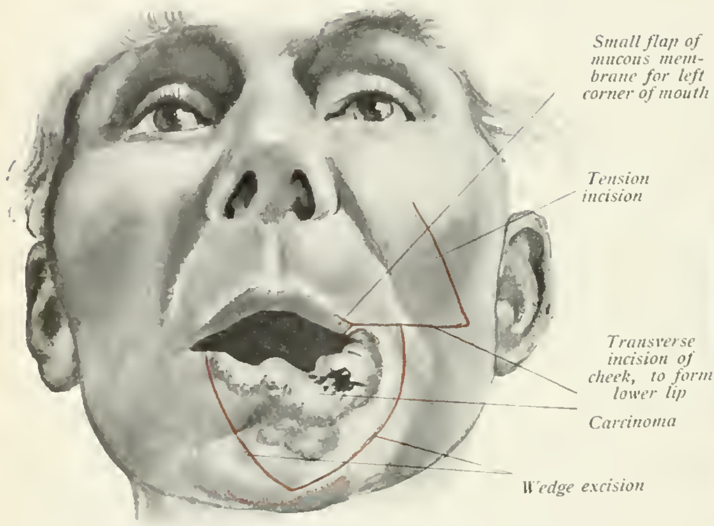

Fig. 69. Line of excision of carcinoma of lower lip.

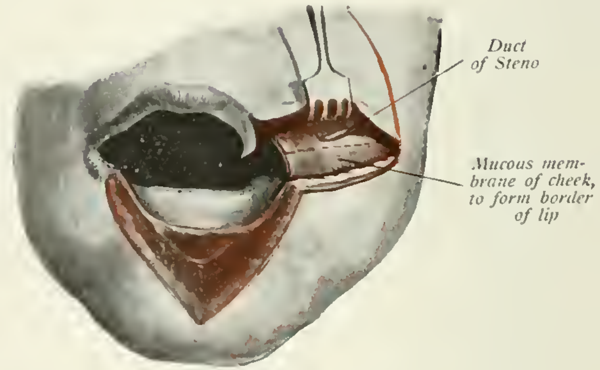

Fig. 70. Completion of excision and exposure of mucous membrane of cheek.

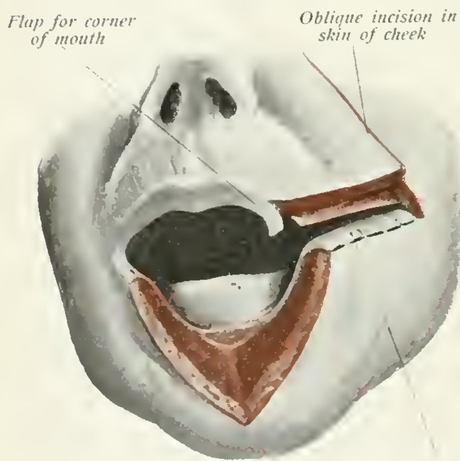

Fig. 71. Plastic formation of border of lip.

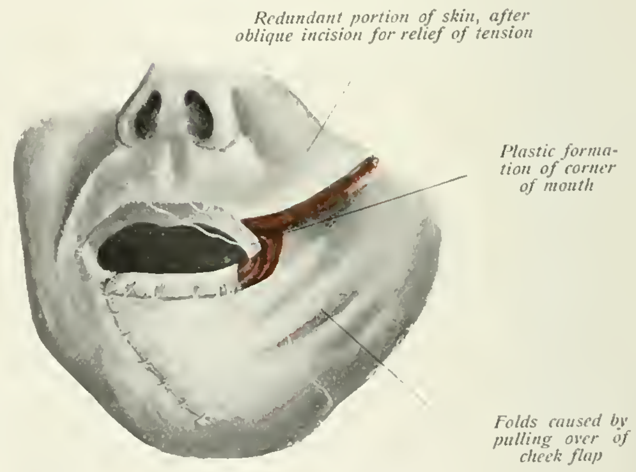

Fig. 72. Completion of suture of lip, formation of corner of mouth.

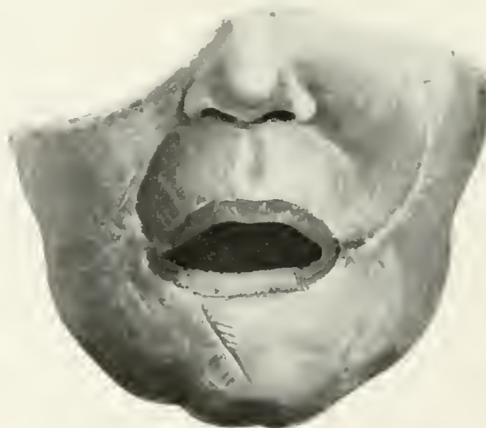

Fig. 73. Appearance after 14 days, mouth open.

neighboring skin of the chin and cheek and a piece of the upper lip 1 cm. wide (Fig. 69, Plate 13). The incision started close to the right corner of the mouth, ran thence down to the hollow of the chin, from there it was carried to the left corner of the mouth and ended after it had been turned to a horizontal direction, more than 1 cm. away from the growth, at the border of skin and mucous membrane of the upper lip. At the left corner of the mouth a small bit of mucous border of the upper lip was trimmed off to be used later in covering over the corner.

After excision of the tumor the horizontal incision in the cheek was lengthened in the direction of the ear for a distance proportionate to the width of the excised lower lip, as this cheek flap was to form the new lip. The duct of the parotid gland was freed by blunt dissection and displaced upward. Inside the mouth a portion of the mucous membrane of the gum at the chin had to be excised. Both inferior coronary arteries were seized and tied after the compression was relieved.

Next the border of the new-formed lip was made of the mucous membrane of the cheek. A rectangle of mucous membrane 1 cm. high was cut so as to retain its connection with the lower flap of the cheek (Fig. 70, Plate 13), and laid down and sewed upon the cut edge of the lower flap of the cheek (Fig. 71). Enough mucous membrane for this new mucous border of the lip could only be obtained by dissecting the upper part of the cheek from its lining membrane (Fig. 70, Plate 13). The duct of Steno could easily be displaced upwards and its orifice remained in the mucous membrane of the upper flap.

At the end of the transverse cheek incision an incision was made, avoiding the duct of Steno, which ran obliquely toward the inner corner of the eye (Fig. 71, Plate 13), and the lower flap was then mobilized by means of scissors and raspatory from the alveolar process of the lower jaw until the mucous membrane of the edges of the wedge-shaped defect of the lower lip could be brought together within the mouth and sutured with buried catgut. By drawing up these sutures the width of the orifice of the mouth could be decreased until the mucous membrane of the remnant of the lip and the mucous membrane of the cheek flap would be approximated without appreciable tension. In the depths of the pouch behind the lower lip only was there a small surface uncovered with mucous membrane, and to this a small wick was laid. Then followed a careful approximation of the

old and the newly formed lip borders with catgut and the union of the skin edges with silk (Fig. 72, Plate 13).

After the orifice of the mouth, with the exception of the left corner, was thus completely bordered with mucous membrane, the flap which had been freed from the upper lip for this purpose (Fig. 69, Plate 13) could be employed to cover in a corner.

The end of the oblique cheek incision was then united with the corner of the wound of the upper lip, and after a triangular piece was completely cut out of the skin of the cheek in the vicinity of the nose (compare Burow's method [Figs. 23 and 24, page 99]) the defect of the cheek could be closed by a linear suture. By this procedure the mucous membrane within the cheek was pushed into folds, but without interfering with the flow of saliva from Steno's duct.

Fifteen days after the operation, the wound having healed by first intention (Fig. 73, Plate 13), the patient was discharged from the hospital. He could open and close his mouth comfortably. A year and a half later the patient presented himself again; nowhere was recurrence to be seen. The lower lip had retracted somewhat as a result of scar formation, but the cosmetic and functional result was thoroughly satisfactory.

In the plastic formation of a lower lip by this method, attention must be paid to the following points: The flap from the cheek must be laid out high enough so that the new-formed lower lip will not later shrink and its margin be drawn down below the level of the teeth. Too high a lower lip does no harm; it interferes in no way with the cosmetic result, while a tightly stretched narrow bridge of skin causes disfigurement.

The height of this flap is limited by the course of the duct of Steno. But if necessary this without great difficulty may be freed up and sewed with its orifice into any satisfactory position in the mouth. It is useful to dissect out a square of mucous membrane in connection with the orifice, and to sew the edges of this square into the mucous membrane rather than the orifice of the duct itself.

Further, it readily happens that the newly formed mouth comes out too wide, because, in the endeavor to prevent scar contraction of the orifice of the mouth, the restitution flap has been designed with too long an upper margin. As the result of the great extensibility of the orbicular muscles of the mouth the formation of too small a mouth is not to be feared and the restitution flap may be cut in the

horizontal direction rather narrow. It is important to cover over the corners of the mouth with a bridge of the mucous membrane in order to prevent fissures and rhagades, such as result when the corners of the mouth are subjected to pull in opposite directions.

If the entire margin of the lip is lost, small flaps of mucous membrane may be split off from the ends of the upper lip so that only a short piece remains intact in the middle. These two flaps may be employed to restore the lip margin in the same way as the single flap was used in this case at the left corner of the mouth. This method is analogous to the procedure of Langenbeck.

PLASTIC OPERATION FOR HARELIP

Congenital fissures of the upper lip are treated on the same principles as defects of the lip created by operation. But emphasis must be laid on the fact that in freshening the edges of the defect the separation of mucous membrane from skin and the cutting away of any material whatsoever must be done as economically as possible, for surplus tissue may be used to advantage in assisting wound healing or for improving the cosmetic effect. In freshening the edges it is a good rule to follow closely the border between skin and mucous membrane. Only when the edges of the defect appear unusually thin in comparison with the segments of the lip should an incision for freshening be carried away somewhat farther from the edge, so as to provide sufficiently wide wound surfaces to approximate solidly to each other.

For cosmetic reasons the freshened portions should be brought together in such a way that the border of the mucous membrane will form a continuous line: and moreover, all the remnants of mucous membrane bordering the defect should be most carefully removed, that later the resulting linear scar may not be disturbed by the healing in of a remnant of mucous membrane, which will create a disturbing element on account of its color.

Harelip represents an incomplete union of the facial anlage surrounding the mouth, and all degrees of the defect may be seen. Usually they are located on one side and not in the middle line; for the premaxilla projects, during the period of development, between the two fetal lip masses, so that harelip occurs as the result of incomplete union of a lateral mass with this middle segment.

Complete harelip represents the highest grade of this defect of development, while in the incomplete form the premaxilla and the lateral lip mass have at least partly united. In the former the fissure

reaches into the nasal cavity, while in the latter a bridge of tissue occurs between fissure and nose. Harelip may be limited to one side, in which case it is usually upon the left, or it may be double, and then it is practically without exception combined with cleft palate.

Incomplete harelip of slight degree is treated by the Nélaton method (Fig. 74),* in which an angular incision is made through the lip above the fissure, the edges drawn apart and sutured in a vertical line (Fig. 75).

Fig. 74

Fig. 75

Wide defects are freshened up after the method of von Gräfe with the help of a crescentic incision, and the wound edges of the lips as well as the lip margins are united by sutures (Fig. 76). This method is recommended only in cases in which the lip is much narrower at the fissure than at the sides. For in drawing together the wound edges which have been freshened by a crescentic incision to a straight line, the lip is given a considerable width at the line of union.

Fig. 76

Fig. 77

Fig. 78

Better results are afforded by the method of Malgaigne, in which the freshening of the edges of the defect is carried out in a straight line (Fig. 77). The mucous border, however, after it is freed from the edges of the fissure, are preserved and, as in the method of Nélaton, are drawn downward and sewed together (Fig. 78). As a result of making the lateral wound edge more perpendicular than the medial, the difference in height between the two halves is compensated

*These schematic drawings are taken from the article on Harelip in the Real-Encyclopädie der gesamten Heilkunde, fourth edition, Vol. six.

for in suturing. The nipple which remains after the suture may, if it does not shrink of itself, be removed after some weeks.

Favorable cosmetic results and a solid line of suture are offered by the frequently employed method of Mirault (Figs. 79 and 80). On one-half of the lip the incision is carried through the border, on the other it is only carried down to the margin between mucous membrane and skin, so that the mucous border remains attached by one end (Fig. 79). This flap is then turned down so that the other freshened edge fits into the angle. The line of suture then corre-

Fig. 79

Fig. 80

sponds with one edge of the filtrum (Fig. 80); the suture of the mucous membrane is run obliquely in such fashion that no nipple results. Division of the mucous border should take place on the larger half of the lip because in the neighborhood of the split this is usually thinner and runs more obliquely to the apex of the fissure, so that in suturing only the least amount of tension is created. The smaller but stronger remnant of the lip gives rise to the pediculated mucous membrane flap.

The Mirault method finds its application also in complete harelip, but in such cases particular attention must be paid to the deformity of the nose, since the fissure continues into the nasal cavity and the ala of the nose is apt to be flattened out and shoved over to one side. The rectification of this half of the nose and the closure of the hind wall of the nasal orifice can only be brought about if the upper lip is mobilized together with the ala. In order to accomplish this the upper lip can be loosened with a knife and periosteal elevator from the superior maxilla as far as the lower margin of the orbit. The hemorrhage which results may be controlled by pressure. Further mobilization when necessary may be accomplished by the undulating incision of Dieffenbach, which, starting from the fissure, is carried around the base of the ala up to its upper end and then transversely across the cheek (Fig. 81).

Once the ala is well mobilized, a deep silver wire stitch is carried from one naso-labial sulcus to the other, a perforated shot is threaded on each end, the alæ compressed between them, and the shot squeezed by a clamp. If only one ala is flattened, the stitch can come out on the other side of the septum. There is no better method of correcting a flattened nose in all forms of harelip, but care must be taken that the

Fig. 81

shot does not cause a pressure slough, or, in one-sided cases, perforate the septum. The stitch should be out by the sixth day.

If the remnants of the lip are unusually thin and under strong tension, the zigzag incision of J. Wolfe unites the edges with considerable assurance. At the border of the skin and mucous membrane or just above this line the two halves of the lip are divided horizontally

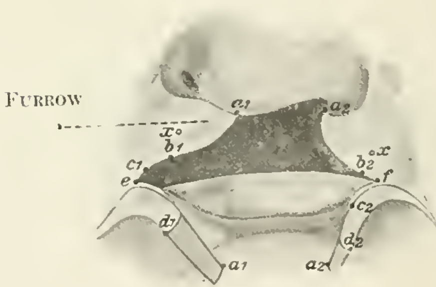

Fig. 82

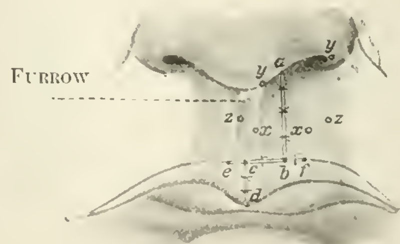

Fig. 83

(Fig. 82) and the suture is carried out in a zigzag line. At the points Y and Z (Fig. 83) tension sutures may be inserted through the entire thickness of the lip. On both edges the portion of the mucous border which is situated at the apex of the fissure is sacrificed, while the remaining portion is employed for the formation of the new mucous border.

Double harelip is treated on the same principles as single. The

Operation for double hare lip.

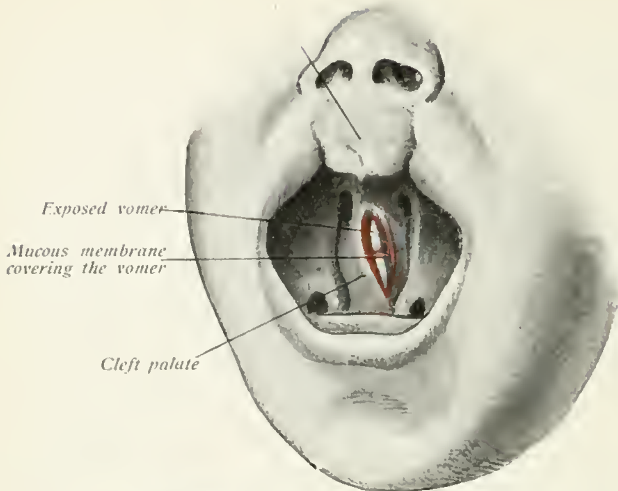

Fig. 84. Exposure and division of vomer.

Fig. 85. The anterior half displaced backward.

Fig. 86. Formation of lip flaps.

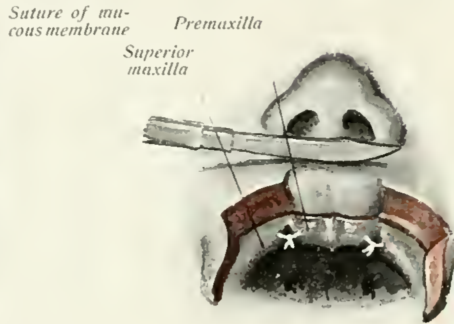

Fig. 87. Sewing in place and freshening the premaxilla.

Fig. 88. Tension incision of Dieffenbach.

Fig. 89. First holding stitch placed in centre of upper lip.

Fig. 90. Suture of lip.

Fig. 91. Suture of lip and cheek.

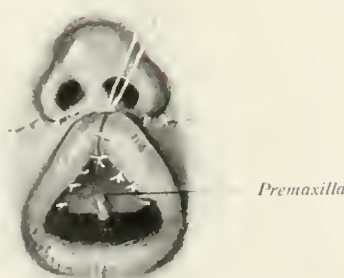

Fig. 92. Suture of inner side of lip.

Fig. 93. Scar 8 days after operation.

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choice of operative procedures depends entirely upon the size and width of the defect, and still more upon the situation of the premaxilla, which projects in the middle. This element offers severe difficulties if it projects beyond the level of the lip surface, as usually occurs in these cases. The necessary replacement of the premaxilla is carried out on the principles devised by Bardeleben, through a subperiosteal division or wedge-shaped resection of the vomer. Even if it is determined that the replaced premaxilla does not enter into solid union with the two halves of the upper jaw, nevertheless its maintenance in this position is important for the cosmetic and functional results. For in the first place if the premaxilla is retained the two halves of the alveolar process cannot fall together later on, and in the second place the arc of the upper lip maintains its natural prominence in the middle line.

The following case will serve as an example of an operation for double harelip and replacement of the premaxilla:

A ten-weeks-old girl baby was born with double harelip, a markedly projecting premaxilla and a cleft of the soft and hard palates. The vomer was displaced somewhat to the right, so that the cleft in the hard palate was particularly definite on the left side and on the right it appeared much smaller.

The harelip was closed first. For this purpose the premaxilla was replaced backwards after the method of Bardeleben: After the mucoperiosteal covering of the lower edge of the vomer, which projected into the cleft, was incised longitudinally (Fig. 84, Plate 14), it was freed up on both sides by means of the periosteal elevator, and the vomer was divided with bone cutting forceps. This allowed the premaxilla to be replaced by light pressure, causing the two bony segments of the divided vomer to overlap (Fig. 85, Plate 14). In order to hold the vomer in its replaced position a catgut suture was carried with a strong needle through the overlapping segments and tied; the mucoperiosteal covering was then completely closed (Fig. 86, Plate 14).

Freshening of the edges of the premaxilla and of the fissures in the lip followed as the second step in the operation. This began with the formation of a flap of the mucous membrane of the lip on each side by means of a transverse incision several mm. long carried above the red border through the entire thickness of the lip (Fig. 86, Plate 14). This was followed by freshening of the lower border of the premaxilla where it was covered with mucous membrane, and here

the mucous membrane was separated on a level to avoid injury to the tooth buds (Fig. 87, Plate 14). The hemorrhage which resulted was controlled by short compression.

In an attempt to close the cleft by approximation of the freshened edges the tension on the two halves of the lip appeared too great, and in spite of the suture of the vomer, the premaxilla sprung back into its original position. In order to overcome this it was held in place by a suture on each side, uniting its mucous membrane with that of the alveolar process (Fig. 87, Plate 14). To overcome the tension, Dieffenbach's incision was made, separating the ala by a crescentic incision, and carrying a transverse incision through the cheek (Fig. 88, Plate 14).

In this way the upper part of the remnants of the lip were rendered freely movable, so that suture of the mucous membrane of the lip on the further side could be begun. The first stitch, which was placed at the tips of the mucous membrane flaps (Fig. 89), was left long after tying, to be used as a hold in introducing the other stitches. Approximation could be made without distortion until a sufficient height of lip was obtained (Fig. 90, Plate 14). This left the flattening out of the alæ, which would interfere badly with the later cosmetic result. It was accordingly corrected on each side by means of a deep-lying suture, which was placed transversely from just behind the nasal orifice to the apex of the division between premaxilla and ala (Fig. 90, Plate 14). By the suture of the previously closed upper lip to the cheek (Fig. 91, Plate 14) which now followed, a permanently good position of the nasal orifices was obtained.

The operation ended with suture of the inner surface of the mucous membrane of the lip (Fig. 92, Plate 14). It was carried out by everting it by pulling on the ends of the suture which had been left long, which made the sewing up of the edges of the defect on the premaxilla as well as the lip easy of performance.

No dressing was applied. Eight days later the freshened surfaces had healed together so that the sutures could be removed (Fig. 93, Plate 14). On discharge ten days after operation the child had gained over three ounces in weight.

The suture of the cleft palate was postponed until later.

Since harelip involves considerable danger for the child during the first months of life and the mortality without operation is high, the question arises when such a child should be operated upon. The de-

termination of this question depends upon whether it is strong enough to stand the limited but serious loss of blood during the operation, and the interference with nutrition which results during the first few days after the operation. The first danger may be met by unremitting compression on the two halves of the lip during the operation; the other by accustoming the child beforehand to taking milk with a spoon. The interference with nursing and drinking endangers the child with harelip so seriously in its nutrition that it should be operated upon if possible within the first few days after birth.

The danger of the operation grows less as the child grows older, but it is a mistake to believe that in later years the conditions are more favorable for plastic operation than in the early days. It is true that the plastic material increases in amount with age, but the defect increases proportionately, and the gradual atrophy of the edges of the defect and retraction of the remnants of the lip easily renders difficult a good cosmetic result. Also in late cases the soft parts and bones lose their adaptability, so that in spite of a successful plastic operation the lines of expression are apt to continue distorted. In any case nursing children with nasal or bronchial catarrh, intestinal catarrh, or stomatitis should be operated on only after recovery from these diseases. Also nurslings should be guarded from any change in milk before the operation. A child brought into the hospital should be given a few days to see if the change in nourishment causes any trouble. Finally, no attempt should be made to disinfect the mouth. The operative field does not allow of asepsis, and the stomach and intestines are injured by antiseptic agents, while the useful activity of the mucous membrane of the mouth is diminished or entirely lost.

Usually no dressing is necessary. If the freshened wound is to be protected from soiling with milk or nasal mucus, the rapidly hardening airol paste may be painted along the line of suture. If the suture threatens to give way during crying, a strip of adhesive cut in the shape of a dumbbell or butterfly, with wide ends and narrow in the middle, will lessen the tension. The broad surface is stuck down on the skin of the cheek on either side while the cheeks are brought together so as to pucker the lip; the narrow bridge in the middle lies over the region of the suture and is kept from contact with it by means of a small bit of gauze, which is laid under the plaster. Or the same thing may be done with crêpe lisse and collodion. The wound must be protected from the hands of the child by enclosing them in cylinders of pasteboard and bandaging them down to the body.

If the tension is slight, the wound, as is usual in small children, heals rapidly, and after eight days the sutures can be removed. But if they cut through before that they should be allowed to remain nevertheless until they become entirely loose; for the small bridges of the skin between the sutures serve as satisfactory sources of scar formation if the tension increases. Small fistulæ or gaps may be closed later by secondary operation.

PLASTIC CLOSURE OF CLEFT PALATE

Double harelip as well as marked cases which are limited to one side are usually associated with congenital cleft of the hard and soft palate. Since both these deformities originate in the same way and also have much in common in the way of operative treatment, we shall give consideration here to the more important points in the treatment of cleft palate.

If the cleft extends from the lips through the hard and soft palates, there results a complete split of the upper jaw, which is called uranoschisis. Since the floor of the nasal cavity and roof of the mouth coincide, the two cavities are thrown into one. The lower edge of the vomer projects in such cases into the common oro-nasal cavity, and since it divides the cavity into two portions, one speaks of such a case as a double cleft palate. This is in contradistinction to the clefts which occur to one side of the vomer. These result from the fact that the lower edge of the vomer has become adherent on one side to the premaxilla and the half of the palate while this closure has not occurred upon the other side.

If the cleft is limited to the roof of the mouth, that is to say the soft palate or the hard and soft palate together remain ununited, but union of the lips, the premaxilla, and the alveolar process has taken place, such a deformity is called a simple cleft palate.

Cleft palate, like harelip, may have a serious influence upon the vitality of the child. This is particularly the case if the two deformities occur together. The special danger lies in the interference with nutrition which results from the fact that the infants are not in condition to suck and swallow milk in sufficient quantities. In swallowing a portion always flows back through the nose. Also such infants are exposed to gastric and intestinal diseases and bronchitis as the result of lack of closure of the lips. Plastic closure of the cleft palate may therefore be considered, like the operation for harelip, as a life-saving procedure.

Operation for cleft palate after B. v. Langenbeck. I.

Preliminary extirpation of hypertrophied tonsils.

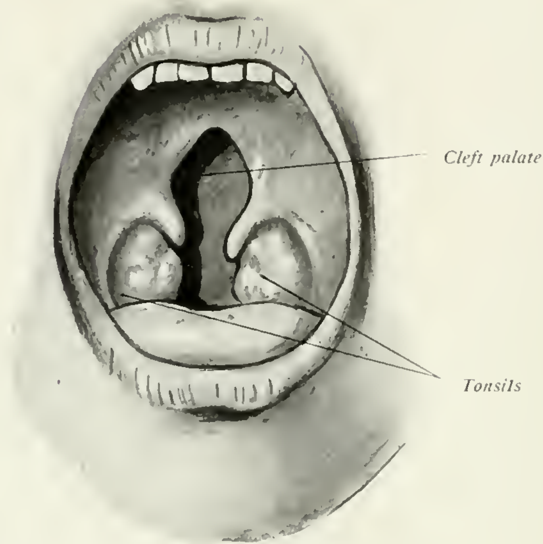

Fig. 94. Cleft palate with hypertrophied tonsils.

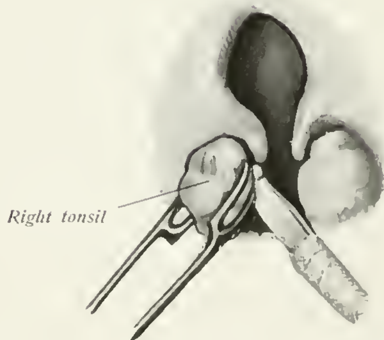

Fig. 95. Extirpation of the right tonsil.

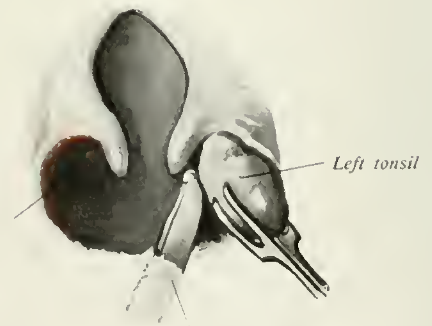

Fig. 96. Extirpation of the left tonsil.

If these two deformities occur together it is advisable first and as early as possible to repair the harelip, and later to close the cleft palate. There are many grounds for this practice. In the first place the operation of repairing cleft palate is the more extensive procedure, and operative injury and manipulation within the mouth in the first year of life is attended with possibilities of danger to the gastro-intestinal track. In the second place, at a later date one can succeed better in closing the cleft, because the material available for plastic closure increases with the age, and the stability of the suture is increased in proportion. Finally, the possibility remains that the cleft may spontaneously lessen in width; this is particularly apt to be the case if the harelip has been previously closed and the projecting premaxilla replaced. Also in the first and second years union of the premaxilla with the alveolar process of one side may take place without surgical interference.

But the cleft should be operated upon also as early as practicable, and the closure should not be put off, as some of the older authors recommend, to the middle or end of the first decade. The outlook for a successful closure is better in infancy than in later years, and the difficulty of operation and the loss of blood need not necessarily be greater. Helbing* regards as of greatest advantage the functional result, since early operated children learn to speak clearly in a way which is hardly to be differentiated from the normal. And if the cleft palate is not combined with a harelip, it should be operated upon early, because many of the unoperated nurslings die in the first year from the disturbances which result.

Plastic closure of the cleft palate is carried out after the method of Langenbeck. It consists in three steps: loosening of the mucoperiosteal covering of both sides of the hard palate, freshening the edges of the cleft, and the suture. The following case will serve as an example:

In a seven-year-old boy an attempt was made by others in the second year to close a cleft palate by operation. A few scars present in the neighborhood of the edge of the alveolar process originated in this procedure. Since both tonsils were hypertrophied (Fig. 94, Plate 15) and were covered with white plugs, in order that they might not infect the sutures they were seized with tonsil forceps (Fig. 95, Plate 15) and excised by means of a knife, the blade of which was wrapped in gauze up to the middle (Fig. 96, Plate 15). This could

*Berlin. klin. Woch., 1909, Nr. 39.

be done because the two halves of the uvula were well formed and tonsil tissue did not seem to be needed for plastic restoration of the uvula. Bleeding was light, and it ceased after a few minutes under pressure.

The operation itself was carried out with the head hanging over the end of the table, in the Rose position (Fig. 97, Plate 16). In order to keep the mouth open a Whitehead gag was introduced. First a linear incision was made on each side close to the alveolar process of the upper jaw, from the posterior margin of the hard palate forward through the muco-periosteal layer down to bone (Fig. 98, Plate 16). Through these lateral incisions the muco-periosteal covering of the hard palate was loosened up to the middle line with a curved periosteal elevator. This freeing up of muco-periosteum was carried out in the same way at the posterior margin of the palatal bone and at the hamular process. Since mucous membrane and periosteum are here very closely adherent, they must be torn from the bone with considerable force. In order to overcome the tension sufficiently to mobilize them to the middle line, a trial demonstrated that the edges could be brought together so as to overlap several millimeters without tension. The hemorrhage from the lateral incisions was controlled by sponging and pressure.

After this preparatory freeing of the flaps, the edges of the clefts were pared in the following manner: A small double-edged knife (a cataract knife will do very well) was introduced in the apex of the defect (Fig. 99, Plate 16) in the neighborhood of the alveolar process, directed obliquely inward, and the border was removed in one piece from before backward through the soft palate and the tip of the

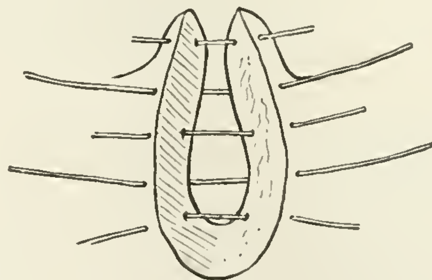

Fig. 105

uvula (Fig. 100, Plate 16). As a result of the obliquity of the knife, more was taken from the oral surface of the mucous membrane than from the nasal. In that way two wide freshened wound surfaces were

Operation for cleft palate after B. v. Langenbeck. II.

Plastic of Palate.

Whitehead mouthgag

Cleft palate

Fig. 97. Operation with head hanging over edge of table (Rose position).

Exposing the hard palote

Elevator

Fig. 98. Freeing up of muco-periosteal layer.

Two edged knife

Fig. 99. Freshening of the edges of cleft.

Fig. 100. Removal of margin of cleft.

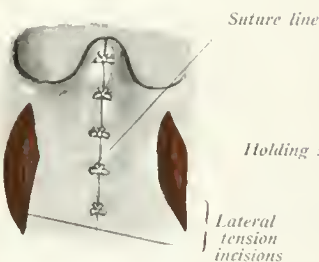

Fig. 101. Completion of suture of cleft.

Fig. 102. Suture of uvula.

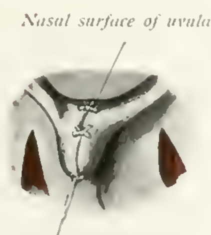

Fig. 103 Suture of nasal surface.

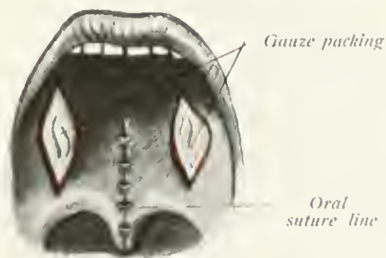

Fig. 104. Packing the tension incisions.

Rebman Company, New York

created, which was particularly desirable for lasting approximation in view of the scars which remained behind from the old operation.

This was followed by the suture of the two halves of the palate. A tension suture to hold the wound surfaces together was not necessary, and the suture could be laid close to the wound edges (Fig. 101, Plate 16). A part of the stitches were introduced so as not to perforate the mucous membrane of the nose (Fig. 105). Between these sutures others were laid which included the nasal mucous membrane

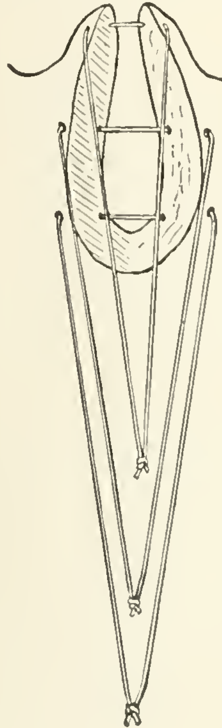

Fig. 106

as well as that of the mouth, but always close to the wound edge. None of these sutures were tied at once, but to avoid snarling and to make it easy to tie them later, they were knotted at some distance from the wound (Fig. 106). The sutures were placed by a stab needle with a curve like a fishhook (Fig. 107), but an ordinary small curved needle on a holder will do as well. By this method of alternating sutures it is easy to bring the wound edges together exactly, and where the mucous membrane has a tendency to roll inward, it may be drawn out with tooth forceps at the moment of tying and turned into the mouth.

Finally the two halves of the uvula were carefully united and the last suture at the tip of the uvula (Fig. 102, Plate 16) on the oral aspect was left long, so that by pulling on it the nasal aspect of the uvula could be made approachable with the needle. It was brought together here by means of two sutures (Fig. 103, Plate 16).

In each of the lateral incisions in the base of the alveolar processes a short piece of vioform gauze tape was introduced (Fig. 104, Plate 16) and allowed to remain three days.

Fig. 107

On the fourth day after operation the boy developed scarlet fever. He vomited violently several times and as a result some of the stitches pulled through, so that the line of suture gaped for about 1 cm. The rest of the line healed smoothly and the closure of the small opening in the middle was postponed until later.

Similar small residual operations are necessary in many cases of cleft palate as well as in harelip, and it usually suffices in such an event to freshen the edge of the defect anew and to sew it up.

The functional result in later years in children who are operated upon does not always correspond with the surgical result. In spite of the fact that a satisfactory partition has been created between the mouth and the nasal cavity from an anatomical point of view, nevertheless in many cases a definite nasal quality remains in the speech. This is due to defective mobility of the soft palate, if, for instance, it is pulled backwards against the posterior wall of the pharynx by a stiff band, or if the length of the newly formed uvula does not suffice, or if it is not compact enough to lay itself against the posterior wall of the pharynx in the formation of certain sounds. But usually by means of systematic exercises in expression and respiration the patients can learn to improve their enunciation. The best prophylactic against such speech defects is the earliest possible operation.

From the point of view of the dentist even the widest clefts may be closed by means of hard rubber prothetic appliances. Not only is the result often not inferior to the operative result, but it may excel it. But a natural separation of the mouth from the nasal cavity is to

Plastic closure of a cleft ala nasi.

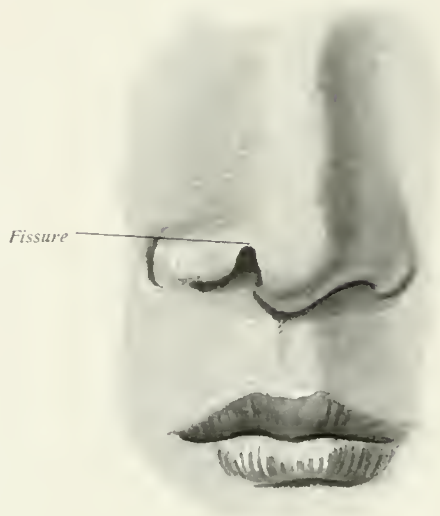

Fig. 108. Incomplete cleft right ala of nose.

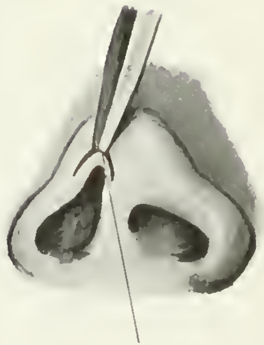

Fig. 109. Freeing margin of cleft.

Fig. 110. The separated margin drawn downwards.

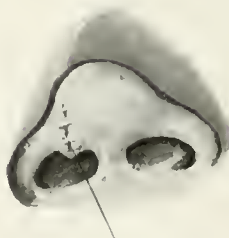

Fig. 111. Vertical suture of freshened wound edges.

be preferred over any prothetic; and moreover, obturators cannot be applied until after the molar teeth have appeared. Nevertheless, there are cases in which recourse must be had to such appliances. Among the cases to which this treatment can properly be applied are the widely gaping clefts with steep and narrow palatal segments, as well as wide clefts with badly scarred surfaces, such as result from unsuccessful attempts at operation, and in addition all cases in which in spite of successful operation the soft palate and the uvula are too small or do not function properly to be of use.

In order to protect even the widest clefts from the use of prothetics, Helbing* has attempted to diminish the cleft before carrying out the operation itself. He accomplishes this by chiseling through the zygomatic process of the upper jaw at the level of the second premolar tooth from within the mouth, and in that way to free the upper jaw from its bony union with the zygomatic process, and further by approaching the mobilized halves of the palatal process of the upper jaw by means of metal plates, which fit about the alveolar arch and are bound together across the mouth with wire. The wire is drawn through the alveolar process at the level of the first premolar tooth, and it is drawn back again posteriorly in the region of the last molar through the alveolar process on the nasal surface of the palatal bone, and is tied over lead buttons. This is similar to the method of Brophy in new-born children. The result consists in a gradual diminution of the cleft, which proceeds so far that even very small palatal segments may be employed for plastic closure according to the method of Langenbeck.

PLASTIC OPERATIONS ON THE NOSE

Plastic operations for the purpose of restoring portions of the nose and re-establishing its outer form may become necessary for the closure of congenital fissures and later-acquired defects.

It has already been explained under harelip how fissures in the posterior margin of the nasal orifice may be closed after mobilization of the ala and freshening of the edges. A congenital median or lateral fissure of the nose may be similarly closed. As long as the defect is not too extensive or deep-lying, or is connected with other deficiencies of the face or scalp, an incomplete lateral fissure of the ala (Fig. 108, Plate 17) may be closed by a simple technique similar to that for incomplete harelip. Just as in the Nélaton operation (see p. 128),

*Zentral f. Chir., 1910, No. 48.

an angular incision is made through the ala, parallel to the edge of the fissure, and the loosened portion is pulled down and the incision sewed up in a vertical line.

In a workingman with a congenital fissure of the right side of the nose (Fig. 108, Plate 17) the operation was carried out thus:

A small double-edged knife was introduced in the middle of the fissure close to the mucous border (Fig. 109, Plate 17) and an incision was made parallel to the edges of the defect. At both ends the separated margin was left in connection with the skin of the nose. To correct the deformity the loosened margin was drawn downward with a strabismus hook so that the freshened surface took the shape of a rhombus (Fig. 110, Plate 17), and the incision was sewed up in an oblique line from right to left with four fine silk sutures. The result, except for a small protuberance at the upper edge, was a nasal orifice which was normal in every way (Fig. 111, Plate 17). If the protuberance had not itself shrunk into shape within the course of two months it would have been removed by scissors or knife just as the nipple formation on the lip after a harelip operation. After eight days the stitches were removed. The patient remained in the hospital longer on account of other conditions.

Acquired deformities or defects of the nose result from injury or follow operative procedures or destructive disease. The destruction may involve the entire nose; in this case a total rhinoplasty is demanded, or if portions of the nose, such as the tip, the ala or the bony bridge, have to be replaced, a partial rhinoplasty. The form and the extent of the defect determines the choice of plastic procedure, of which there are many.

In order to form a nose which shall give lasting satisfaction first of all requires a bony support and second the formation of an outer as well as inner lining of skin, so that it will not shrink. The Indian method of rhinoplasty from the forehead and the Italian method from the arm have been abandoned in their original form because the nose made entirely of skin rapidly shrinks together into an ungainly lump. They are employed now for repair only, if everything remains intact except the skin of the surface.

These old methods are useful for building up a nose if bone covered with periosteum is transplanted attached to the skin flap. After the teaching of König, a small flap of skin is cut out obliquely on the forehead and in conjunction with it a flat shell of bone is chiseled out.

The skin of this flap forms the inner lining of the nose, and the bone which is attached to it forms its framework. The outer covering must be made from another forehead flap (König) or from triangular flaps from the lateral halves of the remnant of the nose (Israel). In syphilitic and traumatic saddle nose, which results from destruction of the nasal bones, these modifications of the Indian method find application.

In the same way the Italian method, if the result is to be lasting and good, must be combined with an osteoplasty. It may be carried out after the method of Israel, the skin flap being cut over the ulna and at the same time a piece of this bone taken for the framework of the nose, or the strip of bone which shall serve as a support after the flap is transplanted must in the first place be transplanted under the area selected in the skin of the arm and allowed to heal in. The inner lining of the new nose must also be taken, according to this method, from the skin of the forehead in order that soft parts and framework shall not shrivel up or die after transplantation. The flap on the arm before union with the root of the nose is to be lined with this piece of skin.

The formation of an entire new nose after these principles rarely succeeds in fulfilling all the cosmetic requirements. Improvements of greater or less extent must be carried out by later operation, whether it is the nasal orifice, a portion of the bridge, the ala or the columna which requires correction. The following observation will show how the various methods of free and combined plastic procedures may be employed for the building up of a nose:

In July, 1908, a twenty-five-year-old locksmith suffered a crushing injury of the face in an elevator accident. The right upper jaw and the root of the nose were crushed and the upper lip and the head wounded in various places. The middle portion of the lower jaw was broken free, but still remained attached to the soft parts of the chin; it was replaced and made fast by a few deep catgut sutures in the periosteum and mucous membrane. In the nasal orifice which was open the widest a rubber tube was placed as far as the nasopharynx and the wounds of the soft parts were given a dry sterile dressing. In August a small splinter of bone came down through the left side of the nose. In October a sequestrum about 3 cm. long and ½ cm. wide came away from the right half of the upper jaw, in which an air cell could be recognized.

At the beginning of January, 1909, all wounds were healed and the middle portion of the lower jaw had grown in fast to the lateral portions. The upper part of the face as a result of the fractures of

the jaw and of the nasal bones appeared flattened and badly disfigured, so that many attempts to find a position for the injured man failed, on account of his objectionable appearance. His union sent him once more to the hospital, in order to correct the deformity as far as possible.

Upon entrance the following observations were made (Fig. 112, Plate 18): Both sides of the upper jaw were markedly depressed, so that the infraorbital margins, particularly the right, were considerably posterior to the level of the cornea. This deformity was the result of fracture of the upper jaw. The columna of the nose was lacking, except for a tab of skin a few mm. long. The entire cartilaginous nose was pressed flat upon the face. The bony framework was present, but likewise sunken, so that the bridge appeared flat and wide. A deeply drawn furrow between the nose and the upper lip caused the upper lip, which was deformed by numerous scars, to project tumor-like.

First the nose had to be built up, no external defects being visible upon its skin surface. For this purpose the upper lip was separated from the nose in the transverse furrow, and the nose was mobilized through loosening the upper edge from the bone (Fig. 113, Plate 18). Thereupon a small transverse incision was made through the skin at the root of the nose (Fig. 114, Plate 18) and the skin was lifted from the bony and cartilage framework down to the tip by means of a pointed elevator, so that a subcutaneous canal about 1 cm. wide and 5 cm. long was formed. In this process the nasal mucous membrane was not injured.

The attempt to straighten up the nose with the elevator by means of this subcutaneous canal and its mobilization was impossible on account of scar contraction within the nose. Accordingly, the bony framework inside had to be divided with a chisel. Since the small remnant of the columna increased the strong tension, it was cut through. After the mobilization of the framework of the nose was successfully accomplished, the nose was straightened up with the index finger and by means of lateral pressure with the other hand the nasal bones were shoved together. In this position the nose was held by means of a rubber tube the size of a finger wound with vioform gauze (Fig. 114, Plate 18). The transverse separation of the upper lip for the time being was disregarded.

In order to keep the nose permanently in this corrected position it was given a new support by means of a free transplantation of bone

Rhinoplasty: restoration of the ridge of the nose by means of a tibial transplant (Lexer).

Fig. 112. Deformity 9 months after injury.

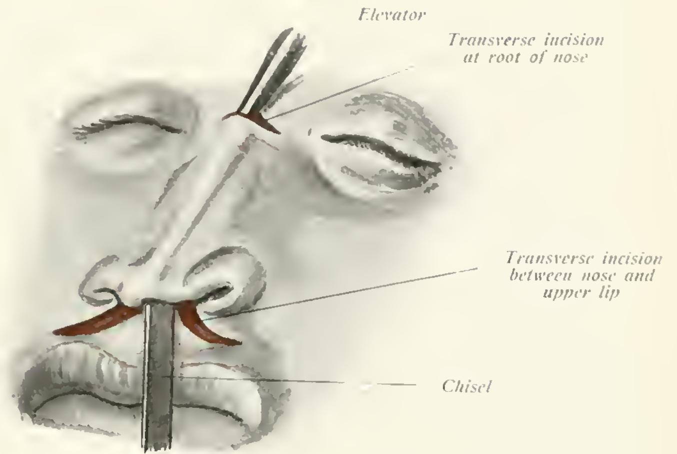

Fig. 113. Mobilization of the soft parts.

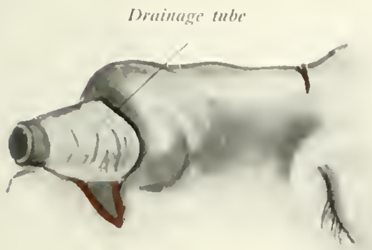

Fig. 114. Rubber tube wrapped in gauze serving as provisional support of nose.

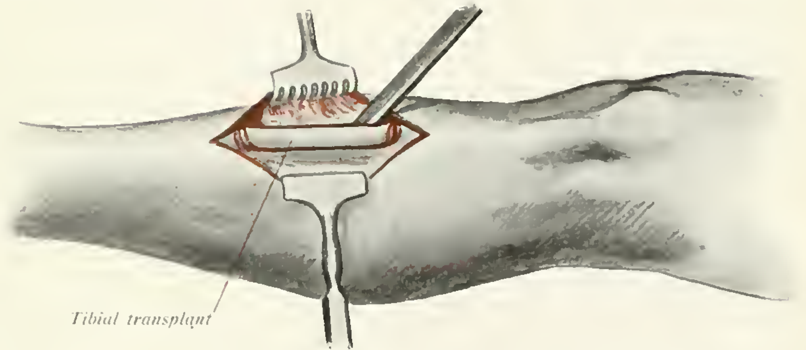

Fig. 115. Removal of strip from crest of tibia.

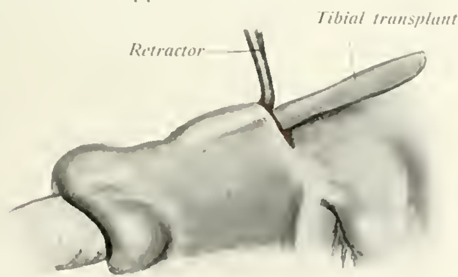

Fig. 116. Transplantation of section ot tibia.

Fig. 117. Burying upper end of transplant under skin of forehead.

Fig. 118. Cosmetic result after healing in of tibial transplant.

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Plastic restoration of sunken cheek by free transplantation of fat.

Fig. 119. Right cheek is sunken in.

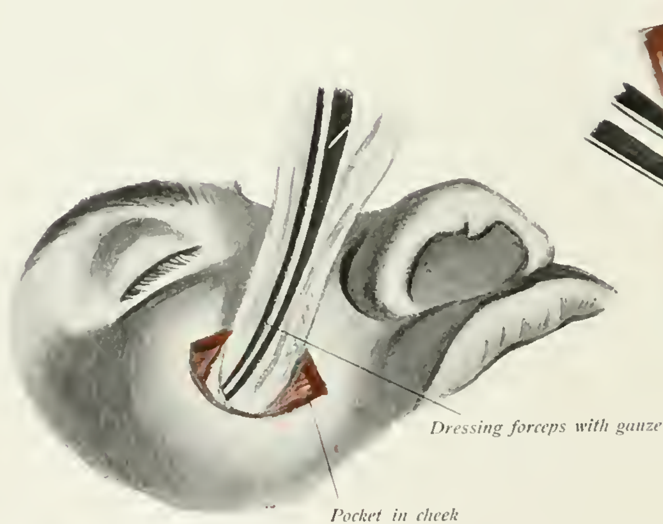

Fig. 120. Packing pocket with gauze.

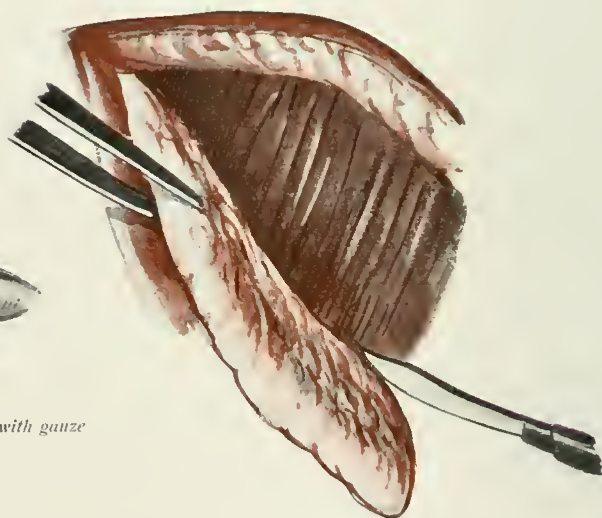

Fig. 121. Removal of fat-fascia flap from gluteal region.

Fig. 122. Implanting fat flap into pocket in cheek.

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after the method of Lexer. The strip 6 cm. long necessary for this purpose was taken together with its periosteum from the anterior edge of the tibia (Fig. 115, Plate 18). Through a longitudinal incision just over the shin, skin and fascia were divided and periosteum exposed. Then small transverse furrows were chiseled in the bone at the upper and lower ends of the incision and the piece of bone of measured length with its periosteum was chiseled out. The thickness of the bone was about 3 mm.

This piece from the tibia, with this chiseled surface toward the nasal cavity and the periosteal surface toward the skin, was shoved down into the skin pocket from the glabella to the tip of the nose, using a single hook for lifting up the skin (Fig. 116, Plate 18). About 1 cm. of the end, which projected from the wound, was placed in a second shallow pocket, which was formed with the raspatory through the transverse incision in the neighborhood of the root of the nose (Fig. 117, Plate 18). Finally the small transverse wound on the glabella was closed with two sutures and the skin wound over the tibia with seven sutures. The result of the bony transplantation was awaited a few weeks.

When healing was assured (Fig. 118, Plate 18), the formation of a columna and padding of the sunken cheeks was undertaken. As a result of the depressed fracture of both sides of the superior maxilla the entire right portion of the cheek except the nose was sunken considerably below the level of the face (Fig. 119, Plate 19). Since a correction of the depressed fracture of the splintered superior maxilla did not seem feasible, the deformity was corrected by means of a subcutaneous padding with a free flap composed of fat and fascia. In a thin man plenty of fat may be derived from the gluteal region. To make the pocket in which the flap was to heal, the entire superior maxilla up to the infra-orbital edge was freed as far as possible by blunt dissection, with the help of a few snips of the scissors. By packing this pocket with gauze (Fig. 120, Plate 19) and by compression from outside during the remainder of the operation, the bleeding could readily be controlled.

Meanwhile the fat-fascia flap was removed from the gluteal region (Fig. 121, Plate 19). The skin was dissected up through a linear incision and a piece of tissue two inches long by one inch wide, consisting of gluteal fat and superficial fascia, was taken out. This piece in its entirety, without allowing fingers to come in contact with it, was placed in the prepared pocket in the cheek (Fig. 122, Plate 19).

The fascia lay upon bone and the fatty layer next the skin. After the skin was closed over it with five sutures, it transpired that the transplanted fat was somewhat too thick, particularly over the zygoma, so that the skin bulged slightly.

Then the formation of the columna of the nose was undertaken. The small remnant of the original columna which remained at the tip of the nose was employed (Fig. 123, Plate 20). After freshening this piece, it was hardly more than one-half cm. long. The remaining portion had to be made from the two wings of the nose and the posterior wall of the nasal orifice. The upper lip could not be employed for this purpose because it had been changed almost completely into scar tissue. The transverse scar which ran across the base of the upper lip was of particular disadvantage, because it pulled the lip in strongly and held it fast to the bone.

This scar was divided transversely (Fig. 124, Plate 20), and then from the left ala and the posterior border of the nasal orifice a flap 1½ cm. by ½ cm. was taken (Fig. 125, Plate 20). The nasal mucous membrane and the periosteum of the lower portion of the vomer were cut at the same time in connection with this flap, lifted from the underlying stratum with forceps and placed upright (Fig. 126, Plate 20). In this way the missing portion of the columna could be replaced and united with the remnant remaining.

In order to give the septum support from the right, the right ala, which had been depressed by strong scar contraction and had been displaced outwards, was loosened with a knife from its substratum (Fig. 127, Plate 20). Then it was turned in medially and fastened, in its original position as the posterior boundary of the right nasal orifice, to the newly formed columna, by means of two sutures (Fig. 128, Plate 20). In order to prevent the lip from being drawn in again by scar contraction, the lip and the posterior wall of the nose in their entire thickness were mobilized upon the substratum and were then united after bevelling the edges with a knife.

The patient, except for short interruptions, had passed an entire year in the hospital. On discharge his appearance was much more attractive. The cheeks retained a portion of their new roundness, and no longer showed the excess which appeared immediately after the operation. The columna of the nose was replaced and the ridge of the nose stood out from the face after the complete healing in of the piece of tibia.

Formation of a columna of the nose.

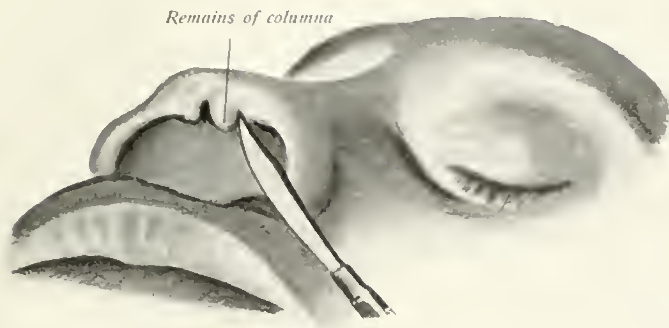

Fig. 123. Freeing up remnants of columna.

Fig. 124. Incision for formation of columna.

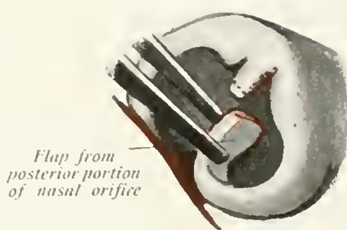

Fig. 125. Formation of new columna, from posterior margin of nasal orifice.

Fig. 126. The new columna is united to the remnants of the old.

Fig. 127. Freeing up the right ala.

Fig. 128. Right nasal orifice completed by suture of right ala to median line.

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As this observation shows, after injuries of the face, plastics of the nose and cheeks not infrequently have to be carried out together. Accordingly in the following section another case of this sort will be cited.

Fritz König has replaced defects which involve only the ala of the nose and cause very disagreeable results by using free grafts taken from the shell of the ear. He cuts a wedge comprising all the layers out of the helix and plants it in the freshened defect of the ala. In this transplantation the flap is so placed that the edge of the helix forms the lateral border of the nasal orifice, and the surface, which was originally directed backward against the cranium, after transplantation forms the outer surface of the ala. These free transplantations of the shell heal in well, but their nutrition should not be disturbed by stitches placed too closely together along the edge, or tied too tight; this particularly has to do with the cartilaginous layer.

PLASTIC OPERATIONS ON THE CHEEK

Plastic restoration of the cheek is indicated in defects which result from injuries, noma, or after the extirpation of malignant tumors. Scar lockjaw, of which the cause, omitting disease of the articulation of the lower jaw, may lie in changes in the soft parts of the cheek, under certain circumstances demands removal and replacement of the affected tissue.

In plastics on the cheek, as in rhinoplasty, care should be taken that the mucous membrane as well as the outer skin be replaced by tissue which will not shrink. The laying of a pediculated flap over the defect will cover it externally, but it will leave a fresh wound in place of the mucous membrane of the mouth which, if it is allowed to go uncovered, must result in scar contraction of the transplanted flap and contraction of the articulation of the jaw. In order to prevent this the oral surface of the flap must be covered with mucous membrane or skin. Mucous membrane flaps may be taken from the neighborhood and laid over the wound, which is accomplished with fair readiness on account of the elasticity and movability of the oral mucous membrane. For covering with skin Thiersch grafts may be used, or the wound surface may be lined with a second pediculated or free flap. If a skin flap from the neighborhood is employed for this purpose, a place which is without hairy growth is to be chosen, so that later hair will not grow within the mouth.

In a case of carcinoma which destroyed the entire cheek, following

the proposal of Israels, we proceeded in such fashion that the defect the size of the palm of the hand which resulted from the extirpation was covered in by a flap taken from one side of the neck (Fig. 129, Plate 21). The wide and long pedicle was divided ten days later, trimmed properly, and immediately sewed into the upper edge of the defect, so that it filled the defect as a doubled skin flap (Fig. 130, Plate 21). Fourteen days later the doubled edge was cut through and the two fresh wound edges were united, the inner to mucous membrane and the outer to skin. Both portions of this flap healed in, with the formation of a fistula in the cheek. A few weeks later, before the fistula could be closed, the patient died of aspiration pneumonia and internal metastasis.

Bardenheuer formed a similar flap for the restoration of a defect of the cheek from the forehead. The pedicle was situated at the zygoma.

In extensive malignant growths the destructive effect and the loss of tissue which results from operative removal is not restricted to the middle of the cheek, but is likely to include also the corner of the mouth, a portion of the nose or the border of the orbit. Accordingly, these, as well as the cheek, must be replaced according to the principles already expounded. The following example will demonstrate what may be done in a severe case:

In a fifty-year-old patient, six months before admission, the left half of the nose was removed elsewhere for carcinoma. In addition to the ala of the nose, the nasal cartilage on the left side was also lacking; on the other hand, the cartilage and skin forming the ridge and the tip of the nose were present (Fig. 131, Plate 22). An attempt made by others to implant a piece of cartilage from a rib under the mucous membrane of the left cheek miscarried, for a fistula in the skin of the cheek exuded pus on pressure. Moreover, the left inner canthus was eaten by a deep funnel-like ulcer with hard edges, which was diagnosed as recurrent carcinoma. Since there was marked injection of the vessels of the conjunctiva of the bulb in the neighborhood of the ulcer, with a certain amount of infiltration, it was decided that radical extirpation with sacrifice of the eye was indicated.

The operation began with exenteration of the orbit (see p. 156). The outer canthus was split down to bone and the entire content of the orbit was cleaned out with a raspatory. Both eyelids were split vertically and the medial halves were removed. In order to excise all the involved tissue, the skin incision was carried down to bone medially

Plastic repair of cheek after James Israel.

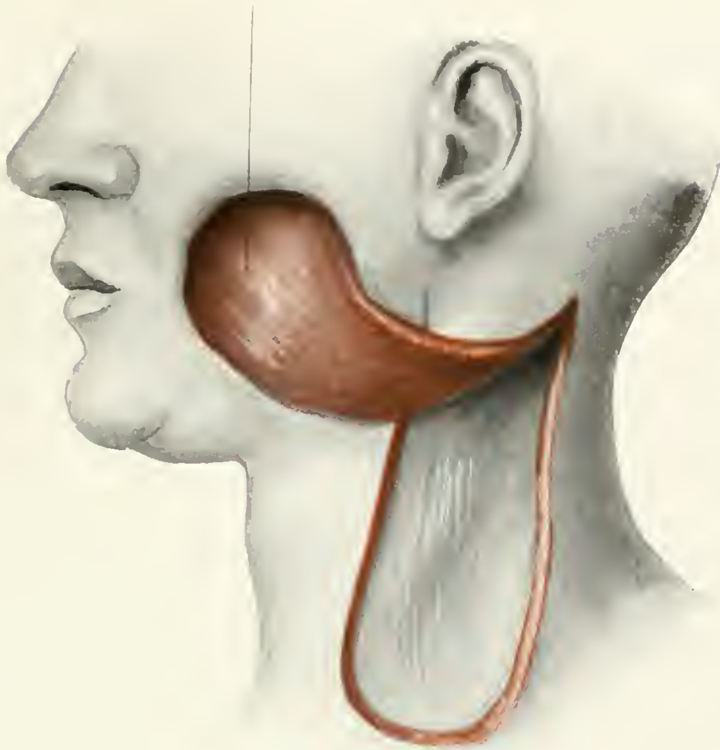

Fig. 129. Flap carried to cheek from neck.

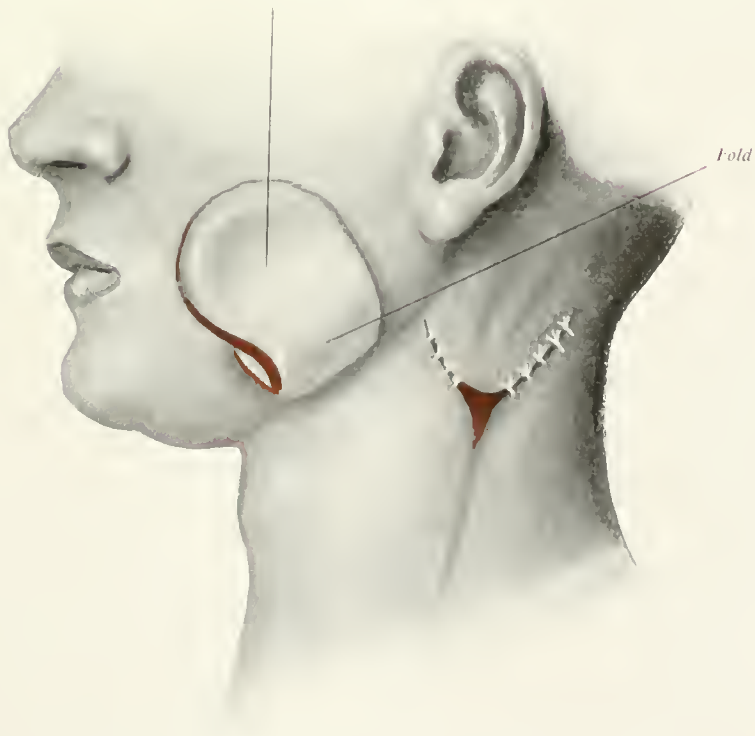

Fig. 130. Folding the flap over after dividing the pedicle.

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Plastic repair of large defect of face. I.

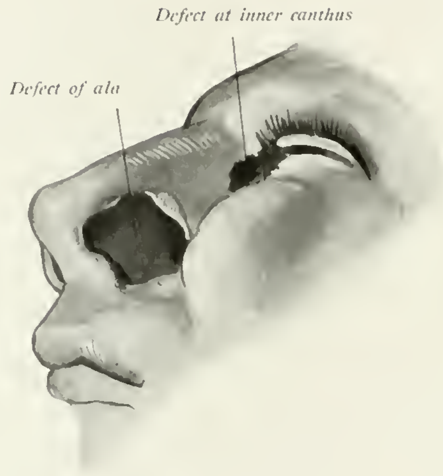

Fig. 131. Defect after extirpation of a carcinoma.

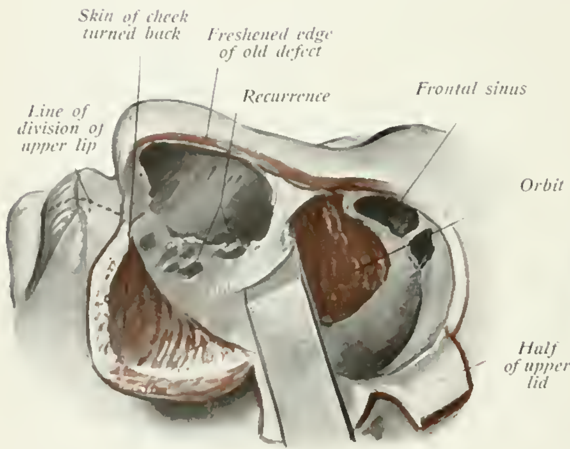

Fig. 132. Partial resection of upper jaw.

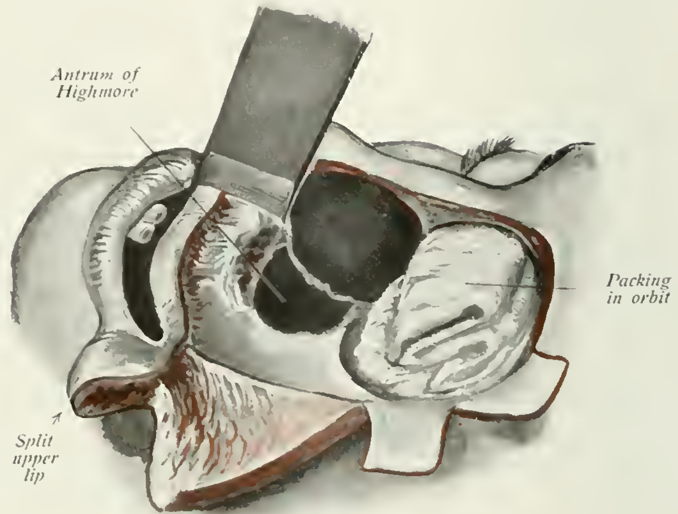

Fig. 133. Chiseling away of hard palate.

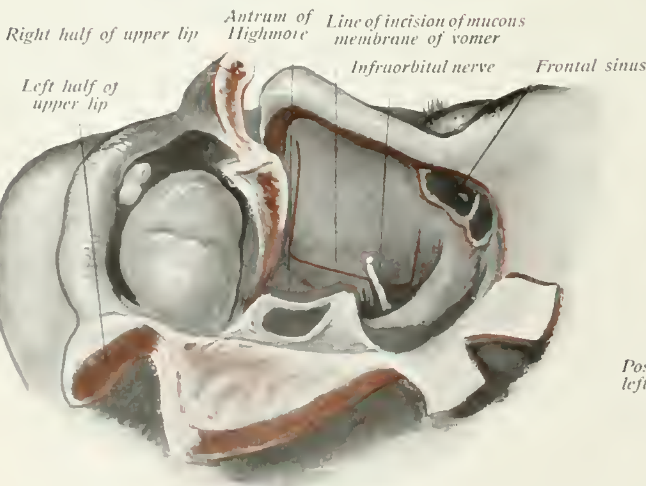

Fig. 134. Appearance of wound cavity.

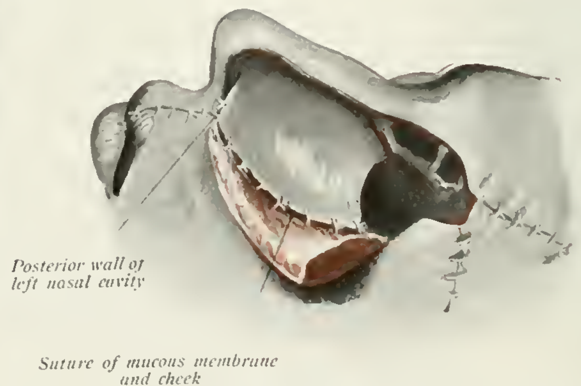

Fig. 135. Lining nasal cavity with a mucous membrane flap from vomer.

Rebman Company, New York.

to the bridge of the nose in such a way as to surround the recurrent ulcer at the inner canthus. Its removal followed in connection with the nasal bone and the nasal process of the frontal bone (Fig. 132, Plate 22). In chiseling off these portions of bone the frontal sinus was exposed. The left nasal cavity having first been packed with sterile gauze, no blood could flow into the mouth.

The cilia and the mucous membrane of the remaining portions of the eyelids were excised and the two freshened edges were sewed together. Next the defect of the ala of the nose in which no carcinoma was visible was freshened up by continuing the incision, which ran over the bridge of the nose. In loosening up the old operative scar there appeared under the skin down to the palatal process and as far as the alveolar process hard and suspicious-looking places. After cutting the septum of the nose along its base and after laying back the upper lip split along the median furrow, a considerable surface of the upper jaw involved by carcinoma was exposed (Fig. 132, Plate 22). This in conjunction with the left half of the hard palate was separated from the alveolar process by two strokes of the chisel, opening wide the antrum of Highmore (Fig. 133, Plate 22). In order to be sure that all the malignant disease was removed, the mucous membrane of the antrum and the infraorbital nerve which hung free were removed at the same time (Fig. 134, Plate 22). All cavities opened by chiseling were packed with iodoform gauze, and the split upper lip was reunited by suture of the mucous and skin surfaces as far as the border of the nasal orifice.

To replace the outer border of the nasal orifice and the destroyed ala, it was planned to use the mucous membrane of the left surface of the vomer as a lining flap, and skin cut from the cheek as an outer covering.

For this purpose the mucous membrane on the vomer was incised as far up and back as possible (Fig. 134, Plate 22), and loosened with a raspatory from the columna to the bridge of the nose, where a pedicle was left. The under surface of the posterior edge of this wide pediculated flap of mucous membrane was sewed against the skin of the left cheek, which had been drawn over to meet it, and the lower edge to the remnant of the medial border of the nasal orifice (Fig. 135, Plate 22). In so far as it lay over the antrum of Highmore and over the defect in the palate, it closed off the nasal cavity satisfactorily from the mouth. At the same time it formed a posterior wall for the nasal orifice. The end of the iodoform drain in the orbit and against

the base of the skull was brought down over this mucous membrane and out through the new orifice, and the defect above the orbit was lessened by several stitches. The operation was thereupon interrupted.

Ten days later it appeared that the flap of mucous membrane which had been loosened from the vomer had not healed in on account of tension, and the soft parts of the left cheek had pulled so strongly on the stitches that they had pulled out and the flap had retracted. At the scarred edge of the upper lip appeared a few small infiltrated nodes, which were apparently carcinomatous, and for that reason excision of the upper two-thirds of the upper lip together with the mucous membrane was demanded (Fig. 136, Plate 23).

In order to carry out a plastic restoration of the left ala of the nose and of the cheek, care was taken first to make a lining flap, since the flap from the forehead which was originally employed to cover in the large defect had in the course of time rolled itself up into an unformed mass. To be sure, one had to be sparing with the comparatively slight material at hand. Accordingly a flap of skin 20 mm. by 55 mm. was cut close above the left eyebrow (Fig. 137, Plate 23). The pedicle lay to the right over the glabella, but it did not go beyond the middle line. In order to assure a permanent suture of this flap in its appointed place, the scarred edge of skin of the ridge of the nose was freshened and undermined for a few mm. The pediculated flap was then turned about at right angles, with epidermal side in, and it was sewed with catgut into the groove under the freed edge of the skin of the ridge of the nose (Fig. 138, Plate 23). Then for lining the defect laterally a strip of skin several mm. wide was turned down from the edge of the defect of the cheek.

Before the cheek-nose flap was planted upon this completed lining flap the defect in the left upper lip had to be restored by a rectangular flap taken from the left cheek with a pedicle running downward and outward (Fig. 139, Plate 23), in such a way that later the hairs of the beard in their growth would follow the direction of the hairs of the mustache. The lower edge of the plastic flap coincided in part with the horizontal edge of the wound of the upper lip.

After exact suture of this cheek flap into place to form a new upper lip (Fig. 140, Plate 23) a large defect still remained behind, which included the medial half of the lids, half of the cheek and the left ala of the nose.

To cover in this hole a proportionately larger flap of skin was taken from the left half of the forehead and beyond the middle line.

Plastic repair of large defect of face. II.

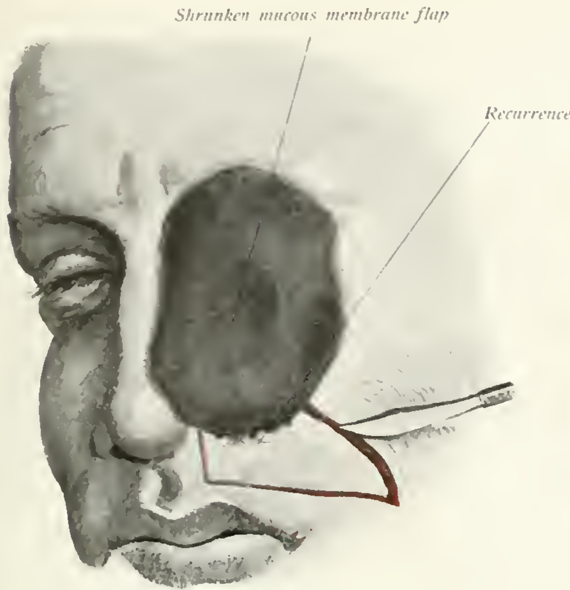

Fig. 136. Wound cavity after shrinking back of cheek flap; excision of recurrence on upper lip.

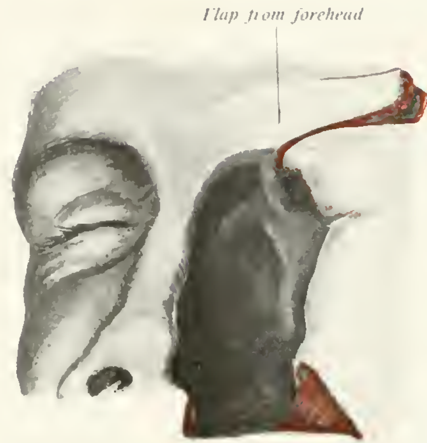

Fig. 137. Formation of a flap on the forehead, for lining nasal passage.

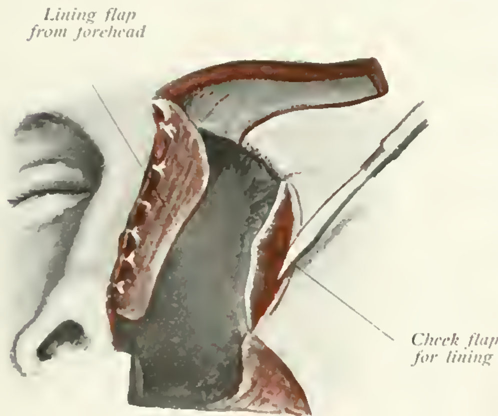

Fig. 138. Suture of lining flap; formation of new lining flap.

Fig. 139. Formation of upper lip.

Fig. 140. Suture of flap from cheek replacing defect of lip.

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Plastic repair of large defect of face. III.

Fig. 141. Gauze used as pattern for size and shape of flap.

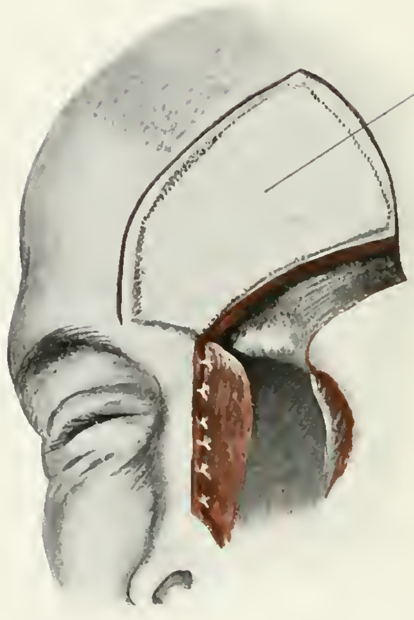

Fig. 142. Outlining the flap upon the forehead, from pattern.

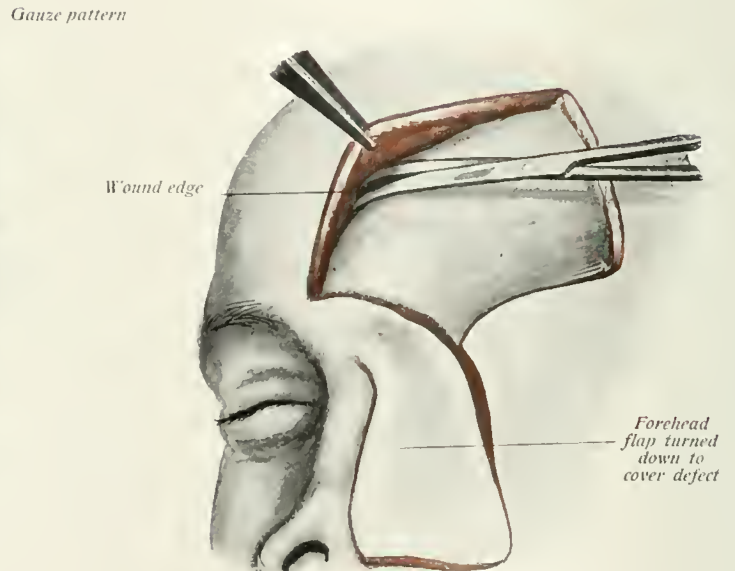

Fig. 143. Undermining skin of forehead.

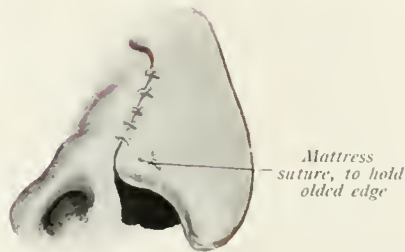

Fig. 144. Formation of anterior margin of left nasal orifice.

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The lower edge of this flap corresponded to the upper edge of the defect which resulted from the cutting of the flap to line the ridge of the nose (Fig. 138, Plate 23). The pedicle of the flap (Fig. 142, Plate 24) lay in the neighborhood of the right inner canthus. The forehead flap was patterned after a piece of gauze (Fig. 141, Plate 24) which was cut to fit the defect. Considerable allowance of skin had to be made for the corner out of which later the edge of the new nasal orifice was to be created. The flap consisted only of skin and superficial fascia. The periosteum, as is always the case when bone is not to be included, remained undisturbed upon the frontal bone, because otherwise necrosis of the superficial layer of the bone might result through drying, in case the uncovered portion was not immediately covered by suture or transplantation.

The defect which remained in the forehead after lifting the flap could, except for a small remnant, be closed after extensive undermining of the surrounding skin (Fig. 143, Plate 24) and by the aid of tension sutures.

The border of the left nasal orifice had to be made on the flap which was to be turned down from the forehead, before sewing it in place. For this purpose at the proper place in the skin as much as possible of the subcutaneous tissue was trimmed away, and the thinned edge was doubled over and held by a mattress suture so as to form a rounded margin of skin (Fig. 144, Plate 24). The upper edge of the turned-up margin, now lying in the nasal cavity, was made fast within by means of three interrupted catgut sutures. After the formation of the margin of the nasal orifice, the flap was united with precision to the skin of the ridge of the nose, the edge of which had previously been undermined.

Now the flap, attached to the ridge of the nose, was brought down over the right side of the face as a cover for the two lining flaps, one for the cheek (Fig. 145, Plate 25) and the other for the ala of the nose (Fig. 147, Plate 25), and was united with them on its inner surface by several catgut sutures. The margin of the nasal orifice made from the doubled-over flap was united below medially with the skin edge at the top of the nose, and in order to form a naso-labial fold (Fig. 146, Plate 25) a small oblique incision was made through the doubled-up edge of the flap at the point of junction with the posterior edge of the orifice. Laterally the edge of the flap from the forehead was united with the cheek, first the flap which had been previously loosened up to be used as lining for the cheek being sutured with

catgut to its inner surface (Fig. 147, Plate 25). In tying these four buried sutures there resulted a hollowing in which resembled the normal furrow between the nose and the cheek (Fig. 148, Plate 25). Then the skin edges were united to each other. Finally, over the orbit the outer edge of the flap had to be united with the remains of the two eyelids (Fig. 148, Plate 25).

Below and to the outer side there remained a rhomboid defect in the cheek where the flap had been taken for plastic restoration of the lip. This defect could be closed, except for a small remnant, by three interrupted silk sutures, which were introduced from the lateral corner forward. The sutures created no tension on the flaps which had been employed for the plastic on the lip or on the nose. Two weeks later the pedicle of the flap from the forehead was divided and turned up. It was used to close the uncovering area in the forehead.

During the next four weeks the flaps healed solidly in place, except for the line of suture between the upper lip and the new ala of the nose, which pulled out, so that the deficiencies at the lateral margin of the nasal orifice over the upper lip made further operation necessary.

In order to form the lateral margin of the nasal orifice, which was still lacking (Fig. 149, Plate 26), the upper edge of the lip was freed with a two-edged knife, turned upwards, and sewed to the tip of the nose (Fig. 150, Plate 26). By close examination of the edge of the defect of the cheek, which had rolled inward through scar contraction (Fig. 151, Plate 26), it was apparent that a portion of the lining had loosened and retracted. Accordingly for a new lining the marginal portion which had rolled inward was so separated that a surface from a few mm. to 1 cm. wide could be employed. For this purpose it was turned inward and loosely held by a few interrupted sutures. As a result naturally the defect of the cheek was considerably increased in size and to cover it in a new flap had to be cut from the neck.

This flap (Fig. 152, Plate 26) had a pedicle to the outer side of the corner of the mouth. It was loosened from the chin and the fascia of the neck and was sewed with a few catgut sutures to the portion of the skin which had been cut for lining, and to the edges of the defect with silk (Fig. 153, Plate 26). The secondary defect on the neck was as far as possible united in a transverse line without distortion (Fig. 154, Plate 26). In a short time, after the skin flap had healed in, the patient returned home.

Plastic repair of large defect of face. IV.

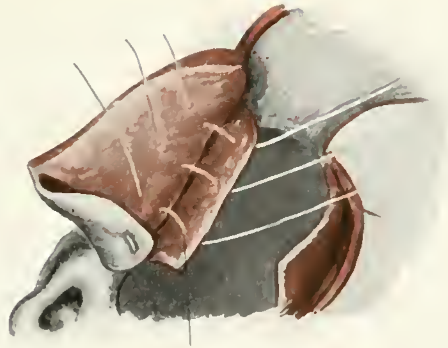

Fig. 145. Union of external and lining flaps.

Fig. 146. Formation of naso labial fold.

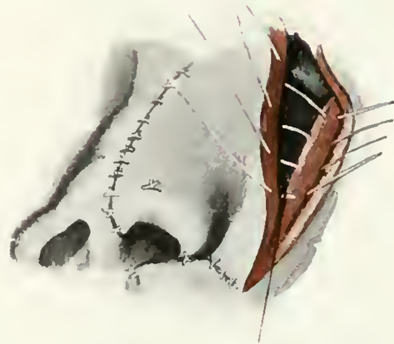

Fig. 147. Closure of defect completed.

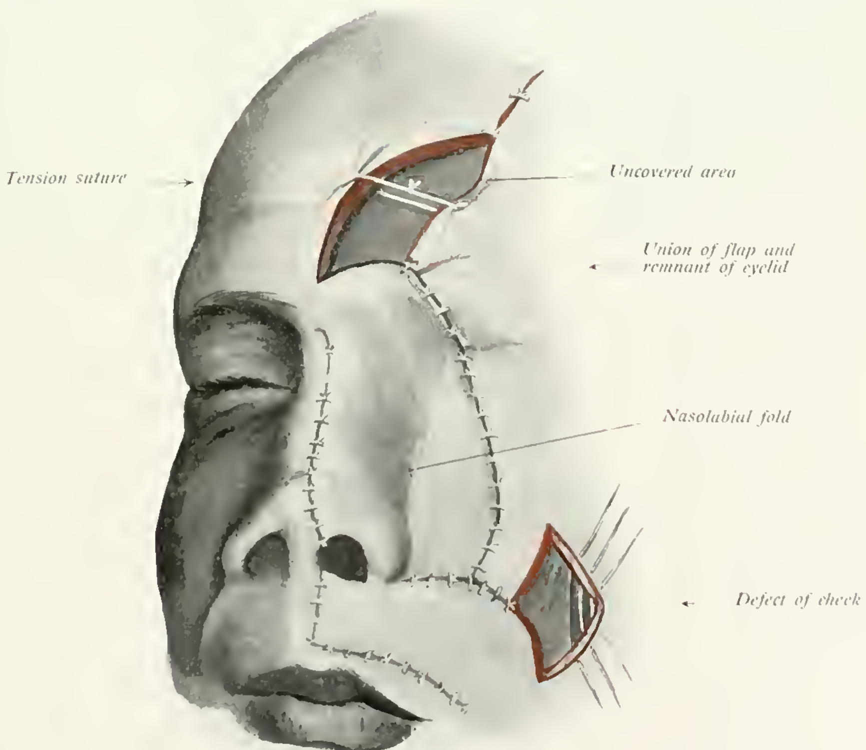

Fig. 148. Appearance after completion of suture.

Plastic repair of large defect of face. V.

Fig. 149. Defect between tip of nose, cheek and upper lip.

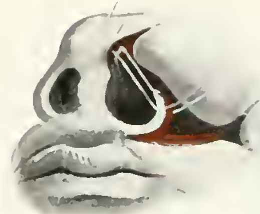

Fig. 150. Formation of lateral margin of nasal orifice.

Fig. 151. A portion of the cheek flap which has rolled in is split off for lining.

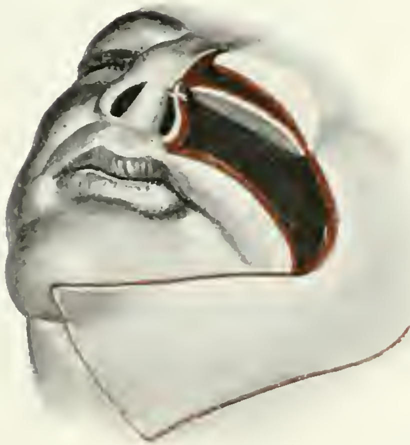

Fig. 152 Defect, and flap to cover it outlined on neck.

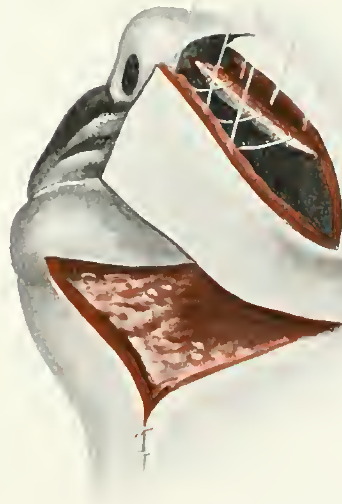

Fig. 153. Suture of flap to edge of defect

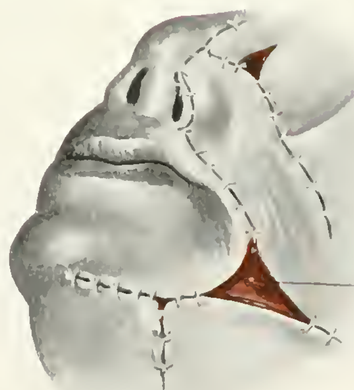

Fig. 154. Appearance after completion of suture.

BLEPHAROPLASTY

Plastic operations are necessary in defects or anomalies of position of the upper and lower lids. Defects of the eyelids result either from injuries or they are the result of malignant or other destructive disease. In the discussion of plastic flaps after the Indian method a case is described in which the replacement of the medial half of the upper lid after the extirpation of a carcinoma is demonstrated (see p. 102).

In similar diseases of the lower lid the technique of Langenbeck may be made use of, in which the skin for the newly formed lid is cut out of the cheek (Fig. 158) and the secondary defect is closed im-

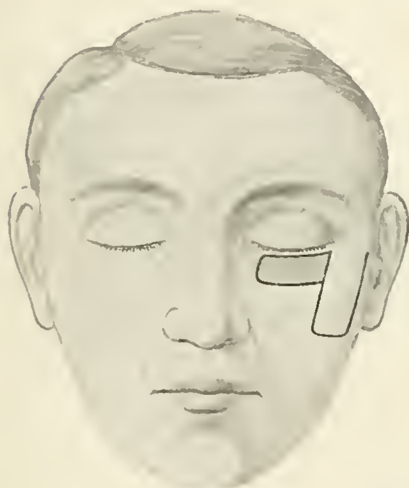

Fig. 158

Fig. 159

mediately after undermining its edges, or is covered with Thiersch grafts. The following schematic drawings will explain the procedure in such cases. For three-cornered defects Czermak* recommends the Szymanowski modification of Dieffenbach's technique. This consists in outlining the outer angle of the flap as acute as possible (Fig. 159), in order that this angle of the secondary defect will allow of easy closure, and the lower lid will have a high support.

The free transplantation of portions of skin may also be used to good purpose in defects of the eyelids. Whole-thickness flaps heal particularly well on the cheek and lower lid, as Wolfe had shown before Krause took up the subject. On the upper lid free transplantation of skin is particularly valuable, because the defects which extend over the eyebrow can be covered by flaps which are taken from the

*Die augenarztlichen Operationen; Berlin and Vienna, 1908, Vol. 2.

border of the scalp, for according to our experience hair continues to grow on free flaps just as if they were still in their original site.

Thus in a nine-year-old boy who had a vascular tumor removed (see p. 96), and whose upper lid as a result was drawn upward through scar contraction and fixed immovably in this position (Fig. 155, Plate 27), after excision of the scar and loosening of the remnant of the lid the defect, which just covered the superciliary ridge, was covered partly by a pediculated flap from the forehead (Fig. 156, Plate 27) and partly by a free flap taken after the method of Krause from the hairy scalp. The transplanted flaps healed satisfactorily (Fig. 157, Plate 27), and the hair continued to grow undisturbed in the new eyebrow. Only in the lateral portion of the flap over an area about 2 cm. long did the growth of hair cease. Eight months after the operation the right upper lid appeared normal and the eye could be completely closed. The hairless portion of the eyebrow flap could be covered easily by combing over it the long scalp hairs of the middle portion, as the transplanted hair in the new site showed active growth.

These plastic methods for upper and lower lid can be employed only if of all the layers at least the conjunctiva has remained intact. This is necessary for lining the new flap. But if the destruction involves all the layers, a new lid must be formed clothed within and without with epidermis, which will then run no danger of shrinking. For this purpose the outer covering as well as the conjunctival surface may be completed out of the portions of the lid which remain, or from the other lid of the same side if this is retained entirely. In order to protect the ocular surface of the new-formed lid from drying and shrinking as far as possible, free flaps of epidermis or of mucous membrane may be transplanted with advantage.

Attempts to replace the entire lid, in so far as the functioning muscle cannot be replaced, result as a rule only in an immovable, stiff fold of skin. For the lower lid this result may be satisfactory, particularly if by this means the eye may be saved. In place of the movable upper lid, however, only a useless curtain hangs down in front of the eye, which, although it forms a protection for the bulb, nevertheless acts as a hindrance to sight.

Anomalies of position of the eyelid may be corrected readily by simple plastic operations. *Ectropion* of the lower lid may be overcome by cutting out a triangle from its conjunctiva and shortening

Plastic from forehead to correct contraction of eyelid, and formation of eyebrow.

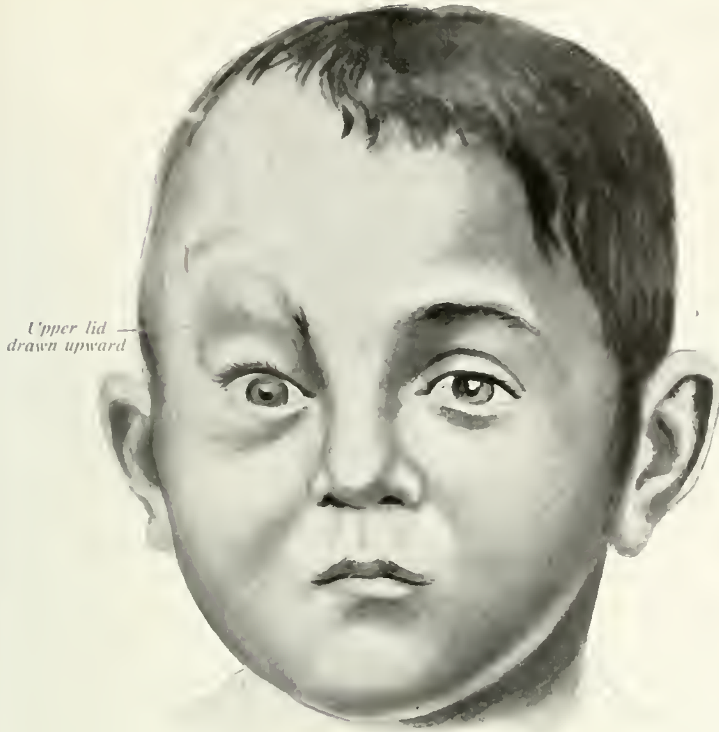

Fig. 155. Scar contracture on forehead and upper lid.

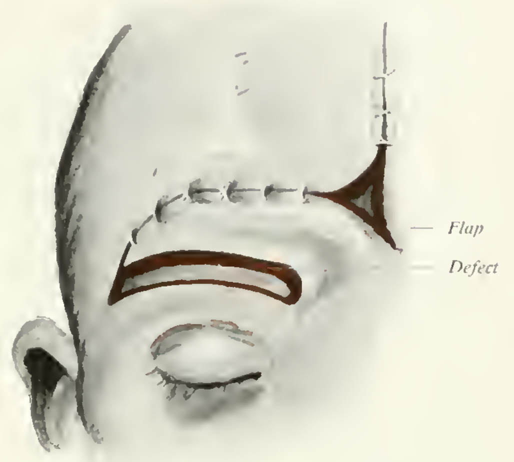

Fig. 156. Defect remaining in region of eyebrow.

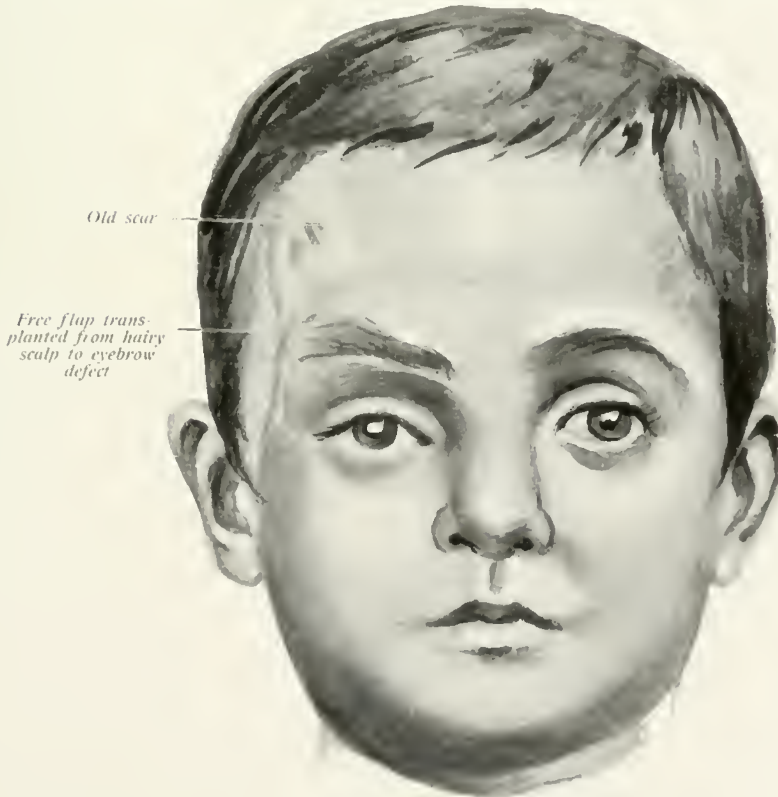

Fig. 157. Cosmetic result after 8 months.

the length of the lid margin, as are shown by Figs. 160 and 161, taken from the textbook of Czermak.

Fig. 160

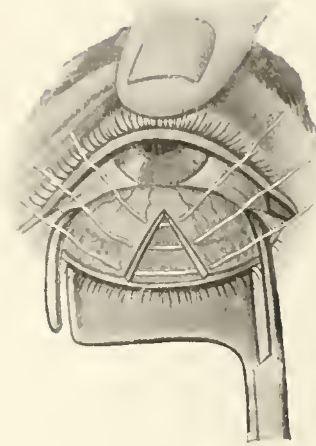

Fig. 161

Entropion may be corrected operatively if a wedge reaching to the conjunctiva, the base parallel to the edge of the lid, is cut out of the entire width of the lid. The base of the wedge is at the skin surface. The suture of the defect, which gaps outwards, results in a turning outward of the ciliated margin.

CHAPTER 9—SURGERY OF THE EYE AND ORBIT

While surgery of the eyeball itself must remain a specialty, every surgeon is at times forced to undertake operative procedures on the orbit and its contents. This applies particularly to such diseases as extend from neighboring portions of the face or from the protective coverings of the eye to the organ of sight itself. Only the procedures necessary in such affections will be treated here.

Fresh *injuries* which result in a complete loss or destruction of the lids, and a portion of the eye is so far destroyed that sight must be considered lost, demand operative removal of the bulb. This rule finds its justification in the danger of sympathetic ophthalmia, which arises in the other eye in cases of purulent infection. In severe *tuberculous processes* in the conjunctiva or the deeper lying coverings of the bulb within the orbit the radical operation comes likewise under consideration.

This can be carried out after either of two methods. *Enucleation of the bulb* consists in shelling out the eyeball from its capsule, separating the conjunctival sack, muscles and optic nerve at their point of attachment to the bulb. *Exenteration of the orbit*, on the other hand, includes a complete cleaning out of the bony orbit; the orbital periosteum is removed in connection with all of the surroundings of the bulb.

ENUCLEATION OF THE BULB

is indicated in infections and injuries above described and in addition in benign tumors and in malignant tumors the boundaries of which have not overstepped the contents of the bulb. The method for carrying it out may be demonstrated by the following case:

A thirty-three-year-old workingman had lost the use of his right eye at the age of thirteen years from a bullet wound. The ball entered at the outer canthus and remained lying in the depths of the orbit. Vision was immediately destroyed, but the eyeball was retained. Although the patient for twenty years had suffered no symptoms in the injured eye, four weeks before entrance, following a blow on the head, headache began which extended on both sides, later more on the left, from forehead to occiput.

The right eye showed total cataract and complete amaurosis. The

Enucleation of the bulb.

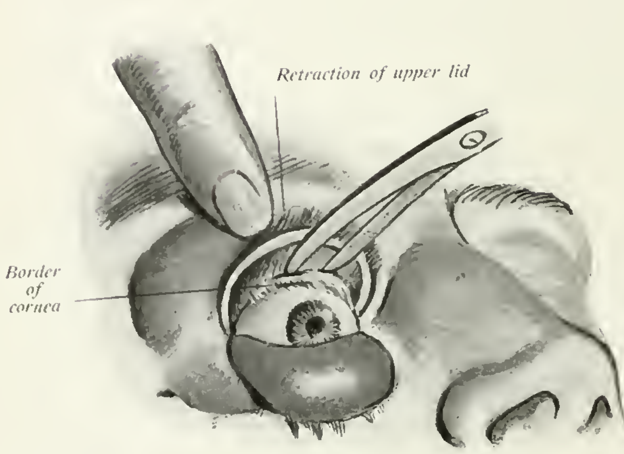

Fig. 162. Dividing the cornea.

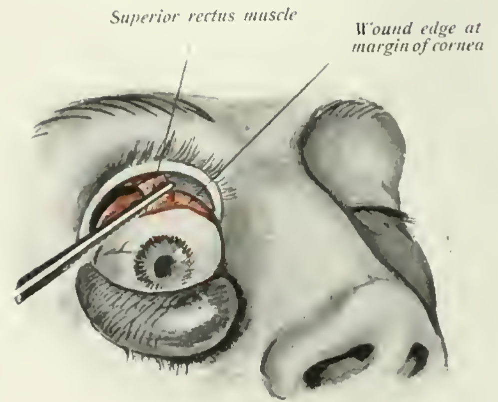

Fig. 163. Pulling out the bulb by the stump of the superior rectus muscle.

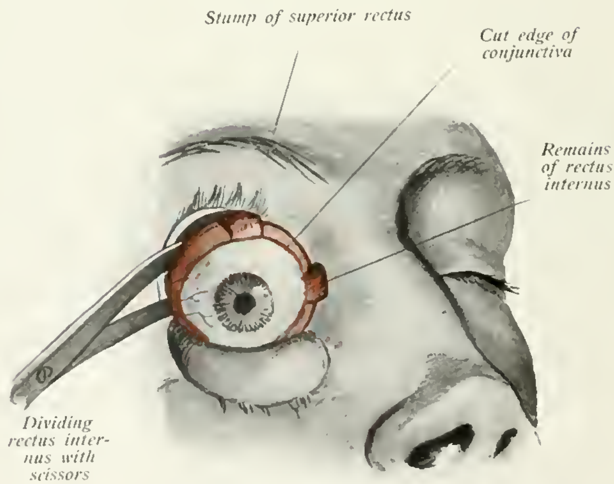

Fig. 164. Further division of recti muscles.

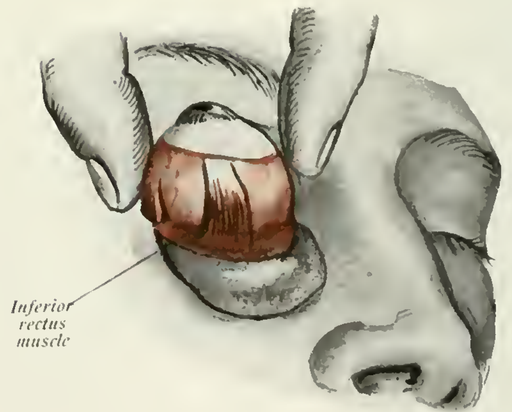

Fig. 165. Lifting out the bulb.

tension was somewhat lessened and the eye was sensitive to pressure, although the motility was undisturbed. The conjunctiva of the lower lid was swollen and edematous for several days (Fig. 162, Plate 28). The right infraorbital nerve at its exit from the orbit was slightly sensitive. X-ray showed the ball lying in the back of the orbit. The left eye showed slight pericorneal injection and was also painful to pressure. On account of the danger of sympathetic ophthalmia it was decided to enucleate the useless eye.

The lids were held apart with two fingers; the same purpose might be accomplished by two lid retractors or a spring retractor. At the upper edge of the cornea the conjunctiva of the bulb was raised with forceps and cut transversely with scissors, and the superior rectus was dissected out with a few strokes of the scissors (Fig. 162, Plate 28), picked up with a blunt hook, and separated near the bulb. The corneal portion of the tendon was seized with a hemostat (Fig. 163, Plate 28), so that it might be used as a handle in further manipulations. Then the conjunctiva was cut in a circle about the cornea, and the three other recti were similarly separated near the bulb (Fig. 164, Plate 28). Curved scissors were then introduced on the medial side behind the bulb, and the optic nerve was divided near to its entrance to the eyeball. Then the bulb became loose and could be drawn out from the orbit (Fig. 165, Plate 28). Finally the tendons of the two oblique muscles were divided at their insertions.

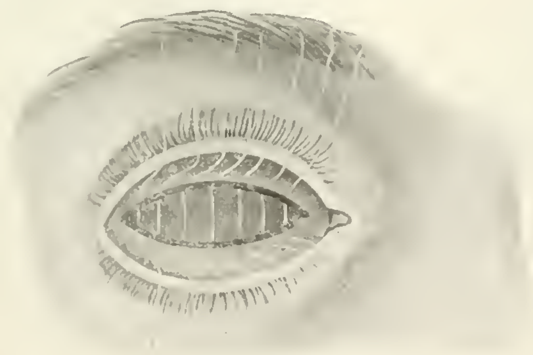

Fig. 166

The muscle stumps were retained so that after healing an artificial eye could be moved voluntarily in the retained capsule; the edges of the conjunctiva were united with interrupted sutures (Fig. 166). Eight days after the enucleation the patient was discharged with a healed wound and later he was fitted to an artificial eye.

The advantage of enucleation over exenteration lies in the preservation of the capsule of Tenon, which makes possible the wearing and to a certain extent the movement of a prothetic. Artificial eyes made of glass may be employed that are so deceptive that they do not affect the expression.

EXENTERATION OF THE ORBIT

is indicated in all malignant tumors which originate in the outer portions of the eye or in its immediate neighborhood as well as in penetrating infectious processes and in progressive cellulitis of the orbit. As all the soft parts of the orbit are to be cleaned out, its inner aspect may be carefully examined in order that infected areas of bone may be recognized. The extensive wound surface is covered by a flap from the forehead after the method of Küster,* or if the upper and lower lids are to be retained, it may be closed by uniting them.

In this way in a series of cases of perforating tuberculosis of the orbit and of purulent phlegmon both lids have been spared at the edges of the orbit. For cosmetic reasons the preservation and suture of the lids after removal of the mucous membrane and ciliated edge is more favorable than turning down a flap built from the skin of the forehead. The inverted scar at the healed edges of the lid is so slightly noticeable that usually an eyeshade does not have to be worn.

EXENTERATION OF THE ORBIT WITH PRESERVATION OF THE LIDS

In a twenty-eight-year-old woman a year before, on account of tuberculosis of the right orbit with practically complete loss of vision, resection of all the involved portions of bone was carried out. After an improvement lasting a few months, the vision suddenly vanished with an appearance of marked choroiditis. The marked exophthalmos, headache and the inflamed appearance of the conjunctiva, as well as the swelling over the orbital bones, spoke for a lighting up of the tuberculosis and its spread to involve the tunics of the eyeball. Accordingly, exenteration of the orbit was decided upon.

The fissure of the lids was extended laterally with a knife to the outer edge of the orbit, and at the same time a tuberculous fistula in the outer canthus was surrounded by the incision (Fig. 167, Plate 29). The lids were pulled apart with sharp hooks and the markedly altered edematous conjunctiva was separated from the inner surface of the lids with a knife down to the upper and lower edges of the orbit.

*Zentral. f. Chir., 1890, Nr. 2.

Exenteration of the orbit, retaining the lids.

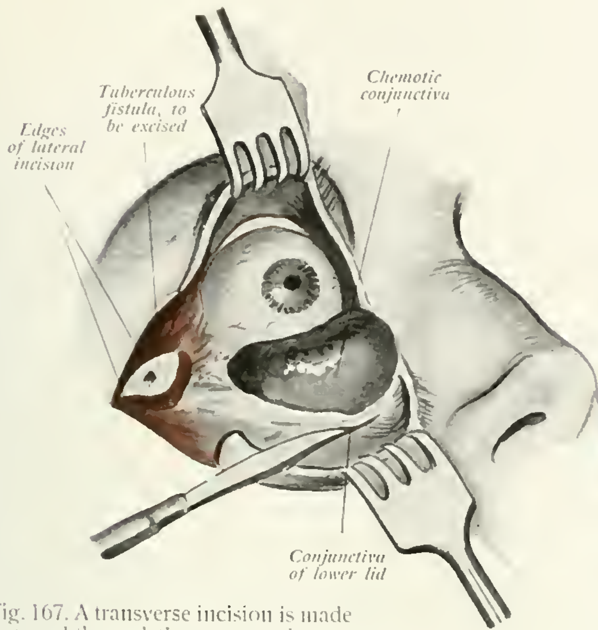

Fig. 167. A transverse incision is made outward through the outer canthus, to give better exposure, and an incision through conjunctiva is made around the globe.

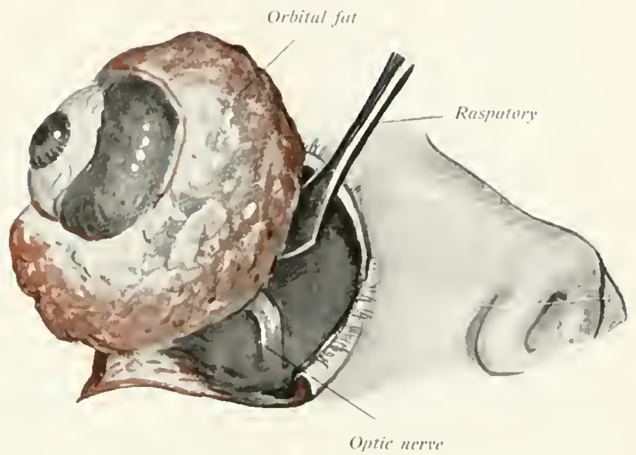

Fig. 168. Luxation of orbital contents.

Fig. 169. Removal of tuberculous granulations.

Fig. 170. Removal of ciliary margin.

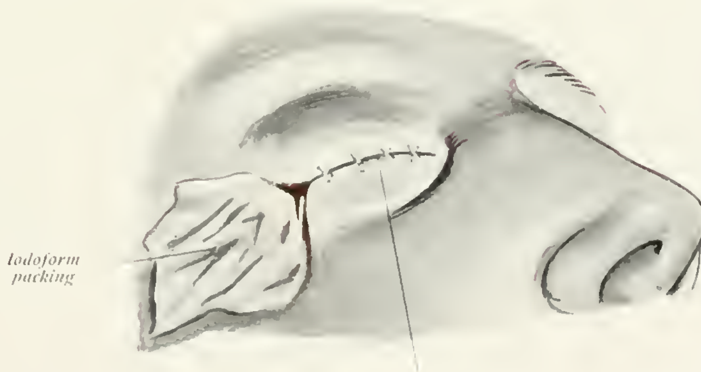

Fig. 171. Appearance at end of operation.

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Then the periosteum was incised around the orbit down to bone, and with a wide raspatory separated from the bony wall of the orbit on all sides until it was possible to dislocate outwards the entire content of the orbit (Fig. 168, Plate 29). This brought to view the optic nerve under tension, together with the ophthalmic artery and vein, as the only structures holding the eyeball, and these were cut with scissors at the optic foramen. The hemorrhage as usual was controlled by pressure, and it was unnecessary to seize and tie the ophthalmic artery in the apex of the funnel. Thereupon all tuberculous granulations and necrotic bone of the orbit were removed with a curette (Fig. 169, Plate 29), also a portion of the upper maxilla had to be dissected out on account of tuberculous infiltration.

In order to cover in the large cavity which resulted, both lids were made use of. The ciliated edges were removed (Fig. 170, Plate 29) and the freshened margins as well as a part of the lateral incision were united by interrupted sutures (Fig. 171, Plate 29). Since the case was one of tuberculosis, the orbital funnel was stuffed with iodoform gauze, the end of which was brought out at the outermost corner of the lateral incision. After five days the packing was removed, so that the already healed lid edges could lie against the wall of the orbit. After eight days more the patient was discharged relieved. As a result of the maintenance of the lids the deformity was so slight that the girl did not have to wear an eye shield.

EXENTERATION OF THE ORBIT WITH REMOVAL OF THE LIDS

If the lids are involved in the disease, as, for instance, in malignant growths, and particularly in spreading epithelioma at the inner canthus, they must be removed as well as soft parts and bone in conjunction with the contents of the orbit. There results a wide wound surface with an irregular base, which, after the technique of Küster, is covered over with a pediculated flap from the forehead or temple. After this operation an eyeshade or a dark or ground glass must be worn.

Since superficial skin cancer in the region of the canthus or on the lids themselves usually extends slowly, ordinarily, in clearly defined cases of cancerous infiltration and ulceration, excision in sound tissue with maintenance of the eyeball suffices. Only the involved portion of the lid has to be removed, as shown on page 102. But if the disease has extended to the conjunctiva of the inner canthus or to the bulb, exenteration of the orbit is indicated, in addition to extirpation of the

lids, even when vision is unimpaired. The operative procedure is demonstrated by the following case:

In a thirty-one-year-old Russian, who in his own country had been operated upon about fifteen times, a crater-like ulcer about 32 mm. deep with hard edges was located in the left inner canthus. The inflamed median surface of the eyeball formed the outer boundary of this crater. In addition there appeared when the eyes were shut a carcinomatous ulcer (Fig. 172, Plate 30) close to the superior edge of the orbit. Although the eye possessed satisfactory vision, it had to be sacrificed; likewise it was necessary to remove at least the inner halves of the lids. The wound cavity which resulted from exenteration of the orbit and removal of half the lids was too large to allow of covering over with the rest of the lids and, therefore, before extirpating the carcinoma, the incisions necessary for the skin plastic had to be planned in advance.

The lids (Fig. 173, Plate 30) were split vertically at the junction of the outer and middle thirds. They were dissected back laterally and the periosteum at the outer edge of the orbit was divided down to bone. From this point the cleaning out of the bulb and periosteum of the orbit was carried out with a raspatory. But on palpation of the lids which had just been split (Fig. 172, Plate 30) small lumps could also be felt, and so each lid was removed in its entirety by an incision following the edge of the bony orbit. In this way the carcinomatous ulcer was surrounded by two incisions, which met at a point over the bridge of the nose (Fig. 174, Plate 30). In removing the orbital contents, beginning at the outer side, by means of the raspatory, naturally some of the carcinoma on the medial surface of the orbit was left behind. The extirpation of this and several suspicious areas of bone was readily accomplished, after the orbit was emptied. Re-examination showed that the carcinoma had extended over the inner surface of the orbit (Fig. 175, Plate 30). The supraorbital nerve, which lay free for about 3 cm., was resected.

In chiseling off the nasal bone and the nasal process of the frontal bone the frontal sinus was laid open (Fig. 176, Plate 31), and after the removal of the roof of the orbit the dura mater was exposed. Medially likewise the bone had to be removed for a considerable extent. As the frontal process of the upper jaw was removed with the chisel (Fig. 177, Plate 31), and as a result the antrum was opened wide, the entire left nasal cavity was exposed (Fig. 178, Plate 31), and the medial boundary of the wound was formed by the turbinates.

Exenteration of orbit with removal of lids. I.

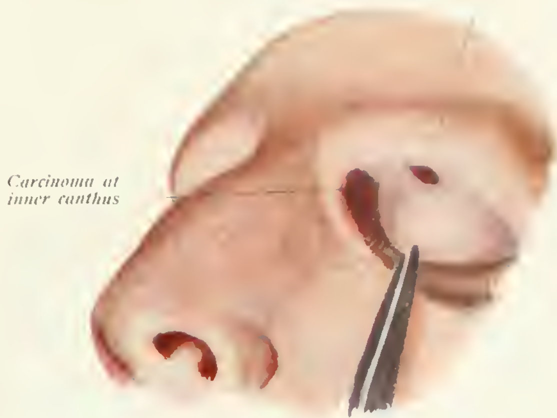

Fig. 172. Carcinoma at inner canthus and on upper lid.

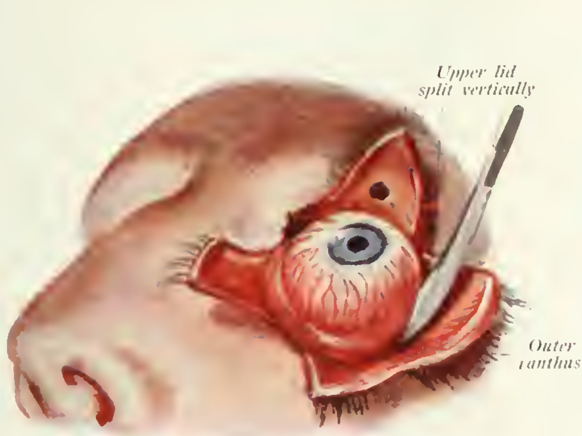

Fig. 173. Incising periosteum along outer margin of orbit.

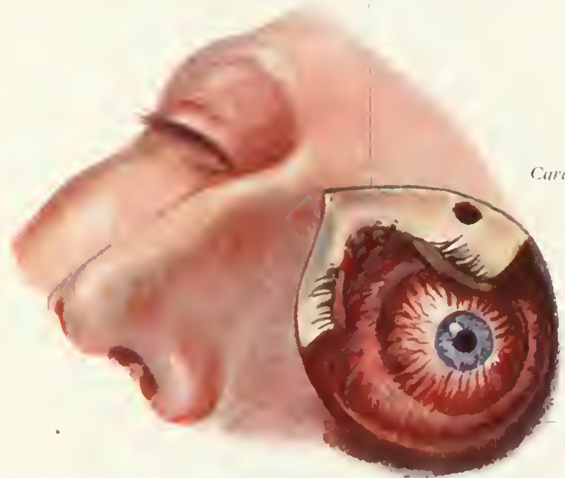

Fig. 174. Removal of lids.

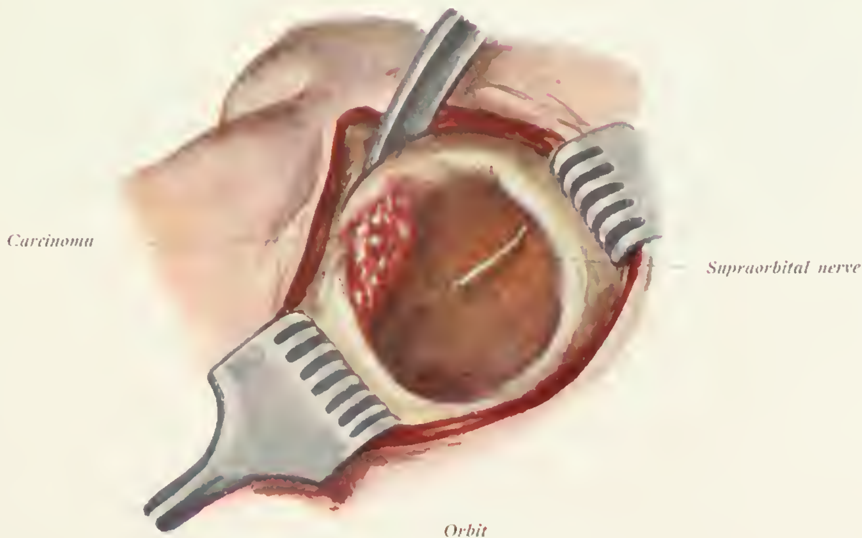

Fig. 175. Exenteration of orbit completed.

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Exenteration and resection of orbit. II.

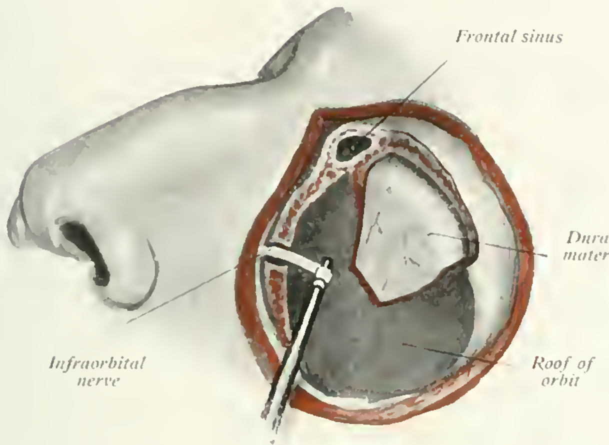

Fig. 176. Resection of roof of orbit.

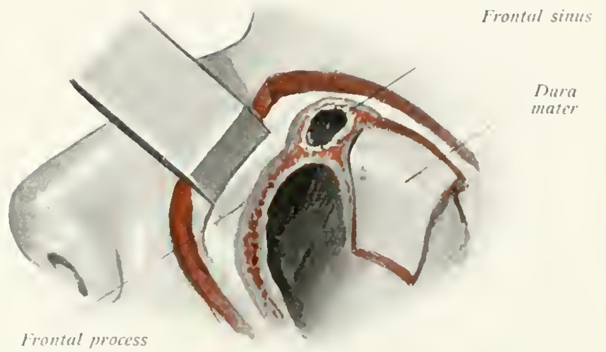

Fig. 177. Resection of frontal process of superior maxilla.

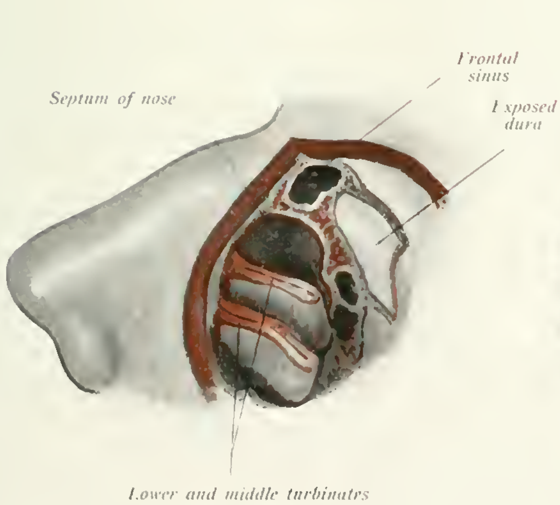

Fig. 178. Exposure of Nasal cavity.

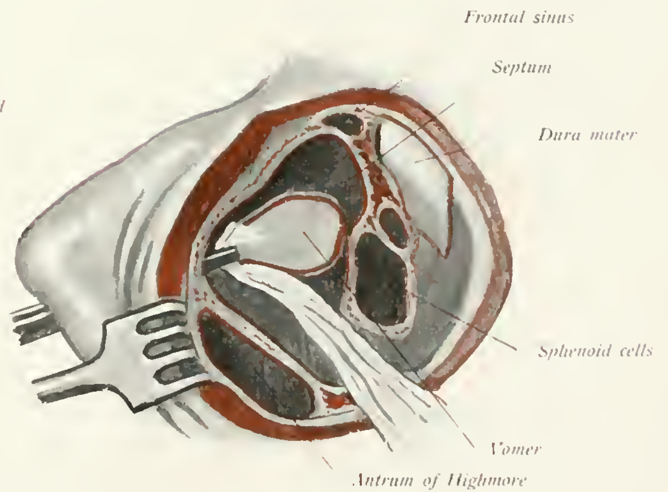

Fig. 179. Packing begun; shows extent of wound.

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Plastic covering of exenterated orbit after Küster. III.

Defect in forehead

Flap

Pedicle

Provisional packing

Suture at outer canthus

Fig. 180. Cutting the flap on the forehead.

Secondary defect

Pedicle

Flap

Fig. 181. Fitting in the flap.

Unclosed portion of defect of forehead

Pedicle twisted

Flap implanted over orbit

Fig. 182. Sewing in the flap, and suture of the secondary defect.

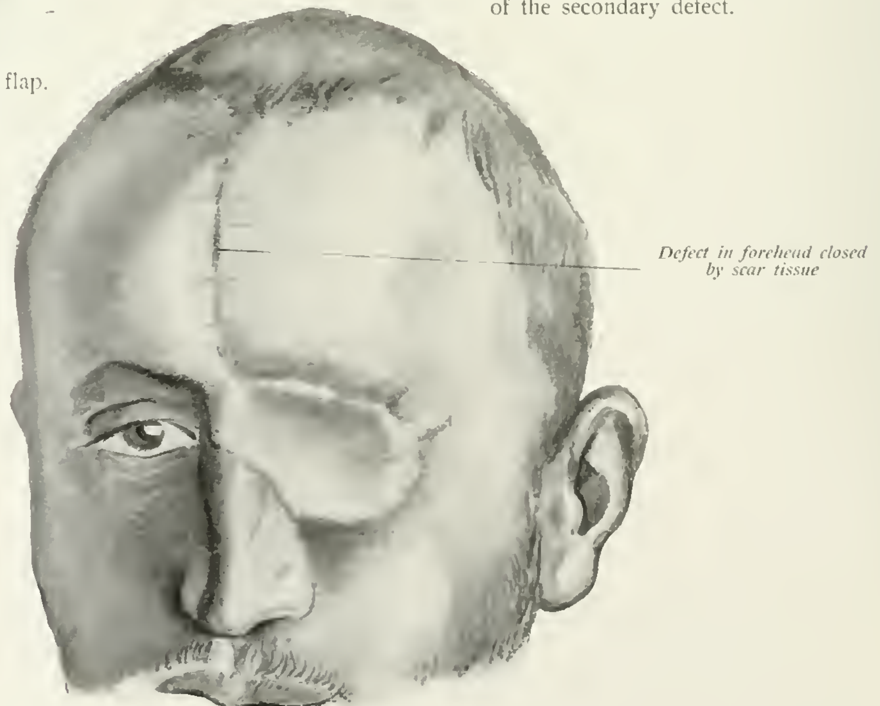

Fig. 183. Wounds healed 3 weeks after operation.

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These also showed areas which were suspicious of carcinoma and were removed in conjunction with the ethmoid cells and the walls of the sphenoid cells, as well as a portion of the mucous membrane of the vomer. The infraorbital nerve was in this process exposed and resected.

From above downward the inferior meatus and the antrum were packed with vioform gauze (Fig. 179, Plate 31), in order that no blood could run down into the pharynx and be insufflated. From the depths of the sphenomaxillary fossa a branch of the internal maxillary artery bled. It was packed with gauze impregnated with iodoform in order to prevent decomposition, because here the packing had to remain for a considerable length of time; this packing was differentiated from the other strips of gauze by tying silk about the end. Likewise, the exposed surface of the dura was protected with iodoform gauze, the end was knotted and was carried out through the left nasal orifice above the other two strips (Fig. 179, Plate 31).

The large wound cavity could be partially closed at the outer canthus (Fig. 180, Plate 32); but the tension was too great to allow of more than three interrupted sutures. The rest of the defect measured 55 mm. from right to left and 32 mm. from above downward. This surface was covered with a skin-periosteum flap from the forehead, the pedicle of which lay at the right side of the root of the nose, and the upper end came to a point so that it would fit into the defect (Fig. 181, Plate 32). The flap was sewed in by interrupted silk, leaving no drainage in the orbit (Fig. 182, Plate 32). Finally the secondary defect on the forehead was closed after undermining the edges, except for a small area 2 cm. long and a few mm. wide.

At the first dressing on the second day after operation the drains were pulled out slightly through the nose. Eight days later the more superficial tampon lying in the neighborhood of the orbit was completely removed and the iodoform packing, which was recognized by the silk tie and the knot, was somewhat shortened. Every second day these were drawn out somewhat until they were completely removed on the twenty-second day after operation. The small gap in the forehead had filled in rapidly with granulations and had meanwhile epidermatized, so that the patient on this day could be discharged healed (Fig. 183, Plate 32). Up to this time if the patient were touched with forceps upon the flap, the sensation was always localized on the forehead above the orbit; contact directly at the base

of the flap alone was rightly localized; only in time was correct localization learned.

KRÖNLEIN'S OSTEOPLASTIC RESECTION OF THE TEMPORAL WALL OF THE ORBIT

Tumors lying behind the bulb, for instance, those of the optic nerve, and inflammatory infections of the orbit, such as cellulitis and tuberculosis, may sometimes be overcome surgically without the necessity of sacrificing the eyeball. In order to accomplish this, the outer wall of the orbit is resected osteoplastically after the method of Krönlein, and, if necessary, the capsule of Tenon is split. After turning back the bony parts one can penetrate into the depths of the orbit as far as the optic nerve and carry out operative procedures here in full view.

Naturally, these conservative methods can only find application if, as was explained in the previous section, no indication exists for the removal of the eyeball, for instance in limited benign tumors in the orbit, whether arising from bone, connective tissue, muscle or optic nerve. Krönlein devised this method for the removal of a laterally situated dermoid cyst. It seems to be indicated also if tuberculous masses have penetrated the bony wall of the orbit, and cause the bulb to project without involving it, or if a cellulitis has spread over the floor of the orbit.

In a twenty-eight-year-old young woman who had had a tuberculous abscess over the zygoma incised a year before, the Krönlein operation was performed in order to put a stop to the rapid loss of vision which was resulting from proliferation of tuberculous granulations behind the bulb. X-rays showed no bony changes. Retinal examination of the right eye showed papillitis with advancing optic atrophy. The eyelids were swollen and edematous (Fig. 185, Plate 33), and there was present a marked degree of exophthalmos. All movements of the eye were present, but limited.

The skin was divided outward from the middle of the right eyebrow in crescentic fashion as far as the outer corner of the orbit, and from this point, following the Kocher modification for the purpose of avoiding the branches of the facial nerve, continued transversely outward (Fig. 185, Plate 33). After dividing the periosteum at the edge of the orbit, the bulb in all its coverings could be so far loosened from the outer wall of the orbit with a raspatory (Fig. 186, Plate 33) that the instrument reached in the depths to the inferior fissure of the orbit. There was very little bleeding, but even at moderate depths

Kroenlein's osteoplastic resection of the temporal wall of the orbit.

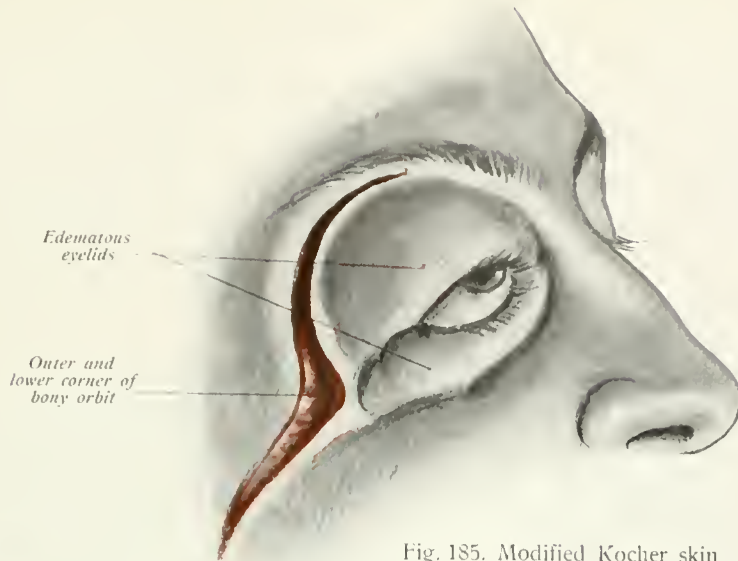

Fig. 185. Modified Kocher skin incision.

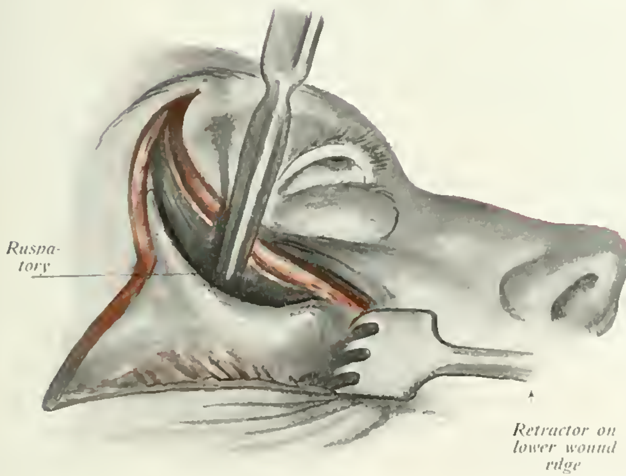

Fig. 186. The bulb with its coverings intact is lifted away from the external orbital wall.

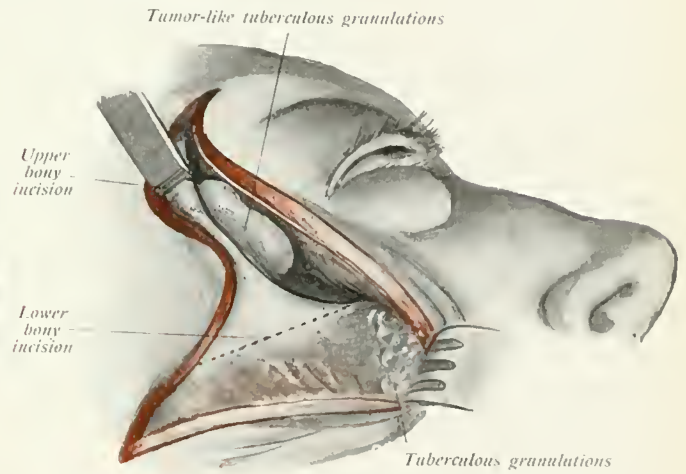

Fig. 187. Making the bony incisions.

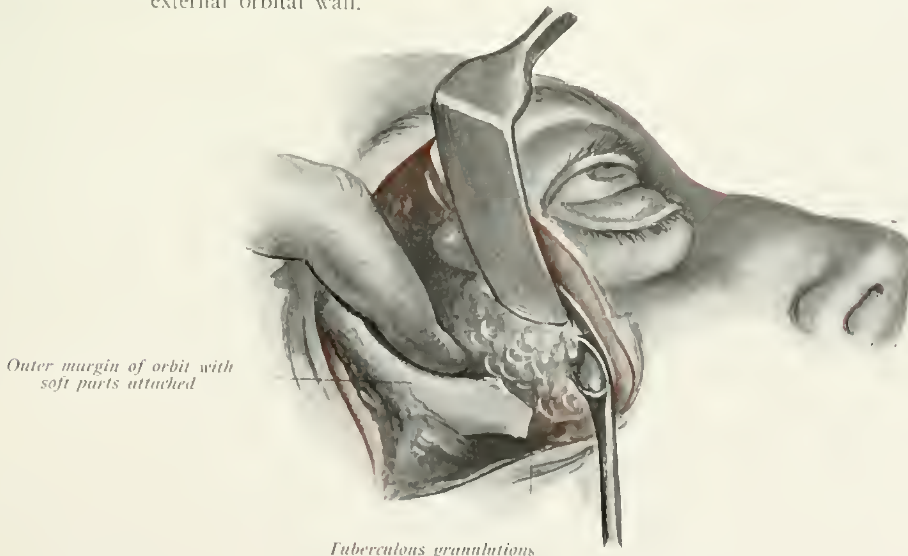

Fig. 188. The bony wedge is displaced outward.

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hard tumorlike granulations appeared, which resembled in form white beans (Fig. 187, Plate 33).

During the freeing up of the periosteum within the orbit all pull on the upper outer edge of the skin was avoided, in order that the soft parts might not become loosened from the bone. But on the other hand the wound had to be pulled strongly downward to expose partially the lower margin of the orbit (Fig. 186, Plate 33). There-

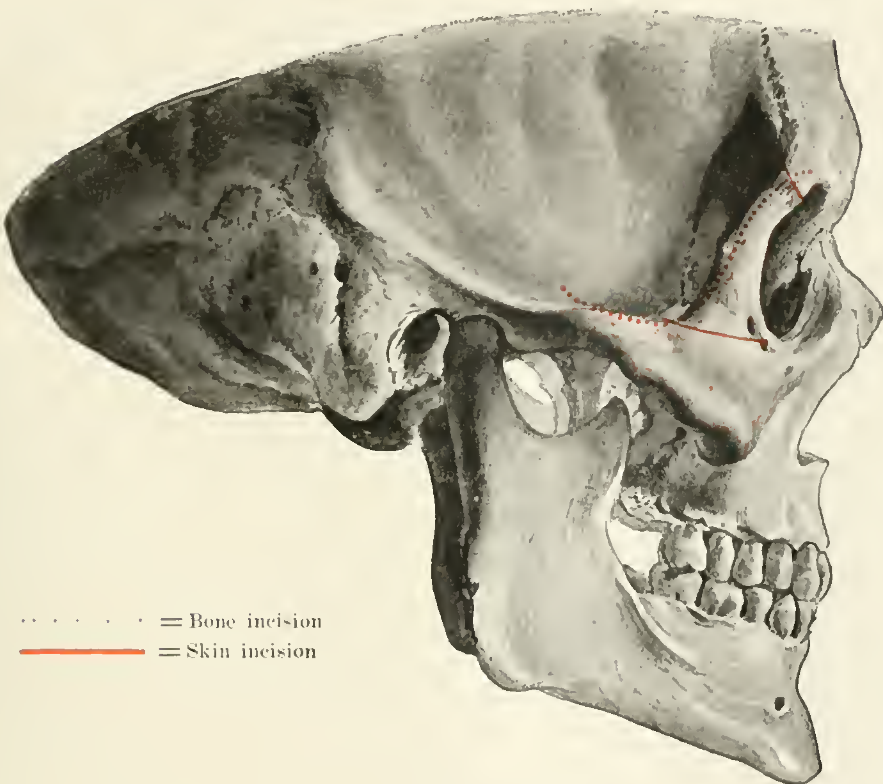

Fig. 184

upon the outer wall of the orbit was chiseled through above and below (Fig. 184) and the bony incision was carried in the direction of the raspatory, which was stuck in the lower orbital fissure. Above, the chisel was introduced just over the suture, which could be palpated between frontal bone and zygoma: below, at the level of the zygoma. A portion of the zygoma was removed by the lower cut. In this way one could form a bony wedge from the lateral wall of the orbit, which, in connection with muscle and skin, could be turned backwards over the temple (Fig. 188, Plate 33).

There now appeared in the orbit tumor-like tuberculous granula-

tions, which were particularly luxuriant on the floor and along the inferior orbital fissure. These were removed with a curette as well as soft areas of bone, with the result that the antrum was opened. As there was no indication for incising the periosteum of the orbit laterally, thus exposing the external rectus as well as the optic nerve or the posterior surface of the bulb, the skin-bone flap was replaced after a strip of iodoform gauze and a thick drainage tube were left behind down to the position of the removed granulation masses. The wound at the outer canthus was closed by a suture, including at the same time skin and periosteum. Five days later the gauze and a few days after that the drainage tube was removed. The bone healed in by primary union. The removal of the masses of granulation tissue had no effect on the vision. The extrusion of the bulb and the edema of the lids did not completely disappear. Six months later, on account of advancing tuberculosis, the upper jaw had to be resected.

TREATMENT OF CELLULITIS OF THE ORBIT

Through temporary resection of the outer wall of the orbit foci of pus in the orbit may be exposed. In addition to the regular symptoms of sepsis, phlegmon of the orbit expresses itself in a protrusion forward and limitation of motion of the eyeball, as well as in swelling and reddening of the lids. Purulent infiltrations develop from infected wounds which are situated near the eye or the orbital veins, and sometimes result in empyema of the accessory cavities of the nose. The prognosis is always unfavorable because there is danger that the phlegmon may extend to the brain and its envelope. On the other hand, the prognosis is more favorable if the abscess is the result of a penetrating foreign body.

Small incisions at the canthus or at the upper orbital margin do not suffice to expose all the infiltrated area: moreover, satisfactory drainage cannot be obtained from such incisions. Orbital phlegmon and abscess must be opened much more widely. The following observation shows how the Krönlein operation allows free approach to the depths of the orbit:

A forty-year-old woman was brought into the hospital in a state of coma with all signs of phlegmon of the orbit and secondary brain abscess. At the inner upper edge of the orbit was situated a wound of the soft parts out of which a drainage tube and iodoform gauze projected. The upper lid was chemotically swollen in the highest degree. In order to open wide the phlegmon the outer wall of the

orbit was resected after the method of Krönlein, using the Kocher incision to avoid the facial branches.

In loosening up the periosteum of the orbit with the finger foul-smelling ichorous pus welled up, which, being wiped away, kept reappearing at the inner upper corner of the orbit under the floor of the anterior fossa. As the periosteum of the orbit was incised in the horizontal plane and the contents exposed we were struck by the discolored appearance of the lacrimal gland, the fat and the rectus externus: and on introducing the finger into the orbital fat there was found only a turbid serous infiltration, but no fluid pus.

After exposing the orbit the anterior fossa was trephined above the supraorbital ridge, opening up the abscess of the frontal lobe. No anesthesia was necessary during the entire operation, since the patient, being in complete coma, felt no pain. She died the day after the operation without recovering consciousness.

CHAPTER 10—SURGERY OF THE EAR

INJURIES AND DISEASES OF THE EXTERNAL EAR

Injuries of the external ear for the most part demand but little special surgical interest; their treatment follows the rules of general surgical practice. Likewise operations for infection or small tumors in the soft parts and cartilaginous plates of the shell of the ear, or in the external meatus do not depart from the principles of treatment of similar affections in other parts of the head.

In a thirty-five-year-old bookbinder an *epithelial growth* about the size of a cherry (Fig. 189, Plate 34) on the upper half of the right concha, which had apparently developed from a wart, was excised in the form of a wedge under local anesthesia. Since the cartilage as usual projected beyond the upper and lower cut surfaces, it was pulled out as far as possible with forceps, but without tearing it from its surrounding tissue, and with curved scissors the projecting edge was removed (Fig. 190, Plate 34). Then the cartilage was united by two fine catgut sutures (Fig. 191, Plate 34), and the skin with six interrupted sutures of silk (Fig. 192, Plate 34). A dry sterile bandage was applied with adhesive straps to hold it in place, and the dressing was changed in five days; the wound healed by first intention and after ten days the patient was discharged from the out-patient clinic.

In resection of the shell of the ear it is usually unnecessary to replace the loss of substance by the help of any particular plastic method. For the movability of the tissues makes it possible to repair the defect by direct suture of the wound edges. To be sure, attempts have been made to replace the shell of the ear after complete destruction by the use of skin from the temporal region, but the results obtained can hardly be considered satisfactory in any regard,—cosmetically, because there resulted only a misformed flap of skin, which in its shape possessed no similarity to the funnel-like concha,—functionally, because the flabby flap of skin was unable to replace physiologically the first element in the sound-transmitting apparatus.

Among diseases, closure of the external auditory canal may be relieved by surgical methods, if the hearing is disturbed or the removal of secretion is impeded. Such a condition may result from *furuncles*

Wedge-shaped resection of a portion of the shell of the ear.

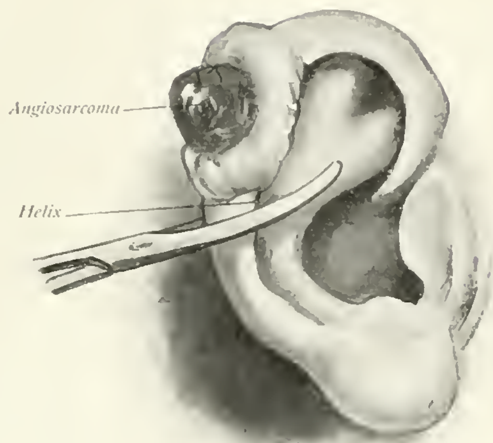

Fig. 189. Incision, with scissors.

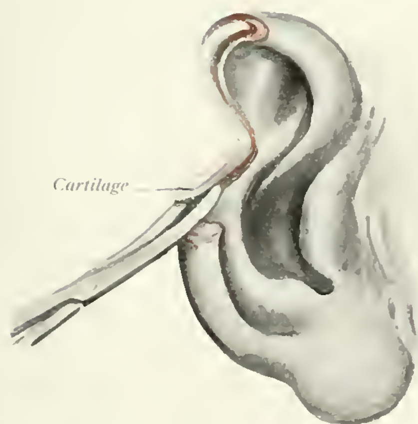

Fig. 190. Removal of excess of cartilage.

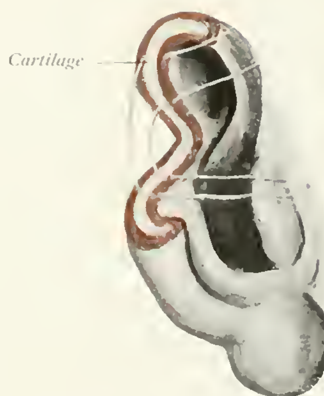

Fig. 191. Suture of Cartilage.

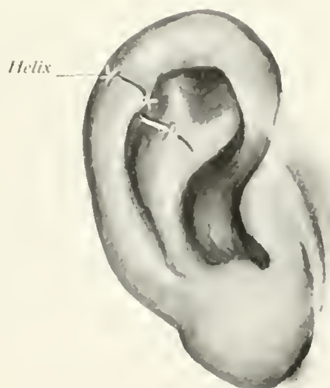

Fig. 192. Skin suture.

which develop in the hair follicles of the canal. They cause acute pain, particularly if the infiltration extends down to the perichondrium, and moreover the acuteness of hearing is ordinarily interfered with, because the canal as a result of swelling of the walls is narrowed or even entirely closed. Early and deep incisions of the reddened and swollen places followed by light packing with moist gauze usually overcomes the symptoms in a short time.

Complete closure of the external auditory canal may take place as the result of the collection of *ear-wax*. This leads finally to the development of a plug of impacted cerumen, which is composed of the inspissated secretion of the skin glands, of epithelium, and of foreign bodies which have penetrated from without. The symptoms consist in a diminution of hearing and a feeling of fulness in the ear. Mechanical closure of the external canal occurs not infrequently, particularly in children, from the introduction of objects into the ear which stick fast. They may remain without reaction, but more usually they lead to severe inflammatory changes and abscess formation in the deeper lying parts of the ear.

In order to render visible such *foreign bodies*, as well as all external changes as far as the drum, the shell of the ear must be pulled backward and upward, so as to straighten out the external auditory canal. If this simple procedure does not succeed, the canal should be examined with an ear speculum.

If there is obstruction to the introduction of instruments, an attempt should be made through irrigation of the canal with lukewarm boric acid solution or through instillation with hydrogen dioxid to wash out the mechanical obstruction. To enter the auditory canal at once with an ear spoon, hook or forceps is dangerous, because in working in the dark with instruments the drum membrane may be readily injured and the middle ear infected. Instruments should only be employed after repeated irrigations or the introduction of softening solutions have been without result. If the foreign body is broken up, it may be easily seized with a small instrument and drawn out.

In an eight-year-old girl the point of a dance-order pencil about 2 cm. long was extracted after it had been situated in the external canal for several days. The girl had attempted to remove a plug of absorbent cotton with the aid of the small pencil, because as a result of the otitis media which was present, it had caused marked irritation. In this way the point was broken off, and was found on examination in an indistinct sticky mass lying between the much-swollen walls

of the canal. The first attempt to remove the visible pencil point caused great pain. Thereupon a cold compress of alcohol and water was applied for twenty-four hours, causing a visible reduction in the swelling. The mass of secretion was then washed out with boric acid solution, until a larger portion of the broken-off tip was visible. With a right-angle forceps similar to the instrument for seizing the iris, the loosened lead could be seized and withdrawn. After the rather painful removal a little blood trickled out of the meatus. A few days later the wad of absorbent cotton, which had remained in the ear for some time, and had been softened up by daily irrigation with warm water and the introduction with a dropper of a 1 per cent. solution of sodium carbonate, could be removed. The meatus was in this case, as in similar cases, filled with a plug of gauze.

Swollen legumins, such as *beans* and *peas*, are best removed with the help of a small, sharp hook, which is introduced parallel to the wall of the canal until the hook is behind the object, and is then turned to a perpendicular position and withdrawn.

PURULENT INFLAMMATION OF THE MIDDLE EAR

Of the diseases of the middle ear, retention of pus in the tympanic cavity and its neighborhood demands particular interest and usually immediate help on the part of the surgeon, for delay in this disease endangers not only hearing, but may involve loss of life. For this reason the most practical methods for exposing foci of pus originating in the tympanic cavity will be described.

Retained pus in the tympanic cavity causes severe pain, and in addition to the ordinary symptoms of infection, there appears, as a rule, difficulty in hearing. The drum examined through a speculum shows marked vascular injection, frequently tumor-like bulging, and in advanced cases before perforation, yellowish, greasy spots elevated above the level are visible. The light reflex disappears with the beginning of bulging, as well as the light streak in the upper anterior quadrant, which marks the attachment of the hammer. Taking these symptoms together, an outlet for the pus must be made by incising the drum. This is accomplished by

PARACENTESIS

which is carried out with a small scalpel or a paracentesis knife with an elbow, on the well-lighted and clearly visible drum. The stroke

of the knife is made in an oblique direction in the lower posterior quadrant. The exit of pus is encouraged by irrigation with a sterile or weakly antiseptic solution under very low pressure. Since paracentesis causes pain, it must usually be carried on under anesthesia. The incision in the drum may be either too long or too short. An incision several mm. long makes the flow of pus more ready, while through a simple puncture, such as is practiced by many, in favorable cases the pus only exudes drop by drop. As a result of the inflammatory swelling of the drum, incisions which are too small close up again readily.

The danger which exists from the retention of pus behind the drum lies chiefly in the open communication of the middle ear with the antrum, and of the connection of this with the air cells of the mastoid process. If the pus does not succeed in running off through the perforated drum, it forces its way into the neighboring spaces and from here by two directions into the temporal bone. The less dangerous outlet is the formation of a subperiosteal abscess under the skin behind the ear, after carious destruction of the mastoid process. Far more threatening for the patient is the invasion of the pus into deep-lying portions of the temporal bone, the sigmoid sinus, the dura mater and the brain.

When the infection goes over from the middle ear to the mastoid cells, the symptoms of otitis media purulenta are apt to subside with the appearance of symptoms of inflammation of the mastoid. In addition to fever and headache, which accompany the pain in the ear, indefinite swelling, reddening and unusual tenderness to pressure in the region of the skin lying behind the ear indicate the local process. In children all subjective symptoms, particularly spontaneous pain, may be wanting completely, and only palpation of the mastoid cause the sensation of pain. Also in mastoiditis as a result of the subcutaneous edema the shell of the ear projects at times from the side of the head. Moreover, for the same reason, the upper wall of the external auditory canal may be depressed and the canal be partially closed.

OPENING UP THE MASTOID CELLS

The rapidity with which purulent infections pass over from the middle ear to the mastoid and cause suppuration in the mastoid cells does not always correspond to the grade of severity. We see in children and sometimes in adults how, after an existing low-grade

otitis media or following close upon an attack of influenza, a breaking down of the cells of the mastoid process occurs. After incision of the overlying skin and a simple opening up of the mastoid cells the stormy advance of the process is immediately stopped. In children particularly there may result complete necrosis of the small mastoid process, which, after being chiseled open, may be sponged away like pulp.

In order to allow free exit for the pus and to prevent the least retention under the protecting soft parts, the usual incision is made ½ cm. behind the shell of the ear and parallel to its attachment and surrounds the mastoid process in a crescent which is convex forward (Fig. 193, Plate 35). After dividing skin and periosteum, the strong cortex of the process is chiseled through in a tangental direction from before backward with a bayonet chisel (Fig. 194, Plate 35), and in that way a skin-periosteum-bone flap is lifted up which exposes the cells of the mastoid. After cleaning out carious masses, a drain is laid in the cavity, whereupon the flap with the thin shell of bone attached is replaced. Since the nutritional bridge is wide, it may lie for some time upon the tampon without danger of necrosis of the bony shell. Even if the bone dries at the edges, after a week or two, when the secondary suture is undertaken, there always remains a sufficiently large piece to cover in by bony growth the deep and extensive wound and induce earlier healing than after any other procedure.

From the circumference of the wound radiating incisions may be made in the soft parts of the head or neck if subperiosteal abscesses have developed in the temporal or occipital region. If pus breaks through at the tip of the mastoid there results a deep cellulitis between the neck muscles. This may be opened also by an incision which runs into the operative incision.

OPENING UP THE MASTOID ANTRUM

The simple operation just described does not suffice if the suppuration, in acute purulent mastoiditis, instead of tending to perforate the hard circumferential layer of the mastoid, progresses into the deeper cells. Then, in addition to opening up the mastoid cells, the mastoid antrum must be laid open in order to reach the seat of infection. The following case may serve as an example of this procedure:

A thirty-two-year-old cook was seized with severe pains in the ear and head. She was rather confused, but was able to tell that for about

Exposure of the mastoid cells.

Fig. 193. Skin incision.

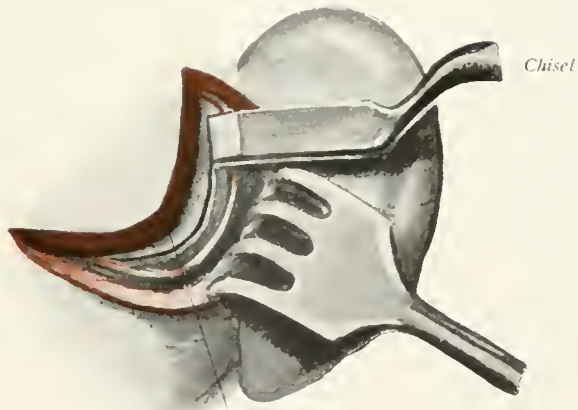

Fig. 194. Chiseling open the cortical bone.

Exposure of the tympanic antrum.

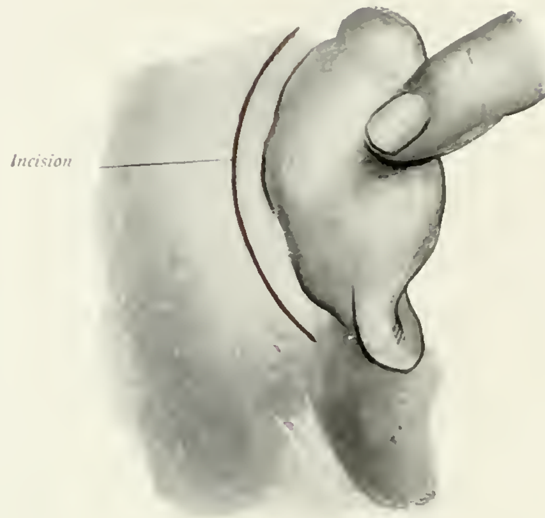

Fig. 196. Skin incision.

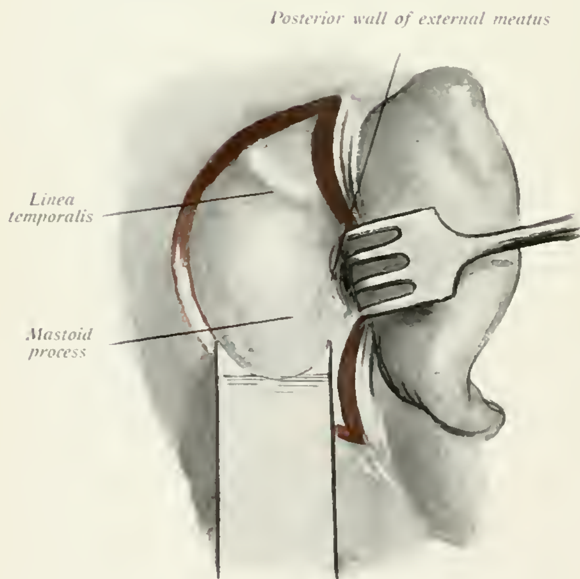

Fig. 197. Chiseling away the cortical bone.

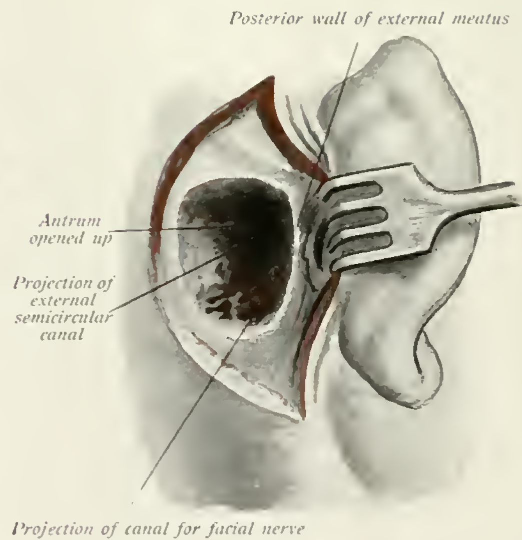

Fig. 198. Exposure of the antrum.

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three weeks she had been under treatment for purulent middle ear disease and that the drum had been incised twice. After the first incision the symptoms had decreased, but the result was not permanent. Her physician sent her to the hospital because the temperature had risen to 102.2 F. in the evening and dizziness and nausea had been present for the past twenty-four hours.

On examination it was found that the right external meatus was much narrowed as a result of swelling of the walls. The attempt to introduce a speculum caused acute pain. Through a small incision there came a little foul-smelling purulent secretion. Palpation of the mastoid and, to a greater degree, tapping with the percussion hammer, particularly in the region of the tip, caused severe pain. Pressure with the finger caused pitting of the swollen skin behind the ear. On account of the poor general condition and the local findings it was decided that immediate opening up of the mastoid cells and of the mastoid antrum was necessary.

The operation was carried out in the half-sitting posture. At the beginning of anesthesia it was determined with a small speculum that the drum was practically completely destroyed and in its place was a pasty, brownish, purulent mass.

A half centimeter behind and parallel to the line of origin of the auricle an incision was made concave forwards 7 cm. in length (Fig. 196, Plate 36). The spurting vessels ceased to bleed as the skin edges were drawn apart with sharp hooks. Pus welled up immediately in considerable quantity in the upper corner of the incision from the temporal bone. Thereupon the incision was prolonged upward so that the subperiosteal abscess could be freely drained. The cortical layer of the mastoid process was removed at once with a chisel (Fig. 197, Plate 36), so that the diploë and the mastoid cells were exposed. In the direction of the tip of the mastoid small areas of suppuration were found in the air cells. The necrosed and softened partition walls were removed with the curette, and with a gouge a smooth-walled bony cavity was created. The posterior wall of the bony auditory canal remained intact in its entire extent (Fig. 198, Plate 36). As drops of pus kept appearing in the depths of the bony funnel thus created, and further necrosis was evident, opening up of the mastoid antrum was indicated.

To reach this the cavity was deepened further by light blows of the gouge. All the strokes of the gouge were made within a triangle formed by lines joining the suprameatal spine, the tubercle of the

supramastoid crest and the tip of the mastoid process (Fig. 195). The edge of the chisel was always directed inwards, upwards and forwards. The chiseling had to be carried out very carefully, since blood continually welled up from the broken-down bony partitions, and as a result the view in the apex of the funnel-shaped opening was rendered difficult. From time to time an attempt was made through pressure with small sponges about the size of a bean, saturated with a solution of suprarenin, to control the bleeding.

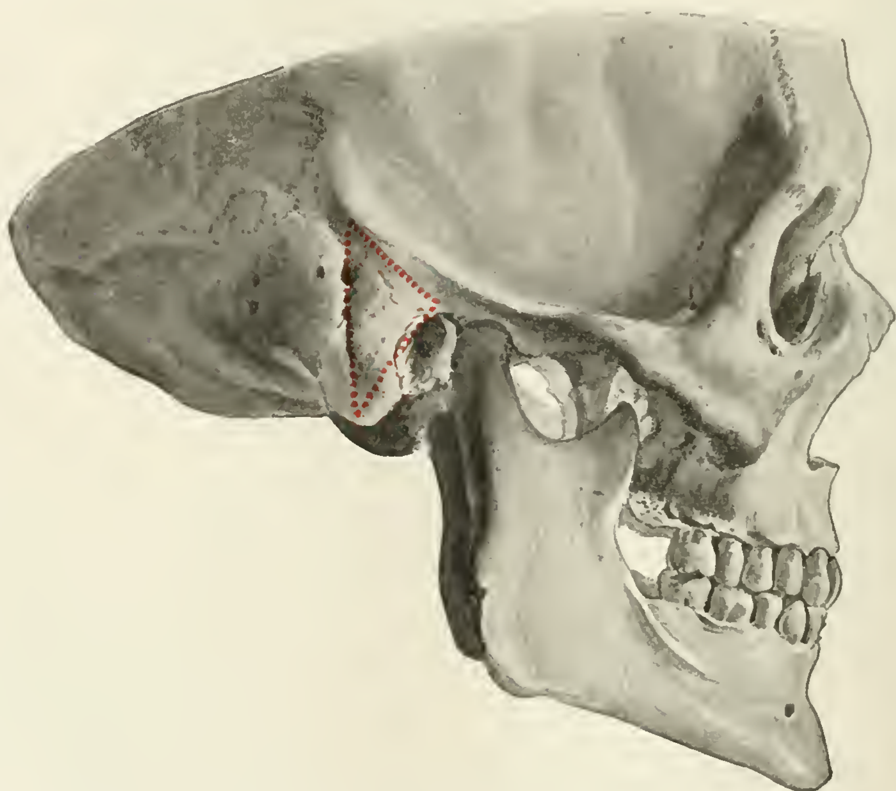

Fig. 195
Area of cortical bone chiseled away in exposure of the tympanic antrum.

At the depth of over 3 cm. the funnel-shaped wound in the bone finally passed over into a large cavity, which by its location corresponded to the mastoid antrum. After cleaning out the slimy, tenacious pus and breaking away the ring-shaped entrance into this cavity, two bony eminences were to be seen, on the floor anteriorly, of which the anterior and lower corresponded to the projection over the facial nerve, and the rather more definitely projecting upper prominence

Radical operation in chronic purulent middle ear disease.

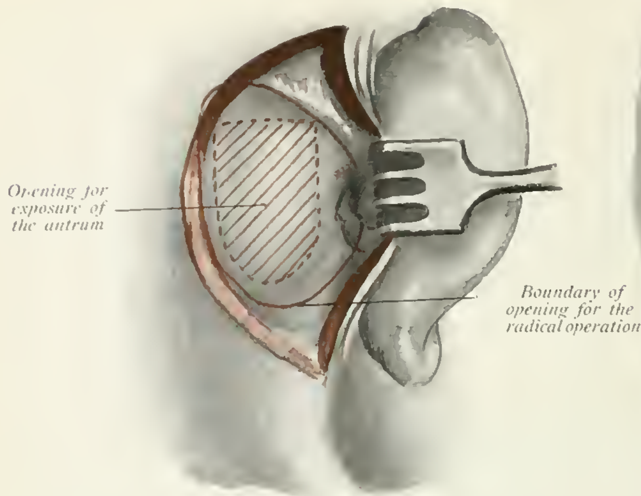

Fig. 199. Area of cortical bone to be chiseled away.

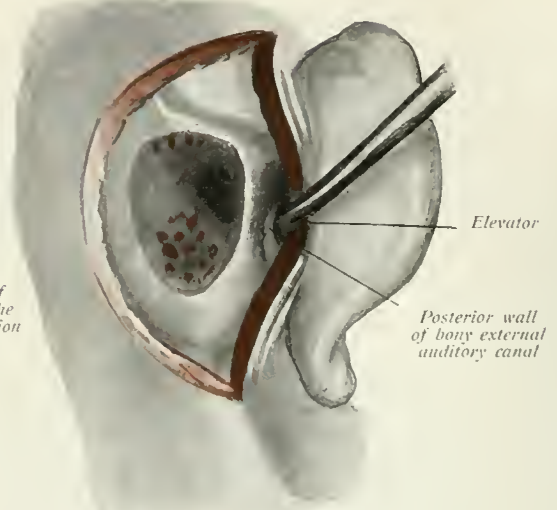

Fig. 200. Prying off the skin lining the bony auditory canal.

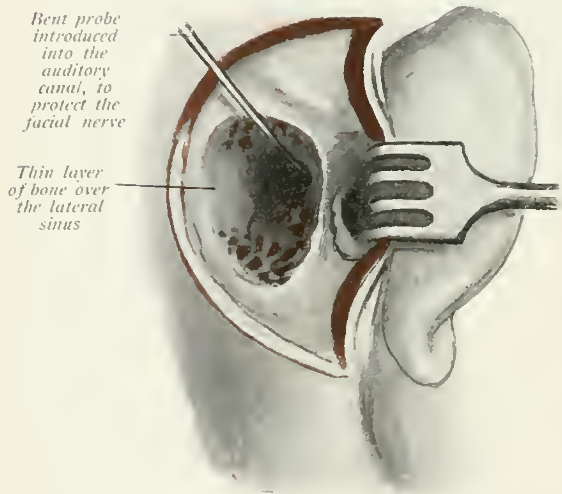

Fig. 201. The facial nerve is avoided.

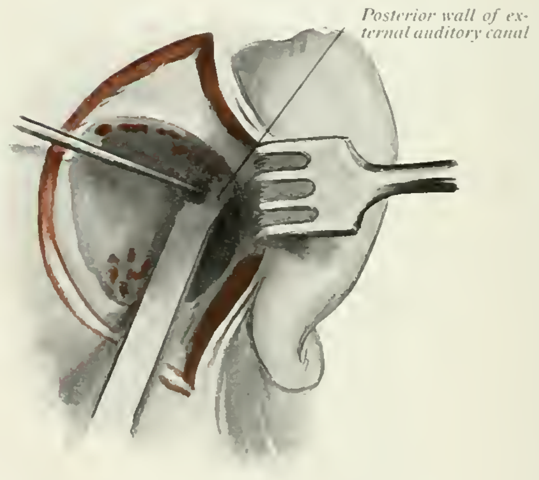

Fig. 202. Chiseling away posterior wall of bony external auditory canal.

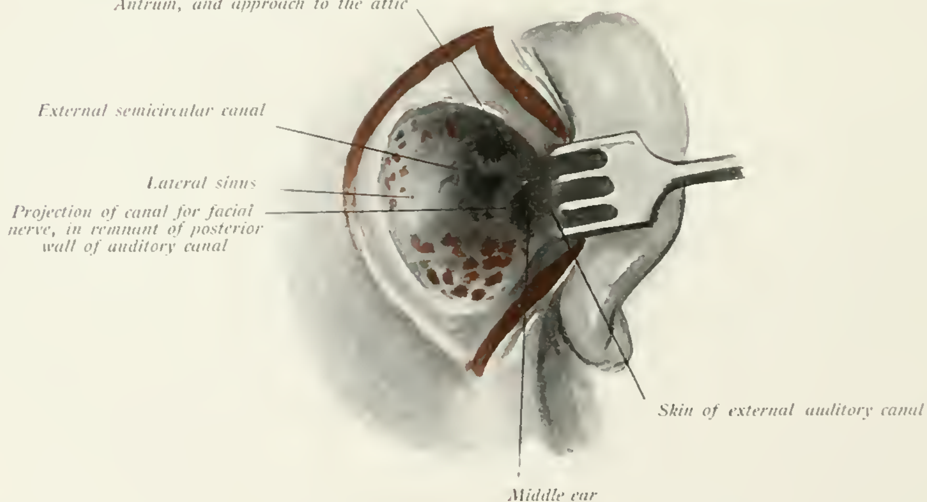

Fig. 203. Wound cavity after radical operation.

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corresponded to the prominence of the lateral semicircular canal (Fig. 198, Plate 36).

Anterior and external there still remained a sharply projecting process, which hindered the view of the passage from the antrum to the middle ear. With a very small chisel this projection, which by its position corresponded with the bony frame of the posterior edge of the drum, was chiseled away. Below, this prominence passed over into the eminence of the canal of the facial nerve. As this was removed, it could be seen that the contents of the middle ear had been transformed into a completely unrecognizable greasy mass. The attempt to find the remnants of the ossicles in this mixture of pus, mucus and necrotic tissue was unsuccessful.

In consideration of the destruction of the contents of the middle ear and drum, as well as the cerebral symptoms, which had appeared after a three-weeks' course of the disease, it appeared necessary to carry out the

RADICAL OPERATION

Since the purpose of this operation is to transform the external auditory canal, the middle ear, the mastoid antrum and the inside of the mastoid process into a single wide wound cavity, as smooth as possible, and opening externally, there remained only the removal of the posterior wall of the auditory canal and a complete opening up of the mastoid process (Fig. 199, Plate 37).

Accordingly the forward edge of the wound, together with the auricle, was pried up from the bony canal with the help of an elevator until the skin lining of the auditory canal tore away within (Fig. 200, Plate 37). The auricle and the portion of the external canal which was torn away with it was next drawn forward, and later in the course of the operation was attached with a few sutures of silk to the anterior wall of the canal.

The bony posterior wall of the canal was removed with a few strokes of the chisel, holding it always directed upward and inward. In order to maintain the direction of the attic and not to endanger the facial nerve, which ran under the floor at the boundary of middle ear and antrum, the technique of Stacke was followed, by which a bent probe was introduced through the antrum and middle ear into the auditory canal (Fig. 201, Plate 37), and on this the blows of the chisel were directed (Fig. 202, Plate 37). Further in, the removal of the posterior wall of the canal was limited to the upper posterior

quadrant, since the facial nerve runs below in the line of the posterior wall.

On the other hand, the upper bony wall was removed freely above until the communication with the antrum and with the attic lay opened up and the probe could be removed. Below this the prominence of the facial nerve completely blocked the vision, and it was removed in small lamellæ with a small, straight chisel, until the anesthetist reported that there was twitching of one side of the face. Finally the strip of bone on the roof of the large cavity (Fig. 203, Plate 37) was levelled off, partly with the curette and partly with very fine rongeurs. In the attic, also, no trace of the ossicles was to be found. Bleeding was stronger on the floor of the cavity than on the roof.

After all bony splinters, inspissated pus and necrotic tabs, as well as the remnant of the drum, were removed by wiping, the bony cavity was packed with iodoform gauze and an occlusive dressing applied. The facial eminence was lightly sponged and carefully packed with gauze in order to avoid injury to the nerve as the result of tearing with bony splinters or through pressure of sponges.

On the day after operation the temperature was normal. The symptoms of septicemia improved rapidly. The superficial layer of the dressing was changed in two days and the gauze packing in the cavity four days later. From that time on the dressing was completely changed every third day. The entire wound covered in rapidly with vascular granulations. The secretion of pus ceased. Two weeks after operation the patient left the bed, and soon the cavity, which was the size of the end of the thumb, began to dermatize rapidly from the edges. The sutures which held the posterior skin wall of the auditory canal to the anterior gradually cut through. The periosteum and skin of the auricle healed to the anterior wall in the following weeks, so that from here also dermatization of the canal spread.

THE PLASTIC PROCEDURE OF PANSE-KÖRNER

When practically the entire wound surface was scarred over, the picture in Fig. 204, Plate 38, presented itself. As not infrequently happens after opening up the antrum, and always after the radical operation, it was necessary to transform the bony funnel which lay open behind the ear by means of a plastic operation into an auditory canal protected by the external ear. For this purpose the Panse-Körner method was chosen.

First the dermatized edges of the funnel were trimmed in the form

Radical mastoid: the Panse-Körner method of plastic closure.

Fig. 204. Bony cavity lined with scartissue.

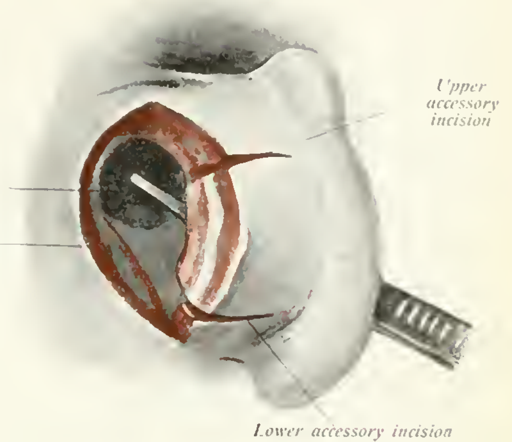

Fig. 205. Freeing up the concha.

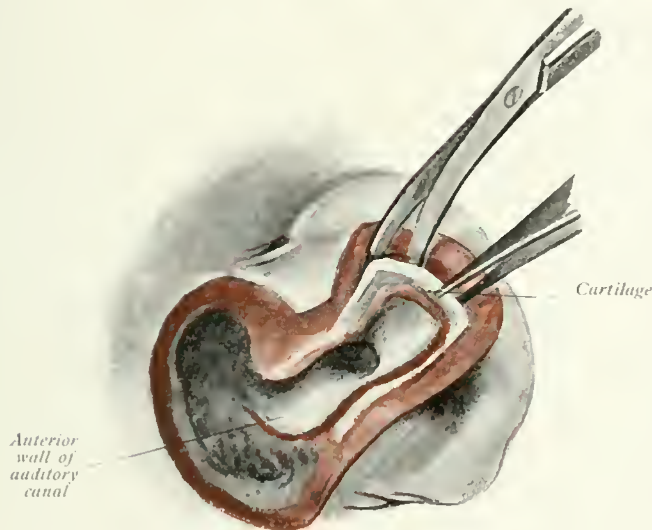

Fig. 206. Freeing up the cartilage.

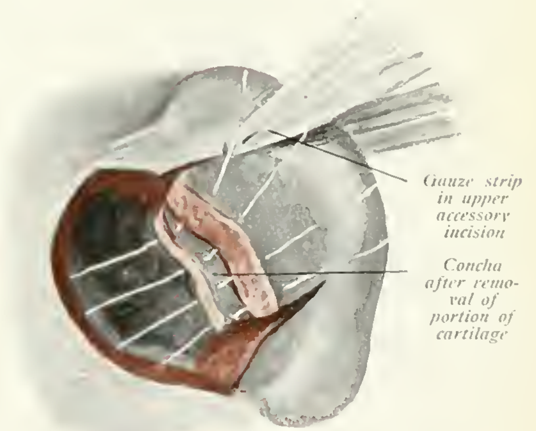

Fig. 207. First sutures applied.

Fig. 208. Sewing concha to posterior wound margin.

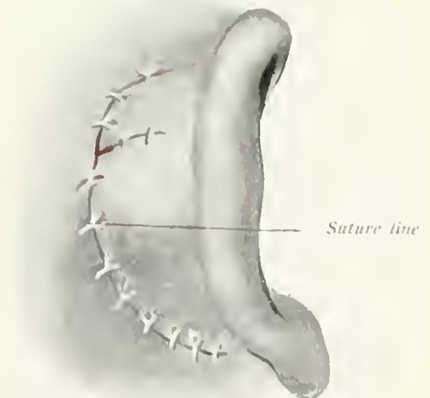

Fig. 209. Completion of suture.

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of an ellipse, and at the posterior circumference of the wound the soft parts were loosened up from the skull. In front the posterior wall of the canal, which had become adherent, was freed up in all of its three layers from the anterior wall, so that a pair of forceps introduced into the meatus was seen in the cavity (Fig. 205, Plate 38). While the posterior wall of the skin of the canal was lifted from the skull, an oblique incision was made through all the layers of the external ear above and below, starting from the freshened edges. Both incisions ran close to the helix above and below in order to give plenty of material for covering the wide bony cavity. Since in the flap thus formed movement was limited to a high degree by the plate of cartilage, this was seized with forceps (Fig. 206, Plate 38), over 1 cm. was exposed and removed with scissors. This allowed the base of the flap to be drawn easily and without tension over to the posterior wall by means of a loop of gauze introduced in the upper accessory incision, and there to be made fast with four interrupted sutures (Fig. 207, Plate 38). In the same way the rest of the mobilized wound edges were sewed together (Fig. 208, Plate 38) until the entire bony cavity was covered with the shell of the ear (Fig. 209, Plate 38). Below the obliquely placed accessory incision was satisfactorily employed for uniting the wound edges, while the upper one was sewed together partially in a horizontal line. Finally, in the external ear, which led directly into the large bony funnel, a strip of vioform gauze was introduced.

Two weeks later the patient was discharged healed. The bony cavity which resulted from the radical operation had to be packed for a considerable time, later through the canal with strips of gauze.

In opening up the mastoid antrum particular difficulties are presented if the mastoid process is converted into a compact mass of bone without means of differentiation between the cortical and the spongy portions. This *eburnization* is the result of chronic inflammation, and in chiseling open such a mastoid neither the narrow space, rich in blood, nor the white-lined pneumatic cells are to be recognized; and as a result all points of departure for the recognition of the facial eminence, the sigmoid sinus, the cranial cavity and of the antrum in chiseling are lost. Also more force must be given to the blows of the chisel than are necessary in the cellular bone.

The passage to the dark antrum may lie high up under and even above the supramastoid crest, and its cavity may be so narrow that from

this point neither the facial eminence nor the prominence of the lateral semicircular canal is to be differentiated. It is better in such cases to make the bony funnel too high rather than too close to the tip of the mastoid process, as opening the middle fossa presents a less danger than injury of the facial nerve in the posterior wall of the middle ear, and at the floor of the antrum.

In the radical operation the facial nerve is in particular danger while the posterior wall of the external canal is being removed. Even if the probe or the facial protector of Stacke is introduced from the antrum to the bony meatus, and all the blows of the chisel are directed to these instruments, the facial may be injured through a fissure made in chiseling, by a bony splinter or by pressure of the forceps which hold the sponge. It is chiefly endangered in its passage from the posterior wall of the canal over to the medial wall of the middle ear.

The sigmoid sinus sometimes deviates from its customary position. While as a rule it runs along the posterior edge of the mastoid process, it may be placed so far to the front in the bony mass of the mastoid as to lie anterior to the middle line of the mastoid, in which case it may readily be injured in chiseling. If this occurs, pressure and packing with a small strip suffice to overcome the bleeding from its injured wall. The operative procedure need not be interrupted.

PHLEBITIS AND THROMBOSIS OF THE SIGMOID SINUS AND LIGATURE OF THE JUGULAR VEIN

Abscesses in the mastoid process always endanger the neighboring large vessels. The infection travels from the mastoid cells to the sigmoid sinus and to the gulf of the internal jugular vein from the floor of the middle ear. Either there results a purulent phlebitis of the wall of the sinus or the formation of a septic thrombus. The thrombosis in the majority of cases remains stationary and only seldom fills the lumen of the sinus completely.

In purulent inflammation of the walls of the sinus first the stream of blood is interrupted within the vessel. Externally the participation of the wall is recognized by the fact that it is covered with a smeary, yellowish layer. The passage of pus organisms through the wall of the vessel may follow readily in this stage and lead to the symptoms of pyemia.

The symptoms of parietal and obstructing thrombosis of the sinus are at first indefinite so long as the clot is limited to only a short stretch of the sinus and it sticks fast to the wall. Only when the

thrombosis progresses to blood vessels in the immediate neighborhood or further removed and if infected portions of the weakened thrombus are torn loose does general pyemia, which is usually fatal, occur.

Therefore, among the symptoms of septic sinus thrombosis the symptoms of pyemia stand first. The obstruction to the passage of blood expresses itself in the filled appearance of the veins of the face and head, in swelling of the skin of the face, particularly the eyelids, and further in paralysis of the cranial nerves, which lie close to the thrombosed vessels or in the sinus cavernosus. These symptoms only exceptionally appear simultaneously, since they depend on the extent of the thrombosis; but for diagnosis and as an indication for operation a single isolated symptom, such as edema of the lids, an isolated nerve paralysis, or a filled vein, or in connection with the findings in the ear and the symptoms of general pyemia, may be a valuable index.

In the further course of the disease one other very characteristic symptom rarely fails. As the result of the advance of phlebitis of the sinus to the jugular vein there occurs a definite tenderness along the vein. The point of greatest tenderness is at the posterior edge of the mastoid process, and it extends sometimes as far as the clavicle. The occiput is usually held immovably upon the shoulder of the affected side and the face is turned to the opposite side. The edematous swelling behind and under the mastoid process, as well as over the upper portion of the jugular vein, may show externally the presence of phlebitis; it may be definite or it may not be present at all, since the deep fascia of the neck and the sterno-mastoid muscle cover the inflamed and infiltrated tissue.

A healthy nineteen-year-old workman was admitted to the surgical section of the Augusta Hospital in a state of coma. Since he himself could give no information, but little could be learned concerning his previous history. For several weeks he had complained of pain in the ears, and the past few days he had frequently vomited in the morning, but he had nevertheless kept at his work until three days preceding entrance. On account of dizziness and severe headache in the morning he could no longer get up. Since then fever and chills lasting more than half an hour had been observed, and finally he had been sent to the hospital by his physician.

It was found that the right side of the neck from the mastoid process to the middle of the sterno-mastoid was markedly swollen. Every attempt to palpate this area for diagnostic purposes was responded to

by the patient, otherwise in a state of somnolence, with active expressions of pain. There existed further painful swelling in the left elbow joint and enlargement of the liver and spleen; the temperature was 104 F. and the pulse rate 140 per minute. No dilatation of the veins of the skin of the neck was visible, but there was tortuosity and injection of the veins of the right retina. The right side of the face moved less than the left.

Examination of the left ear showed nothing abnormal. On the right side the external auditory canal was filled with a brown, pasty secretion, the drum showed a circular hole exactly in the middle, its upper edge was covered with pus and the lower was markedly swollen and hemorrhagic. Nothing was to be seen of the ossicles, but the white light-reflecting surface of the medial wall of the middle ear could be seen. On account of the condition of the patient paralysis of the muscles of the eye could not be determined.

On consideration of these symptoms the diagnosis appeared clear. Starting from an old purulent otitis media, there had developed a purulent phlebitis of the sigmoid sinus and the jugular vein, which, in addition to a local infection of the right side of the neck, had resulted in a general pyemia. In order to prevent further progress of the pyemia so far as possible in a patient whose life appeared to be in the gravest danger, it was decided that the sigmoid sinus should be exposed and the jugular vein ligated.

Under light ether anesthesia the skin and periosteum over the mastoid process were divided ½ cm. behind and parallel to the furrow of the concha, and drawn apart with retractors. Departing from the customary procedure in opening up the antrum, the mastoid process was opened wide and further back than usual, and direct approach was made to the sigmoid sinus. The use of the hammer and chisel was avoided because of the danger that with each jar new pieces of septic clot would be set loose in the vein. For that reason trephining of the mastoid was carried out with the burr (for the technique see chapter on Surgery of the Brain), and the bone was broken out from the edge of the drill hole with rongeurs.

The exposed sinus was yellow and covered with fibrin and pus. This layer could be removed with forceps. Also under it the wall of the sinus was discolored, but blood must have flowed in its lumen, since it filled and emptied itself regularly with respiration. To be sure it was not under normal tension, but on careful palpation nowhere could

Thrombophlebitis of the lateral sinus, and ligature of the internal jugular vein.

Fibrino-purulent layer

Knee of sinus

Dura mater of the cerebellum

Squamous portion of occipital bone

Lymph node

Lymph node

Fig. 210. Exposure of the lateral sinus and the great vessels of the neck.

Internal jugular vein

Common facial vein

Carotid artery

Vagus nerve

Double ligature

Fig. 211. Ligation of the jugular vein and its branches.

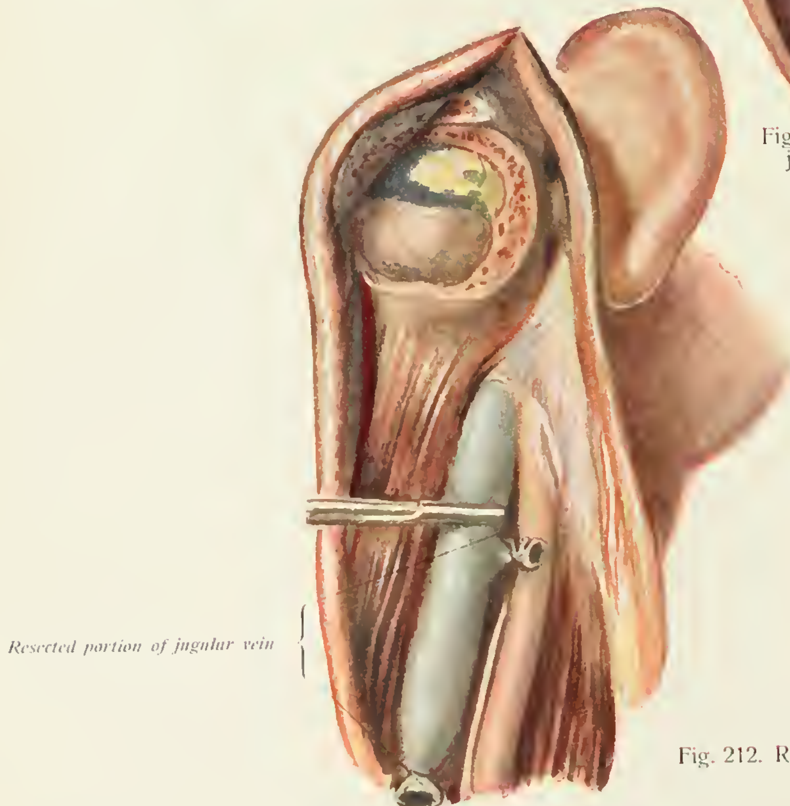

Fig. 212. Resection of jugular vein.

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thrombi be felt. Also the sinus could apparently be emptied in both directions.

Further exposure of the sigmoid sinus, or even of the gulf of the jugular vein, as well as any radical operation, had to be given up on account of the bad condition of the patient. But in order at least to remove the source of the pyemic infection, in addition to the exposure of the sinus, the common jugular vein had to be ligated.

For this purpose the incision behind the ear was lengthened downwards over the anterior border of the sterno-mastoid to near the clavicle. The fascia of the muscle was split at its anterior edge and the sheath containing the blood vessels and lymph glands was opened. As the muscle was drawn backward there came into sight swollen lymph nodes as long as the phalanx of the finger, embedded in brawny edema (Fig. 210, Plate 39). These were the cause of the painful infiltration of the neck. After splitting the sheath, it was seized with forceps and removed, the internal jugular vein was exposed, double tied and divided in the lower end of the wound (Fig. 211, Plate 39). The common facial vein and a series of small branches were divided after double ligature and a piece of the internal jugular vein 6 cm. long (Fig. 212, Plate 39) was resected. The exposed surface of the dura and the wound over the vessels was packed with iodoform gauze and the edges of the skin were loosely united over the gauze by three sutures.

In spite of the short and very superficial ether anesthesia, the patient collapsed at the end of operation. After the operation no more chills appeared, and the fever remained moderate. On account of the increase in pulse rate and persisting disturbance of consciousness, the prognosis, however, appeared hopeless. On the second day after operation the patient died.

From the autopsy protocol (Professor Ostreich) it appears that a purulent thrombosis was found in the right transverse sinus. The wall of the vessel was three times as thick as normal, was discolored and infiltrated with pus. The brain substance was injected, but without foci. The wall of the jugular vein was thickened. Below the point of ligation in the neck the large veins were free of thrombi. There were present also septic infarcts in the lungs, fibrinous deposits in the pleura, softening of the cardiac muscle and septic enlargement of the spleen, as well as fatty degeneration of the liver and kidneys.

If the patient had come to operation in better condition, radical

operation on the ear and exposure of the transverse sinus would necessarily have followed trephining of the mastoid and ligature of the internal jugular vein. If one finds in a similar case that the sinus is plugged by infected thrombi, its walls should be opened and the thrombus removed. Bleeding from the sinus after opening may easily be controlled by introducing a narrow strip of gauze, impregnated with iodoform on account of the sepsis, and allowing it to remain for about seven days. After this time innocuous clot formation is apt to put a stop to further bleeding.

The complication of purulent middle ear disease with disease of the brain and its envelopes will be considered in a special section.

CHAPTER 11—SURGERY OF THE NOSE AND THE ACCESSORY SINUSES

INJURIES OF THE NOSE

may be dangerous if combined with profuse bleeding from the mucous membrane or if wound infection occurs in the tortuous nasal passages. Practically all fractures of the nasal bones result from direct violence and the majority are complicated with wounds of the mucous membrane lining. In every case of fracture of the nose, in addition to the control of hemorrhage and prevention of infection, the threatened facial disfigurement above all things demands surgical intervention.

Usually simple packing of the nasal cavity with iodoform gauze suffices to stop bleeding, and infection in compound fractures is best guarded against by such procedure. In order not to completely obstruct nasal breathing after packing of the nasal cavity with gauze, a small but stiff-walled rubber tube should be introduced at the same time as far as the naso-pharynx.

Iodoform gauze is to be recommended for this purpose over plain sterile gauze because it may remain in place for several days without decomposition taking place. The gauze should always be used in the form of tape, for a packing composed of several tapes may be removed much more readily than a single strip. The packing should, however, not be allowed to stay in too long, as we have seen meningitis develop four days after an apparently mild injury for which the nose was packed, and on withdrawing the packing free pus followed, which apparently had been retained under pressure. Autopsy showed a fissure fracture of the ethmoid.

Markedly dislocated fragments which projected freely into the nasal cavity should be removed at once, for they often become necrotic, and if they are allowed to come away of themselves as sequestra the process is slow and often accompanied by disturbing symptoms of inflammation in the anterior portion of the nose.

Cracks in the bony wall and fresh *deviations of the septum* as a result of injuries are corrected at once by packing. For the hematoma which results from fractures, and at times also the subcutaneous emphysema, immediately renders difficult the view within the nose. While at first the displaced fragments may be replaced readily, later

on this is impossible. Accordingly, many nasal fractures heal with permanent disfigurement. Improvement can then be offered by subcutaneous osteotomy with the help of fat or bone transplantation, as has been shown in the section on plastics of the cheek and nose (see pp. 105 and 139).

Spontaneous bleeding from the nose results from small ectactic veins, and less frequently arteries, which are situated in the lower anterior section of the mucous membrane of the septum, the so-called Kesselbach's spot.

In order to stop the bleeding it usually suffices to press the alæ of the nose together for several minutes between thumb and forefinger. If this does not control it the nasal cavity should be packed from in front with gauze, which may be saturated with a mild solution of suprarenin. If this treatment does not succeed, the nose must be packed from behind, particularly if the blood, without appearing in the nasal orifices, runs down the wall of the pharynx. The packing is inserted through the mouth into the naso-pharynx by means of a Bellocque cannula, or better still, a soft rubber catheter. The catheter is passed along the floor of the nose until its end appears projecting below the soft palate, when it is seized, brought forward through the mouth and the gauze strip is attached to it by a string of silk and drawn back into the naso-pharynx and the posterior nasal orifice. The plug should be of such size that it will not wedge in between the velum and the pharyngeal wall, but will be drawn into the posterior nasal orifice and plug it effectively. The silk cord is made fast to the cheek with a strip of adhesive plaster. After the posterior packing is applied, the anterior nares is packed so as to completely fill the nasal fossa. Iodoform gauze may remain in for a week or more; other packing should be changed earlier, not later than forty-eight hours, because it may decompose and become a source of danger to the patient. Removal of the packing is rendered less difficult if it is previously softened thoroughly by soaking with oil or liquid albolin.

In order to prevent return of the epistaxis, it is recommended to cauterize the bleeding point on the septum or on the turbinate with a galvano-cautery, the Pacquelin cautery, or by means of chemical agents, such as silver nitrate or trichloracetic acid, and in this way induce scarring of the vessels which are inclined to bleed. It is necessary to first dry the bleeding point as thoroughly as possible and have the cauterant agent ready to apply immediately upon withdrawal of

the pressure sponge. The neighboring portions of the nasal orifice should be protected from burning by a speculum.

Death following epistaxis is not uncommon. We have recently seen two patients who in spite of the fact that the bleeding was controlled through posterior and anterior packing, died a few days after admission to the hospital from anemia and exhaustion.

INFLAMMATORY DISEASES OF THE ACCESSORY SINUSES

The source of inflammatory disease of the accessory sinuses is acute and chronic rhinitis, which extends along the mucous membrane lining the open passages which lead from the nose to the sinuses. Of these, the duct of the frontal sinus opens anteriorly below the middle turbinate in the hiatus semilunaris. Somewhat posterior is the orifice of a second canal which leads to the antrum. Between the two projects the largest of the anterior ethmoid cells, the bulla ethmoidalis. Both cavities are easy to probe through the middle meatus after some practice, and to irrigate for therapeutic purposes by means of cannulæ. The passage to the sphenoid cells is more difficult to reach; it opens in common with the posterior cells of the ethmoid in the upper meatus below the superior turbinate. The Eustachian tube opens in the naso-pharynx at the end of the lower meatus, connecting the naso-pharynx with the middle ear.

Simple, acute or chronic sero-catarrhal inflammation of a sinus may disappear like the same affection in the nose without permanent disturbance; in the same way acute purulent inflammations may often be overcome without special surgical procedure. Fever, dull pain in the jaw and forehead, neuralgic pains in the region of the supra- and infra-orbital nerves, as well as nasal speech and the appearance of purulent secretion, are the principal symptoms which denote that the sinuses are involved. The pain is apt to increase in severity on sneezing and coughing. Chronic inflammation is evidenced also by the long course of the disease, and particularly by fluctuations in the symptoms. Thus the symptoms decrease if the swelling of the mucous membrane in the orifice of the canals diminishes and the pus is allowed to drain away into the nose or pharynx. The disagreeable odor and the taste of pus is then found to be very unpleasant by the patient. In the interval asthmatic conditions not unusually appear. Progression of purulent inflammation to the orbit, or even to the interior of the skull, presents in acute as well as chronic suppuration of the sinuses a dreaded but infrequent complication.

Diagnosis of suppuration of a sinus is not difficult to make if one finds pus in the middle meatus through the speculum. Here the secretion empties itself from the frontal sinus, the antrum, and from the anterior cells of the ethmoid. As suppuration of the anterior cells of the ethmoid without the posterior is practically never observed, the antrum and the frontal sinus are usually the source of the pus. If the chronic purulent inflammation is limited to the ethmoid, in addition to the secretion under the middle meatus one will be able to see pus flow from the upper meatus by means of posterior rhinoscopy. Chronic suppuration seldom occurs here alone. As a rule it is combined with the same disease of other cavities. In the same way a primary and isolated abscess in the antrum without involvement of other sinuses is practically never observed. The presence of disease of the sphenoid may be determined by finding secretion from the posterior cells of the ethmoid with the aid of posterior rhinoscopy.

In the *differential diagnosis* between suppuration of the frontal sinus and of the antrum of Highmore, no great weight can be laid upon the statements of the patient, for the symptoms of the two affections may be very similar. Particularly spontaneous frontal headache and neuralgic symptoms in the first and second divisions of the trifacial are observed without distinction in disease of either sinus.

The most reliable means for diagnosis with reference to the seat of suppuration is irrigation of the two cavities through the middle meatus. If the cannula with an S curve cannot be introduced, the anterior portion of the middle turbinate may be removed under local anesthesia, so as to expose the ducts of the antrum and of the frontal sinus. As the result of the local anemia which follows cocaine anesthesia and the removal of the remnants of secretion and of dried crusts, pus usually appears at one or the other orifice; but that cavity alone is diseased from which pus flakes or clots may be washed out, and from which after irrigation no more pus appears. To confirm the diagnosis, oral transillumination is of service. If an electric lamp is introduced into the mouth in a dark room, the normal frontal sinus and antrum are distinguished from their surroundings by a rosy illuminated area, while in case of inflammation of the lining membrane, or, to a greater degree, in the presence of suppuration, the light rays are obstructed and the opacity in comparison with the unaffected sinus is striking. Fluoroscopic examination shows a shadow on the affected side, and

should be employed in doubtful cases for further support of the diagnosis.

OPERATIONS ON THE ANTRUM

Of all the accessory sinuses of the nose, the cavity of the upper jaw, the antrum of Highmore, is most frequently affected. This is explained partly by the unfavorable situation of its duct, which does not originate, as in the frontal sinus, at the lowest point of the cavity, but is situated in the wall at a place which is comparatively high. In the upright position a considerable amount of secretion may collect in the antrum before the surface reaches the level of the exit. The frequency of empyema of the antrum is increased by the fact that it results not only from inflammatory affections of the nose, but also from carious teeth.

OPENING A SINGLE ANTRUM

While acute suppuration of the antrum usually disappears under local applications and irrigation, chronic inflammation demands operative exposure of the cavity, removal of the diseased mucous membrane and the institution of favorable drainage. The longer the disease lasts, the smaller is the outlook for cure without operation.

According to the method of Küster, the antrum may be opened through the canine fossa of the alveolar process, the mucous membrane of the mouth and the periosteum being divided transversely or from above downward, and the anterior wall of the antrum drilled and removed. It is of advantage to enlarge the exit into the nose from within the cavity, in order to procure favorable conditions of drainage. This is done by the method of Cadwell-Luc, by which dressing forceps are passed from the antrum through the lateral wall of the nose into the nasal cavity, and the bony partition is removed down to the palatal process. Resection of the lower and anterior portions of the middle turbinate should not be omitted. The following observation may serve as an example of the operation for *unilateral empyema of the antrum:*

A very deaf sixty-year-old woman stated that for fifteen years she had suffered from headaches, which were focused in the forehead above the right eye. At first the pain came infrequently, then it came as often as every eight days, particularly in the evening, and lasted until midnight. She felt as if a nail with a large head were sticking in her skull. On the same side there were disturbances in hearing, roaring

and ringing in the ear. The attacks at first were unbearable, but later increased markedly in intensity and duration until her physician suspected brain tumor. But on examination no signs of this were found. On the other hand, the X-ray demonstrated a shadow over the right antrum, and transillumination in a dark room showed that all the accessory sinuses were transparent except the antrum; accordingly, although the statement of the patient pointed toward the frontal sinus, the right antrum was opened.

A large sponge was packed in the right lower cheek pouch and a strip in the right posterior nasal orifice. The right upper lip being retracted upward and the corner of the mouth outward (Fig. 213, Plate 40), incision was made through mucous membrane and periosteum at the top of the canine tooth parallel to the edge of the gum down to bone, so that a strip of mucous membrane of the gum about 1 cm. wide remained. Mucous membrane and periosteum were stripped upwards with the raspatory until the anterior wall of the antrum was exposed from incisors to the first molar. Thereupon opening was made with a gouge and enlarged with rongeurs until the index finger could be inserted comfortably. Upon opening the mucous membrane a polyp-like formation projected which had to be removed with a curette (Fig. 213, Plate 40). The opening in the anterior wall was large enough to introduce the curette alongside the index finger and to remove completely the hyperplastic mucous membrane lining the cavity. Meanwhile there flowed out a tenacious muco-purulent fluid.

With the left index finger in the antrum, a strong curved dressing forceps was shoved through the partition wall from the right middle meatus (Fig. 214, Plate 40). In order to establish wide communication between the nasal cavity and the antrum, the projecting margins of bone were removed with chisel and rongeurs, as well as the lower and middle turbinates. The irregularities of the floor of the antrum were leveled off with a gouge (Fig. 215, Plate 40) until the index finger could enter the nasal cavity through the antrum without hindrance. After the antrum had been freed of the thickened inflammatory mucous membrane and all the pockets and hollows were disposed of, it was packed tight with an iodoform strip, the end of which was carried through the wide passage to the nose, and out the nasal orifice. Periosteum and mucous membrane were united over the canine fossa with four interrupted sutures (Fig. 216, Plate 40) in order again to close off antrum from mouth. The packing was removed through the nose on the fourth day. From the day of operation the patient's

Opening of the Antrum of Highmore.

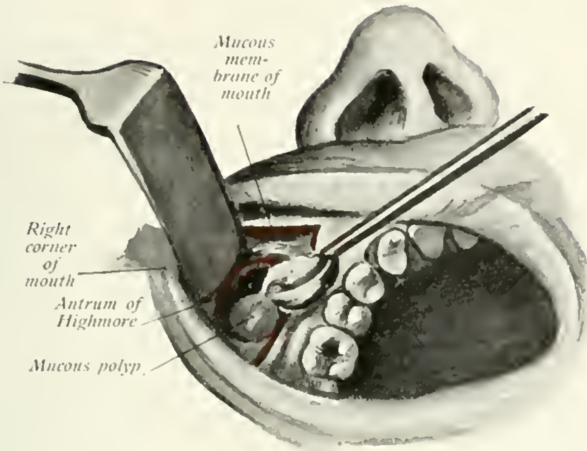

Fig. 213. Removal of mucous polyp with curette.

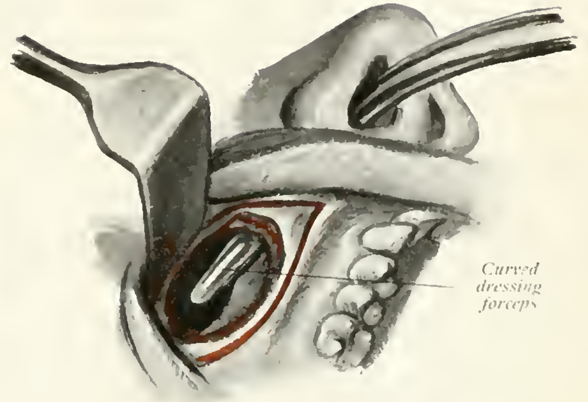

Fig. 214. The lateral wall of the nasal cavity is broken through by forceps introduced through nose.

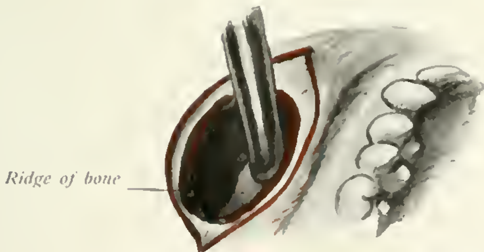

Fig. 215. Smoothing out the uneveness of the interior of the cavity.

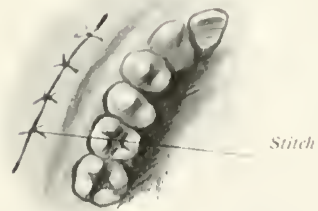

Fig. 216. Muco-periosteal suture.

Radical operation for double empyema of the antrum, after the method of Partsch.

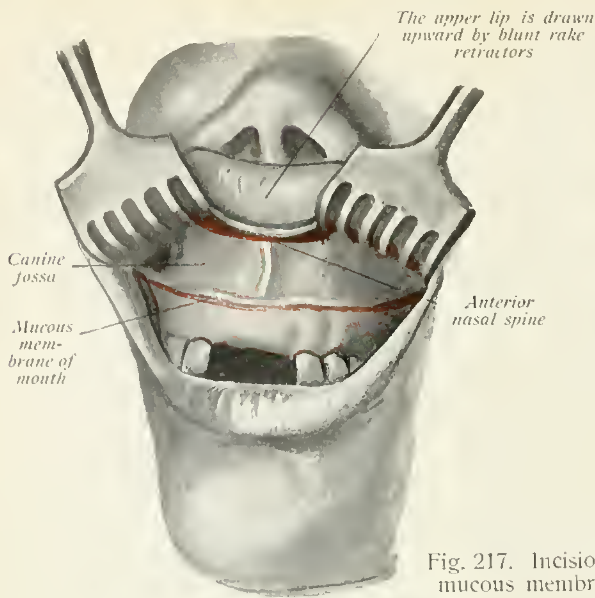

Fig. 217. Incision of mucous membrane.

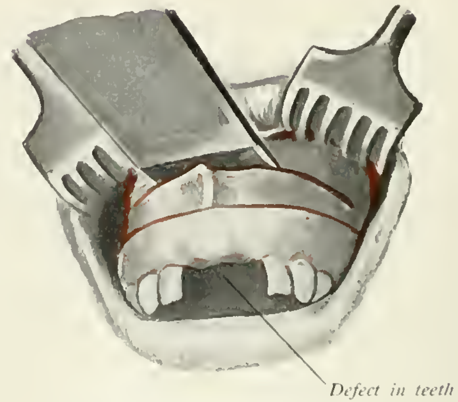

Fig. 218. Chiseling through the bony nasal septum.

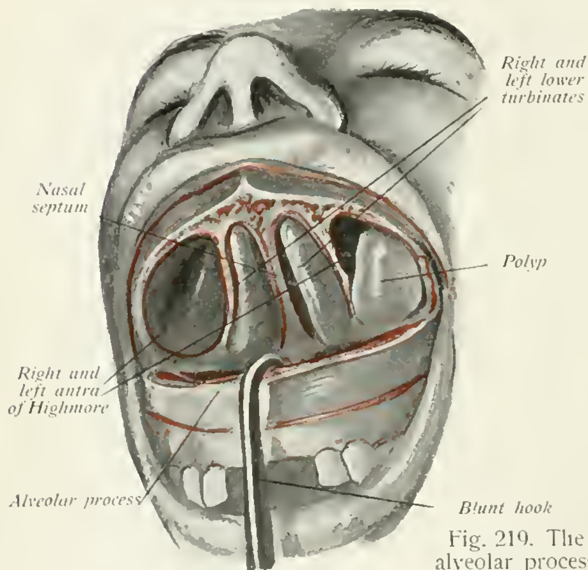

Fig. 219. The alveolar process, chiseled free, is drawn bown by hook.

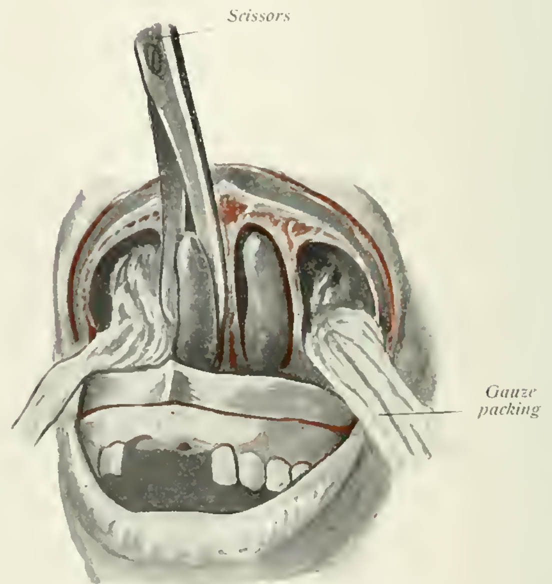

Fig. 220. Resection of right lower turbinate.

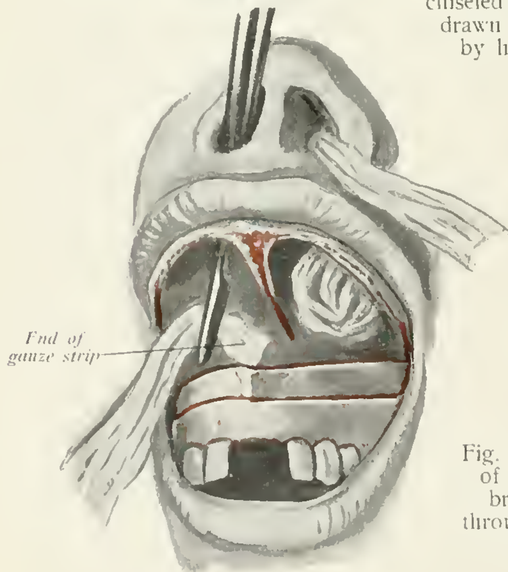

Fig. 221. The end of the strip is brought out through the nasal orifice.

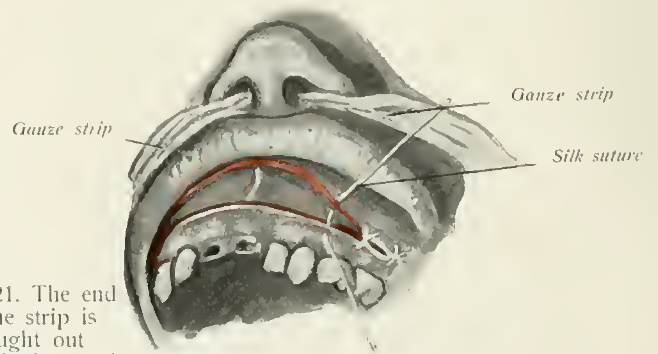

Fig. 222. Muco-periosteal suture.

temperature was normal, and, as she complained of no symptoms, she was discharged two weeks later.

OPENING UP BOTH ANTRA AFTER THE METHOD OF PARTSCH

In empyema of both antra, in case of large polyps in the lower meatus, in bone cysts and malignant tumors of the antrum, opening up of both antra simultaneously may be necessary for a satisfactory inspection. The following case demonstrates this procedure, following the technique of Partsch. The magnitude of the operation is to be balanced against the assurance which it offers that all of the affected tissue may be removed. In spite of the extensive separation of bone, healing results without external scar or deformity.

A twenty-year-old girl suffered for several years in spite of protracted treatment by specialists with double empyema of the antrum, which caused severe symptoms, particularly headache, asthmatic attacks and frequent nausea. In order to relieve her symptoms it was decided to open up both antra. The operation was carried out with the patient in the half-sitting posture; the back was elevated by a thick roll and the head bent over backwards.

After the upper lip was lifted out of the way with a dull rake retractor, the mucous membrane was divided transversely exactly at the point of transition of lip and gum (Fig. 217, Plate 41). The anterior wall of the superior maxilla was chiselled through from before backwards with a wide chisel just above the spine of the nose, and the bony incision was lengthened at each side as far as the pterygoid process. In the same way the bony septum of the nose was separated by chiselling from the spine backward (Fig. 218, Plate 41). The alveolar process with the bony palate, which was separated from the rest of the maxilla, was pried down with the chisel and held downward with a blunt hook (Fig. 219, Plate 41).

The bleeding which resulted from this procedure was controlled by packing the antra, now readily accessible, with strips of gauze. In the left antrum was found a large polyp, which was seized at its pedicle and twisted away; the entire mucous lining of this cavity was removed with the curette and the cavity was repacked with vioform gauze. In the right antrum no polyp was found, but the mucous membrane showed marked inflammatory thickening and was covered with a layer of pus, so that it also had to be removed with the curette. This antrum was likewise packed with vioform gauze. In order to create a wide communication between each antrum and the nose, both

congested lower turbinates were removed with scissors (Fig. 220, Plate 41), and at the same time the lateral walls of the nose, which contained the passage from the antrum to the nose, were removed with chisel and bone forceps.

After all the irregularities and pockets of both antra, particularly on the floor, were freed of inflammatory mucous membrane by means of a curette, each was packed with a vioform strip, the tip of which was carried through the opening in the lateral nasal wall and out through the corresponding nasal orifice (Fig. 221, Plate 41).

Finally the separated palatal plate was replaced in its original position, considerable pressure being exercised in order to control the bleeding. When the bleeding ceased, mucous membrane and periosteum were united with eight interrupted sutures of silk (Fig. 222, Plate 41). Since in this case both middle incisors were wanting, at this place the bony alveolar process could be included in two of the sutures.

On the second day after operation, withdrawal of packing was begun, and by five days later removal from both nasal cavities was completed. For several days thereafter a sanguinolent secretion came away through the nose; but this disappeared after a few irrigations with warm boric acid solution. The sense of pressure which was complained of at first in the upper jaw disappeared after about two weeks. The patient has remained without symptoms since operation.

OPENING UP THE FRONTAL SINUS

Empyema of the frontal sinus is not observed as frequently as empyema of the antrum. This is explained by the fact that the drainage of the frontal sinus is carried out under more favorable conditions than that of the antrum, for its duct leads from the deepest point of the sinus downwards in a straight line into the nasal cavity.

Indication for surgical treatment may exist if as a result of the closure of this canal retention of pus calls forth threatening symptoms. As such in acute cases, outside of the high fever which usually occurs with the empyema following infectious diseases, and especially after influenza, occurs intense headache, and in very rare cases extension of the suppuration to neighboring parts. This last complication may lead to purulent meningitis or cellulitis of the orbit. Although both these are rare sequelæ of acute empyema, nevertheless they should be particularly feared on account of their usually fatal termination.

Chronic suppuration of the frontal sinus is ordinarily indicated by a

periodical lighting up. It may run for a month or more without symptoms, but the symptoms reappear with great severity if as result of a transitory coryza or mild sore throat the mucous membrane of the duct swells up and drainage of the secretions is interfered with. Then the same symptoms appear as in acute empyema. The diagnosis may be made in the interim only by finding pus in the middle meatus. But at the same time fever, spontaneous headache, and particularly neuralgia of the first or second trifacial branches, and diffuse edema of the root of the nose may serve as guides to the site of disease. All these symptoms are apt to increase in severity on sneezing or coughing, or after overindulgence in alcohol. The statement of the patient as to the seat of the spontaneous headache may lead to mistaken conclusions, so frontal headache may frequently exist in empyema of the antrum. In doubtful cases the diagnosis may be determined by means of a shadow in the X-ray picture or opacity in the affected cavity on oral transillumination.

TREPHINING THE ANTERIOR WALL OF THE FRONTAL SINUS

If in fresh disease of the sinus the attempt to pass a probe through the duct and to irrigate the cavity is unsuccessful, even if the middle meatus is cocainized or the middle turbinate removed, as the simplest and safest means to give exit to the pus, trephining of the frontal sinus must be performed. The proper incision for this purpose from the cosmetic point of view is one placed in the middle of the medial half of the eyebrow. In order to create better drainage from the frontal sinus, after the anterior wall has been removed sufficiently with rongeurs introduced in the trephine hole, a dressing forceps which is bent anteriorly is pushed down through into the nasal cavity in the neighborhood of the naso-frontal duct, and a rubber drain is seized and pulled back through the nose.

The removal of the mucous membrane from all pockets and irregularities of the sinus with the curette is possible only after the anterior wall has been removed in sufficient extent. As a result a flattening of the operated side of the forehead is noticeable after healing, and if operation has been done on both sides, there results a considerable deformity. For that reason extensive resection of the anterior wall is no longer carried out in this form, but it has been replaced by the radical operation of Killian, by which a bridge of bone is left to support the arch of the brow. In acute empyema of the frontal sinus, which requires drainage for the retained pus, simple trephining with-

out extensive removal of bone through an incision in the eyebrow suffices; in chronic empyema in which careful cleaning out of the mucous lining and a leveling of all unevenness within the cavity is decidedly necessary, the radical operation of Killian, as is shown by the following observation, presents the most assured technique:

THE RADICAL OPERATION OF KILLIAN

A thirty-one-year-old patient when seven years old received a blow on the right side of the forehead to which he refers his trouble. Soon after throbbing pain appeared in the region of the forehead over the right eye. He was disposed, since childhood, to stubborn and recurrent coryza. With intermissions, this condition over the right eye continued in spite of internal medication, and local alcohol injections, so that four years before the right supraorbital nerve was resected elsewhere. After operation the pains returned.

On entrance to the hospital X-rays showed the right frontal sinus considerably larger and more opaque than the left. Moreover, in the right middle meatus was found a thin, slimy secretion, which, after diagnostic irrigation, was determined to come from the affected frontal sinus. Accordingly all the symptoms were referred to suppuration of the frontal sinus. In order to induce a radical cure in the patient, who was psychically depressed from his long suffering, it was decided to do the Killian operation.

A skin incision was made through the shaved eyebrow, and was continued somewhat inwards and downwards upon the dorsum of the nose. It corresponded in part to the earlier incision for the resection of the nerve. The upper edge was retracted (Fig. 223, Plate 42) and the periosteum divided transversely about five or six mm. above the supraorbital margin; the lower edge was likewise retracted, and the periosteum was incised below exactly at the bony edge of the orbit, so that a small strip of bone which corresponded to the superciliary ridge remained covered with periosteum. The bleeding could be completely controlled by tension on the retractors. The periosteum was then stripped upwards from the superior incision and downwards from the inferior for a considerable extent, laying bare the frontal and orbital walls of the sinus (Fig. 223, Plate 42).

A half centimeter outside the middle line the frontal sinus was opened with a small burr drill, which showed a considerable thickened wall. By probing it was determined that the sinus passed for a considerable distance beyond the outer wall of the orbit. In order to

Radical operation for infection of the frontal sinus, after Killian.

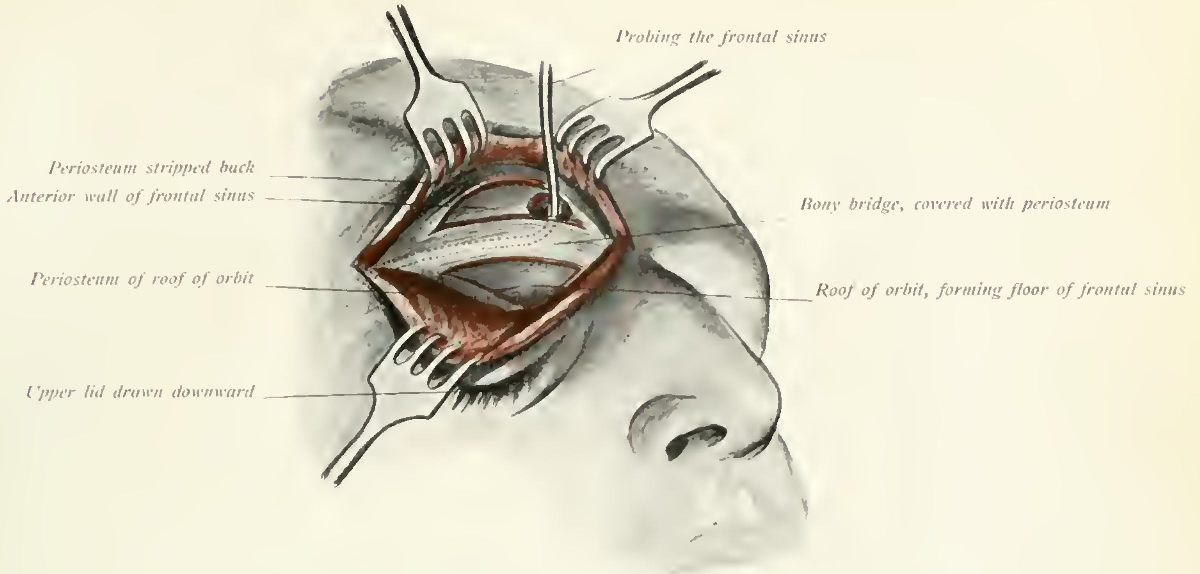

Fig. 223. Exposure of anterior and orbital walls of frontal sinus; probing the cavity through a drill hole.

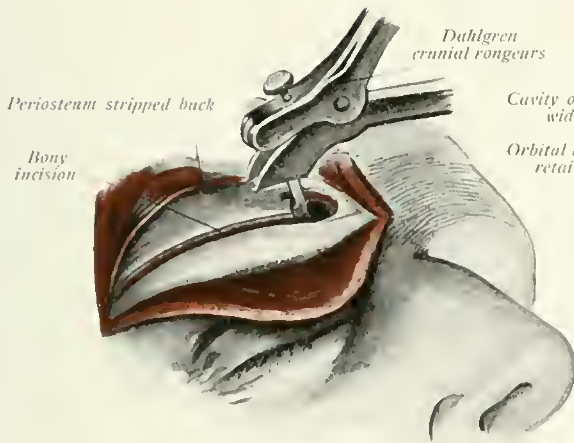

Fig. 224. Cutting out the anterior wall.

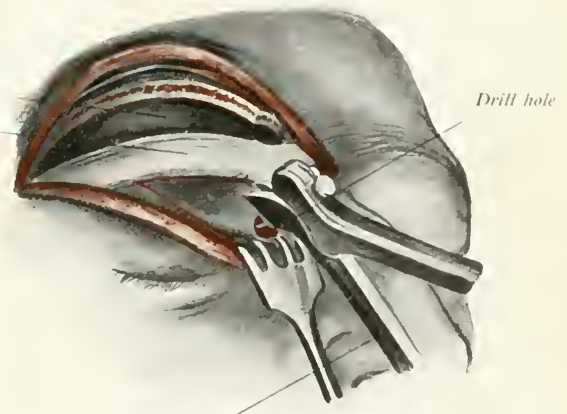

Fig. 225. Resection of orbital wall of frontal sinus.

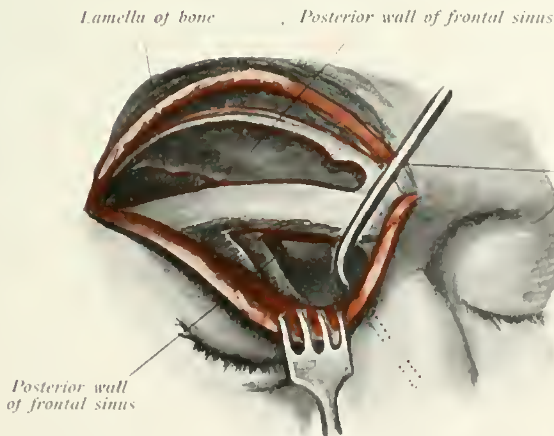

Fig. 226. Communication etablished with nasal cavity.

Fig. 227. Scar after 3 weeks.

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open it wide, the frontal wall was divided exactly in the line of the upper periosteal incision by means of cranial rongeurs (Fig. 224, Plate 42). Medially this was successful without lengthening the skin incision; externally the upper periosteal incision had to be lengthened for several cm. in a horizontal direction until a piece of bone fully 1 cm. across of a lengthened oval shape representing the entire frontal wall was removed (Fig. 225, Plate 42). Thereupon the mucous membrane of the sinus could be easily investigated; it showed the changes of chronic inflammation and appeared like a thick white membrane. In the attempt to remove it by sponging the unusually thin posterior bony wall broke through in several places. The same thing happened when the mucous membrane was being removed with the curette from the medial wall and the orbital surface.

While the mucous membrane in the lateral half of the sinus was being removed, it was found that the paper-thin lamelæ of bone comprised the anterior wall of a second cavity 2 cm. deep by 4 cm. wide, which lay externally and posteriorly. After this partition was completely broken away with forceps another third cavity of about half the size was found medially in the direction of the sphenoid.

After removal of the mucous membrane and bony septa, the cavity was packed with 10 per cent. iodoform gauze and the removal of the orbital wall was begun. Here also the burr drill and the cranial rongeurs were employed (Fig. 225, Plate 42).

The enlargement of the bony orifice on the floor of the sinus and its extension to the lateral nasal wall was carried out with the rongeurs, by which procedure the ethmoid cells were simultaneously opened. Here the mucous membrane appeared similar to that of the frontal sinus, and it was removed, together with the middle turbinate, so far as was possible, through the lateral opening. Thus a wide communication was established between frontal sinus and nasal cavity, and a dressing forceps could now be introduced without difficulty through the nasal orifice (Fig. 226, Plate 42) to draw up a drainage tube. The tube was left together with a drainage strip in the frontal sinus; the drainage tube alone was carried out through the nasal orifice, but the skin was sewed with four interrupted sutures over the iodoform packing along the superciliary ridge.

Four days later one suture was removed in order to take out the iodoform gauze; to remove this through the nose would have been too painful for the patient. The drainage tube was allowed to remain for about one week longer; at the beginning it drained off a bloody

fluid, but later a pure mucous secretion. Fourteen days after operation the patient was discharged well (Fig. 227, Plate 42). Three years later it was determined that he had remained free of recurrence and had not suffered again either from neuralgia or from headache. The wound had healed without disfigurement of the face, and after the hairs had grown again upon the eyebrow, only the medial end of the incision between the inner lid and the bridge of the nose was visible.

The method of Killian has distinct advantage over the radical resection of the anterior wall of the frontal sinus from the cosmetic point of view. With this operation the cavity is freely exposed, and the mucous membrane may be removed just as completely as by other methods. If only a small strip of bone remains along the supraorbital margin, the arch of the forehead is not lost, as is the case in other methods.

Another advantage of the Killian technique consists in the fact that from the incision along the inner canthus the periosteum may be removed from the lamina papyracea and the radical operation for chronic suppuration of the ethmoid may also be performed. Quite frequently suppuration of the frontal sinus is combined with a similar infection of the ethmoid.

In bilateral chronic suppuration of the frontal sinuses the radical operation may be performed on the second sinus a week after the first, continuing drainage of the cleaned-out frontal and ethmoid sinuses through the nasal orifices for a somewhat longer period. After removal of the packing they are irrigated for some time through the drainage tube, which is allowed to remain in place, with a mild solution of boric acid, in order to lessen the secretion of mucus. The cosmetic result in these cases has been thoroughly satisfactory; after two months, when the eyebrows are grown out again, nothing is to be seen of the incision except the extension over the ethmoid in the region of the root of the nose.

EXPOSURE OF AND RADICAL OPERATION ON THE ETHMOID

In the description of the Killian operation the method of approach for chronic suppuration, polyps and tumors in the ethmoid cells has already been shown. If exenteration of the ethmoid cells without opening the neighboring sinus is under consideration, it may be carried out through an incision which corresponds to the medial end of the skin incision for the Killian operation. While chronic suppuration

of the posterior cells are usually combined with the same affection of the frontal and sphenoidal sinuses, and is practically not to be considered as an independent disease, suppuration in the anterior cells, particularly in the bulla ethmoidalis, is more frequently observed. It may be opened successfully endonasally after removal of the middle turbinate. But complete exenteration of the anterior as well as the posterior cells of the ethmoid with packing of the wound cavities may be carried out under clear observation only after opening from without.

EXPOSURE OF THE SPHENOIDAL SINUS

Chronic suppuration of the sphenoidal sinus is likewise usually combined with disease of the neighboring ethmoid cells. Tertiary syphilis above all conditions forms an important etiologic factor in empyema of this sinus. Diagnosis may be established if by posterior rhinoscopy pus is visible on the roof of the pharynx or in the upper meatus. Exposure of the sphenoidal osteum is attained after resection of the middle turbinate and the removal of several ethmoid cells.

Suppuration of the sphenoidal sinus is of less particular interest to surgeons than the tumors which occur in relation to its walls. With the exception of polyps, sarcoma and carcinoma, there are in particular the tumors of the hypophysis, which involve the sphenoidal sinus from the side of the sella turcica. With their gradual growth they may by pressure completely perforate its superior wall, so that they appear within the sphenoidal sinus itself or are separated from it only by a thick layer of bone or mucous membrane. The nasal approach to the hypophysis is the same as the technique which is used to make the sinus accessible in its entire extent for tumors, or for radical operation in chronic empyema. The following observation will serve as an example of the technique of Schloffer:

EXPOSURE OF THE SPHENOIDAL SINUS AND THE HYPOPHYSIS AFTER THE METHOD OF SCHLOFFER

A man thirty-five years old suffered for two months with attacks of severe headache, which lasted over an hour, and as a rule were combined with slowing of the pulse to 36 per minute and usually with vomiting. Three years before he had become innoculated with syphilis. In the past year he had noticed recurrent swelling of the nose, which lasted for a week and gradually led to a considerable increase in the size of the entire organ, which was confirmed by his family. A

few weeks before there had developed a pronounced feeling of thirst, but no bulimia or other disturbances of nutrition. The potency was normal. X-rays showed a marked widening and flattening of the sella turcica.

Examination by H. Oppenheim showed double optic papillitis, slight prominence of the eyeballs, changes in the nose and in the region of the eyebrows of an acromegalic type and a slight general weakness and a fine tremor, which were somewhat more pronounced upon the left. He considered the diagnosis of tumor of the hypophysis as probable, with the limitation that there might be present a serous meningitis at the floor of the third ventricle, which had involved the region of the hypophysis.

The operation was performed in the half-sitting posture by the Schloffer method in direct daylight without a reflector, under light chloroform anesthesia.

First the nose was carried over to the right side of the face according to the method practiced by von Bruns, in order that the right hand of the operator might work without hindrance. For this purpose an incision was made through all the soft parts down to bone upon the left side of the nose at the point of transition to cheek; all bleeding vessels were ligatured or twisted off. Above the incision in the soft parts ran to the region of the frontal sinus in order that this could, if necessary, be laid open through the same incision. It curved over the glabella about the root of the nose, and came down on the right side as far as the inner canthus (Fig. 228, Plate 43).

Up to this point the mucous membrane was not injured, in order that no blood might be aspirated by the patient. After careful hemostasis the mucous membrane of the left wing of the nose was divided and the nasal bones were cut through with a straight chisel, beginning from below on the left side, along the line of the skin wound (Fig. 229, Plate 43). Upon the right side the nasal bone was cut in part subcutaneously, and the bony septum of the nose was divided above in a horizontal plane with bone-cutting forceps. Thereupon the nose could be turned freely over to the right side of the face and the nasal cavity exposed. The upper part of the bony septum was removed with strong scissors (Fig. 230, Plate 43), but the lower part and the entire cartillaginous septum did not have to be removed, since the operation proper was to proceed on the under surface of the base of the skull.

The chloroform anesthesia was now interrupted and the operation was continued with local cocain and adrenalin. In order that no blood

Exposure of sphenoidal cells and nasal approach to hypophysis, after Schloffer.

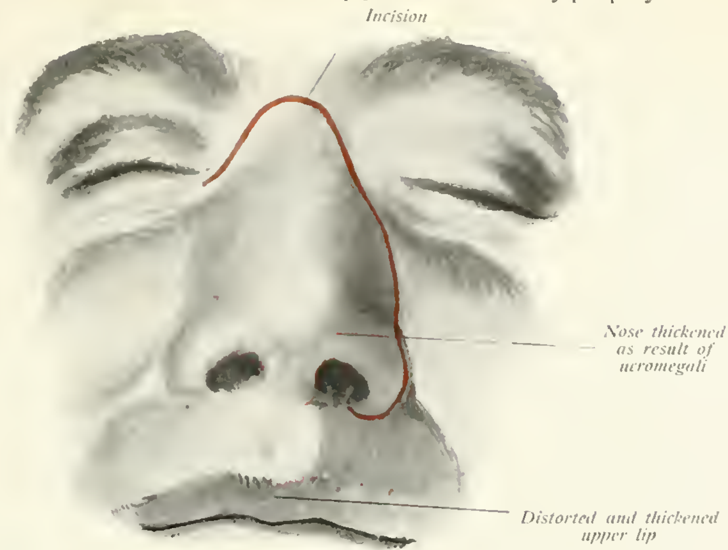

Fig. 228. Laying open the nasal cavity, after Bruns.

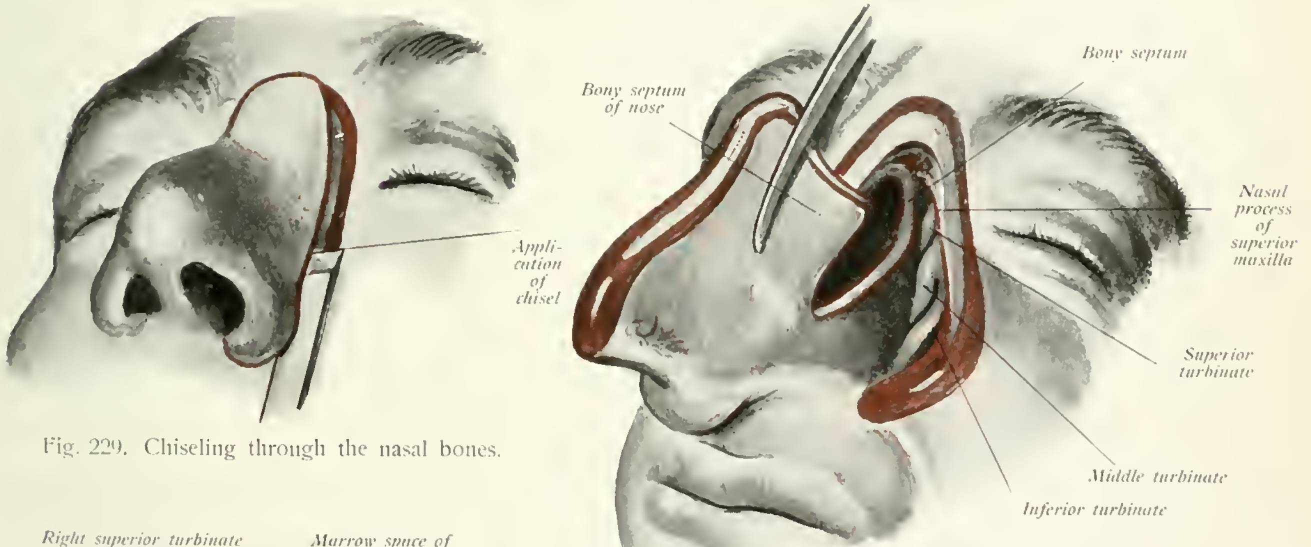

Fig. 229. Chiseling through the nasal bones.

Fig. 230. Resection of septum.

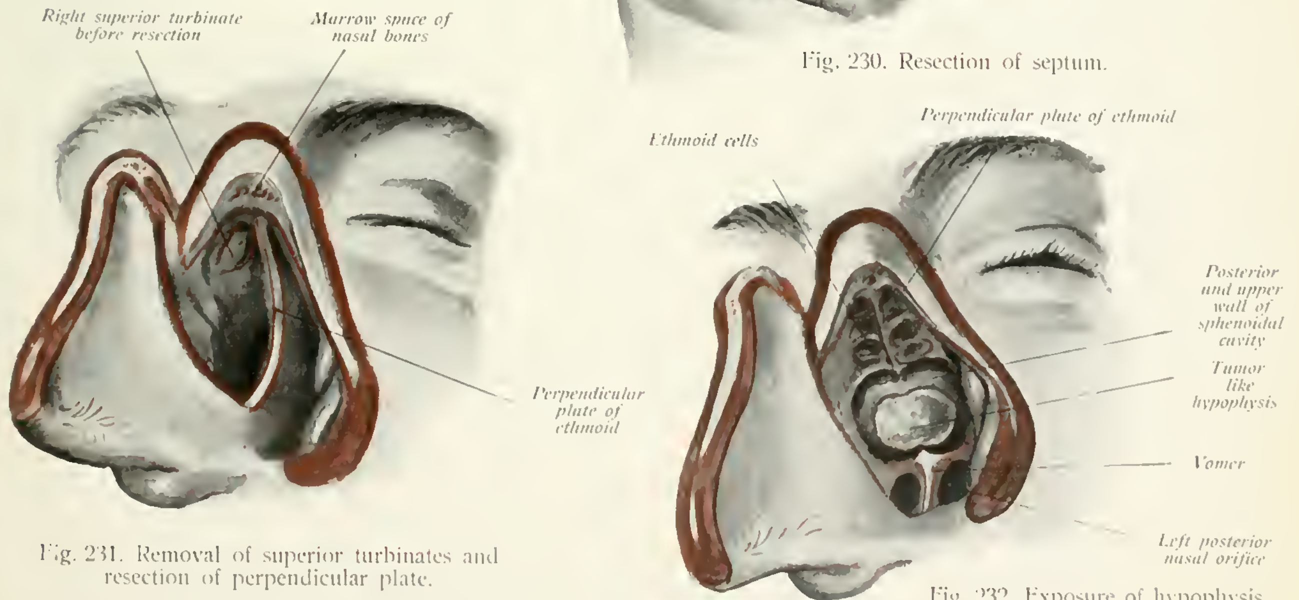

Fig. 231. Removal of superior turbinates and resection of perpendicular plate.

Fig. 232. Exposure of hypophysis.

Rebman Company New York.

might flow down the pharynx, both posterior orifices of the nose were packed with gauze from in front. To reach the sphenoidal sinus, the perpendicular plate with all the ethmoid cells and both upper turbinates were now removed with small rongeurs down to the base of the skull (Fig. 231, Plate 43), while the lower middle turbinates were left. Fifty mm. behind the chiseled surface of the nasal bone the anterior wall of the sphenoidal sinus came into view.

This was now removed in connection with its mucous membrane, and thereupon there appeared at the base of the skull, corresponding with the upper wall of the sphenoidal sinus, a flat vault at least 1 cm. square (Fig. 232, Plate 43). With forceps this entire portion could be pressed in, and immediately it sprung back, reminding one of the parchment crepitation of Dupuytren, the characteristic of myelogenous sarcoma of bone.

After a small sagittal incision was made with a knife in the middle line 56 cm. behind the bony root of the nose through this membrane, a clear fluid came away, which kept on flowing drop by drop. From the cut surface on either side the thin wall of the sphenoidal sinus could be removed with smooth forceps, as it was composed of bone as thin as paper. Behind this appeared a grayish-red mass, apparently a tumor. A venous hemorrhage of considerable extent started up, which disturbed the view, and a sponge saturated in suprarenin was pressed against the exposed surface. When this was removed again in a few minutes, the tumor had protruded further to the size of a hazel nut. As much as possible of this was removed with scissors and forceps, and the resected portions amounted in all to a piece the size of the last phalanx of the little finger. Although the opening in the sella turcica was finally as big around as the finger, nevertheless the tumor could not be entirely removed. Accordingly the operation was discontinued and the opening in the dura was packed with 10 per cent. iodoform gauze, the end being carried out through the nasal orifice, and the soft parts were sewed up.

The optic chiasm did not come into the field of vision. In this case the free-lying surface at the base of the skull was unusually large, since apparently the tumor had caused atrophy of the sella turcica and the neighboring section of the base of the skull through pressure and had made a pocket downwards.

Even during the nasal portion of the operation the pulse, although the loss of blood had been very slight, became bad, so that stimulants had to be administered. Thereupon it improved, but several times

respiration ceased temporarily even before the dura was opened. This disturbance of respiration, which reminded us of our experience with tumors of the posterior cranial fossa, gave us the idea that the case was one of large basal tumor of the brain. This impression was increased by the course of the operation, for the patient, two hours after operation, died with all the appearances of respiratory paralysis, although the pulse remained strong and regular until just before death.

Autopsy (Professor Ostreich) showed the dura under strong tension and translucent; the gyri were flattened. In the region of the left fissure of Sylvius there was a large venous air bleb. The anterior pole of the right temporal lobe felt hard to the touch, and had become attached to the inner surface of the dura in the middle fossa. On section a tumor was found here about the size of an apple, of hard consistency, with a streaky, grayish-red color. The hypophysis was gone and likewise a small portion of the brain substance in the region of the olfactory nerve. The arachnoid was everywhere normal.

The hole in the base of the skull was exactly in the sella turcica and was about the size of a nickel. The chiasm was uninjured as well as all the basal nerves. The hole reached on either side to a few mm. to the medial side of the optic nerve, exactly at the place where it entered the optic canal. The carotid and the cavernous sinus were uninjured.

What had projected tumor-like into the operative field showed itself on microscopic examination to be hypophysis and prolapsed brain substance, while the tumor in the anterior pole of the temporal lobe showed spindle-celled sarcoma. The changes in the sella turcica and the acromegalic symptoms were in this case evidently due to hydrops of the third ventricle.

The temporary osteoplastic opening of the nose after the method of Bruns represents exactly the operative procedure which renders approachable for extirpation new growths starting from bone or from nasal mucous membrane which have developed within the cavity of the nose. Among these are fibromatous polyps which are situated in the orifices of the accessory sinuses, chondromata and osteomata, and further the malignant tumors which always demand radical removal. Usually the polypoid proliferation, mucous polyps, may be removed by the endonasal route in a simple and considerate manner; but extensive deep-rooted fibromata may be removed under satisfactory

observation like malignant tumors only after wide exposure of the nasal cavity, or, if they have attached themselves to the naso-pharynx, after temporary resection of the upper jaw.

KILLIAN'S SEPTUM RESECTION AND THE APPROACH TO THE HYPOPHYSIS AFTER THE METHOD OF HIRSCH

Another nasal method for reaching the sphenoidal cells and the hypophysis is described by Oscar Hirsch. It begins with a preliminary operation which has been devised by Killian for the correction of deviation of the septum. The procedure is described by Hirsch as follows:*

"The mucous membrane of the septum is painted on both sides with a 20 per cent. solution of cocain, and both sides are then infiltrated over their entire extent with Schleich solution. Along the anterior edge of the cartilaginous septum the mucous membrane of one side is incised down to cartilage, and is stripped up by means of the raspatory, together with the perichondrium, that is to say periosteum of the cartilage, back to and over a portion of the bony septum. Hereupon the cartilage is divided ½ cm. from its anterior edge through an incision running parallel with the anterior edge of the cartilage, taking care not to injure the mucous membrane on the opposite side. Between the cartilage and this mucous membrane a raspatory is introduced, and the mucous membrane is freed on this side also from cartilage and bone. By means of the branches of the nasal speculum the two leaves of mucous membrane are held apart, and in this way a medial cavity is created in the nose, in which on both sides the cartilage, stripped of its mucous membrane, is visible. This is removed by one cut of a cartilage knife, whereupon the vomer and the perpendicular plate of the ethmoid are resected in large part with bone forceps. So far the operative procedure is identical with the submucous resection of Killian.

"To expose the anterior wall of the sphenoidal sinus, it is necessary that the mucous membrane on both sides of the origin of the vomer on the sphenoid be lifted away. This may be done readily; when this stripping up is ended, one can reach the anterior surface of the sphenoid, and here also can raise the mucous membrane on both sides until the raspatory falls through the sphenoidal osteum into the sphenoidal sinus. Now within the mucous membrane sack the posterior portion of the vomer and the sphenoid is broken through with a few blows of

*Endonasal operations for tumors of the hypophysis, Archiv für Laryngologie, Vol. 24, N. 1.

the chisel and the opening is enlarged with a bone punch, whereupon after removal of the partition between the two sphenoidal sinuses, the hypophyseal tumor is seen lying free in its surroundings. After chiseling open the sella turcica and division of the dura the hypophysis or the hypophyseal tumor is completely exposed."

CHAPTER 12—SURGERY OF THE TRIFACIAL NERVE

NEURALGIC PAINS

Of all peripheral nerves, the trifacial nerve is by far the most frequent site of neuralgia, that is to say, of pains which come in paroxysms of greater or less severity, and which limit themselves at least in the beginning of the disease to the track of a particular nerve or nerve trunk. Predisposing etiologic factors appear in many nerves, such as the passage of the nerve through a long, bony canal, many branches distributed over a wide field, or a superficial situation which exposes it to many sorts of trauma.

The pains are sometimes preceded by a sort of aura, such as itching, a feeling of tension, twitching of the facial muscles, etc. But usually they come suddenly and are of various grades of severity. All transitions occur from a mild burning sensation to the feeling as if the face was being cut up with a red-hot knife. In other cases the pains are described as stabbing, rending, boring and cutting, and as the case proceeds they sometimes attain unbearable severity, so that the patient is driven to suicide. The attacks appear without occasion, or they are aroused by insignificant causes, such as touching the skin, a cold draught, mimic motions, talking, chewing, swallowing, etc., as well as by psychic excitement. They last at first seconds or minutes, and later often considerably longer.

They may repeat themselves as often as several dozen times a day. In very severe cases the interval between attacks may disappear entirely, so that one can no longer consider them as attacks. The night is often not free of pain. At times there may be a periodic recurrence of the pains, for instance, in the spring-time.

With the course of the disease ordinarily the sensitiveness of the skin to touch increases; but there may be numerous exceptions to this rule. At times there remains permanently in the affected area a feeling of painful tension.

PAINFUL POINTS

Certain points in the course of the affected nerve may be particularly sensitive to pressure; from these attacks may originate. Painful points may, however, be lacking in the most severe neuralgia; at times, indeed, the severity of the pain during an attack may be decreased by pressure.

The painful points have their situation generally in places where the nerves emerge from bony canals or furrows into the soft parts, and where they accordingly can be pressed against an unyielding bone; also wherever the nerve trunk passes over from the deep-lying tissues to branch out in the skin or mucous membrane; and finally where the terminal branches of two nerves anastomose.

As points of this sort we recognize in neuralgia of the first division of the trifacial the supraorbital point at the supraorbital notch, the palpebral point in the upper eyelid, the nasal point at the bony wall of the nose; in neuralgia of the second division the infraorbital point at the infraorbital foramen, a point in the upper lip to one side and below the ala, a point at the anterior portion of the temple and the cheek point on the malar bone; finally, in infra-maxillary neuralgia the chin point at the mental foramen and the temporo-maxillary point just in front of the tragus.

A painful point in the neighborhood of the parietal eminence or a bit above it, which often is particularly sensitive (parietal point), may belong to the distribution of either the first or the third division. As the major occipital nerve, and at times the minor also, send branches to this place, it must be determined by exact observation which nerve in any particular case is responsible.

This impresses upon us the fact that a number of described painful points may lie in the distribution area of two different divisions of the trifacial, which is explained by the anatomical property of anastomosis. Careful examination of other painful points and close observation of the cases and regard for the history will generally serve to determine the affected branch, but not always. For that reason one must at times remove neighboring branches of two divisions; for instance, if pain is located exactly at the corner of the mouth, the infraorbital nerve and the inferior dental.

IRRADIATION

Every sensory branch of the trifacial nerve may become attacked by neuralgia. Often enough the attacks limit themselves throughout the entire course of the disease to a definite terminal branch; for instance, the supraorbital nerve of the first, the infraorbital nerve of the second and the mental nerve of the third divisions. Accordingly one speaks of neuralgia as being supraorbital, infraorbital, etc. In the beginning the pain starts usually from a well-marked point, but only seldom does it remain limited for any length of time to such place. Much

more likely is it for the pains to spread very rapidly over the entire distribution of the diseased branch, or to irradiate immediately into neighboring territory.

Usually this is a question only of the phenomenon of irradiation. This may involve wide areas: in disease of the inferior dental, for example, it may reach into the region of the temple (auriculo-temporal nerve). The irradiation pains in severe cases are no less keen than the original, and if the course of the disease is lengthy the patient loses the ability to delimit exactly the region of the primary affection. The pains are described as vague. They include uniformly one side of the head or face, and they irradiate even down to the neck. At times one loses on examination the impression that it is a question of a case of trifacial neuralgia, for it is impossible to determine in which of the three divisions the neuralgia took its origin. This experience we have had in several patients in whom a series of peripheral nerve resections had previously been done, and in whom finally the Gasserian ganglion had to be removed. The entire hyperesthetic skin of the affected side was hardly less sensitive to pressure than the typical painful points.

DETERMINATION OF THE AFFECTED BRANCH

It is our task in every case to ascertain the nerve or nerves which are primarily affected; in this we may be assisted by the following considerations: In the beginning of the disease the painful area is likely to be more definitely limited, and the irradiation comes on only as the affection progresses. Also in the later stages the attack begins in the primarily affected area, the irradiation pains accompany it after a shorter or longer period, not infrequently after a few moments; in addition, the latter are not consistent; they may remain through several attacks or they may change their course, and usually they are not so severe as the pain in the primarily diseased area.

The permanent sensitiveness which persists between attacks is evidenced in the distribution of the nerve primarily affected. If the patient practices strong pressure in a certain place for the alleviation of pain, this is as a rule over the primarily diseased area, and not in the irradiation zone. At times an injection of morphine prevents the irradiating pains without stopping the attack, and in this way may find use in diagnosis. Nevertheless, all the described characteristics may be without value in severe cases; then only the exact investigation

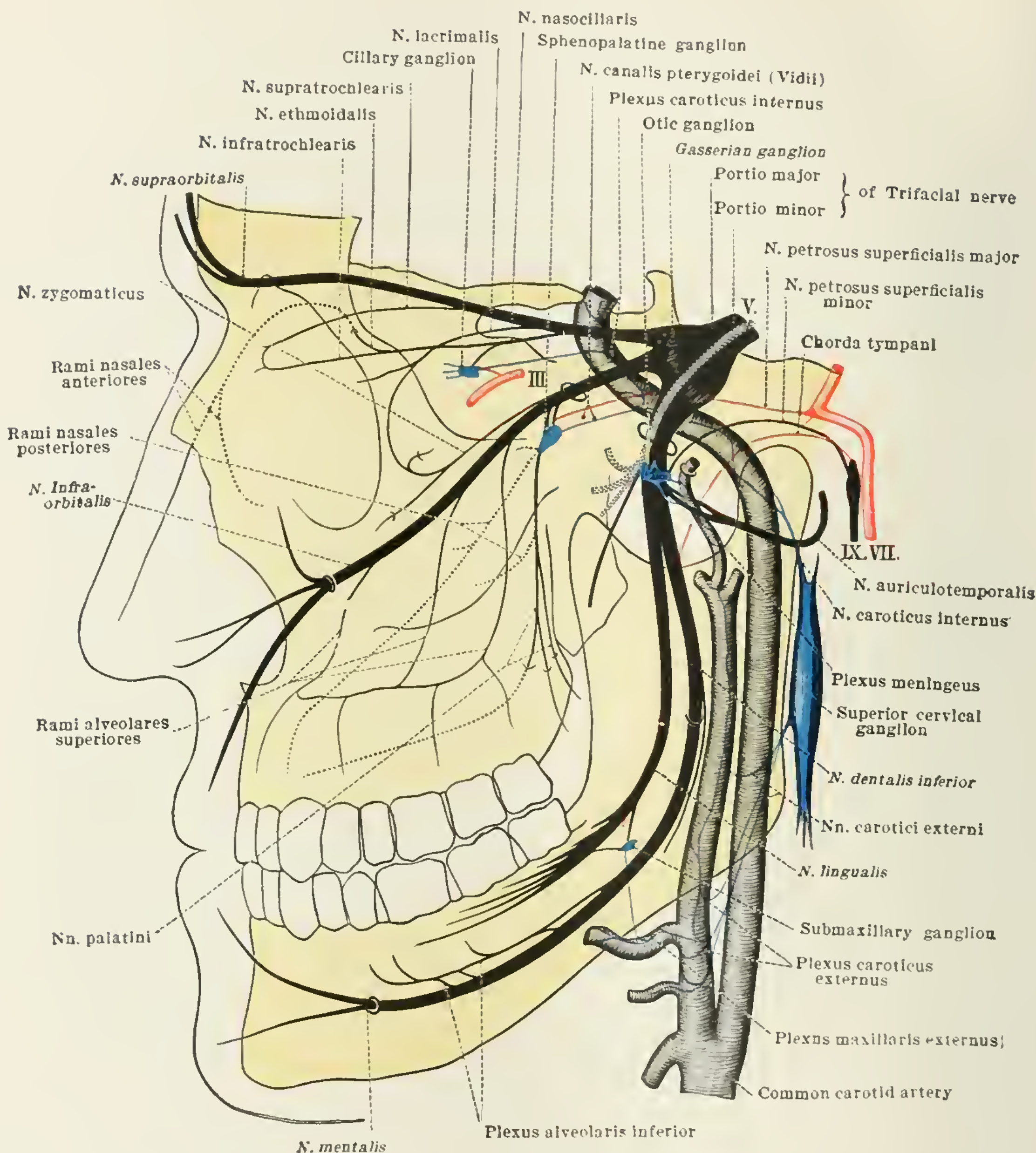

FIG. 233

THE TRIFACIAL NERVE: SCHEMATIC DRAWING OF ITS BRANCHES AND THEIR MORE IMPORTANT ANASTOMOSES

(The nerves shown in red are the motor oculi (III) and the facial (VII); the root of the trifacial is shown by V. and the glossopharyngeal by IX. The ganglia of the trifacial, as well as the branches of the sympathetic system, are colored blue.)
(From Toldt, Anatomischer Atlas, 7th edition, 1911. Fig. 1298, page 859.)

of the origin of the pain may be of help, just as the history may be of considerable importance.

If one can determine clearly how far the affected area reaches, it is

ordinarily not difficult, with the help of a knowledge of anatomy, to determine the affected nerve. One must have due regard for the law of the eccentric phenomenon, according to which the sensation that a sensory nerve has been stimulated on reaching consciousness is always referred to the peripheral distribution of the nerve at the place in its

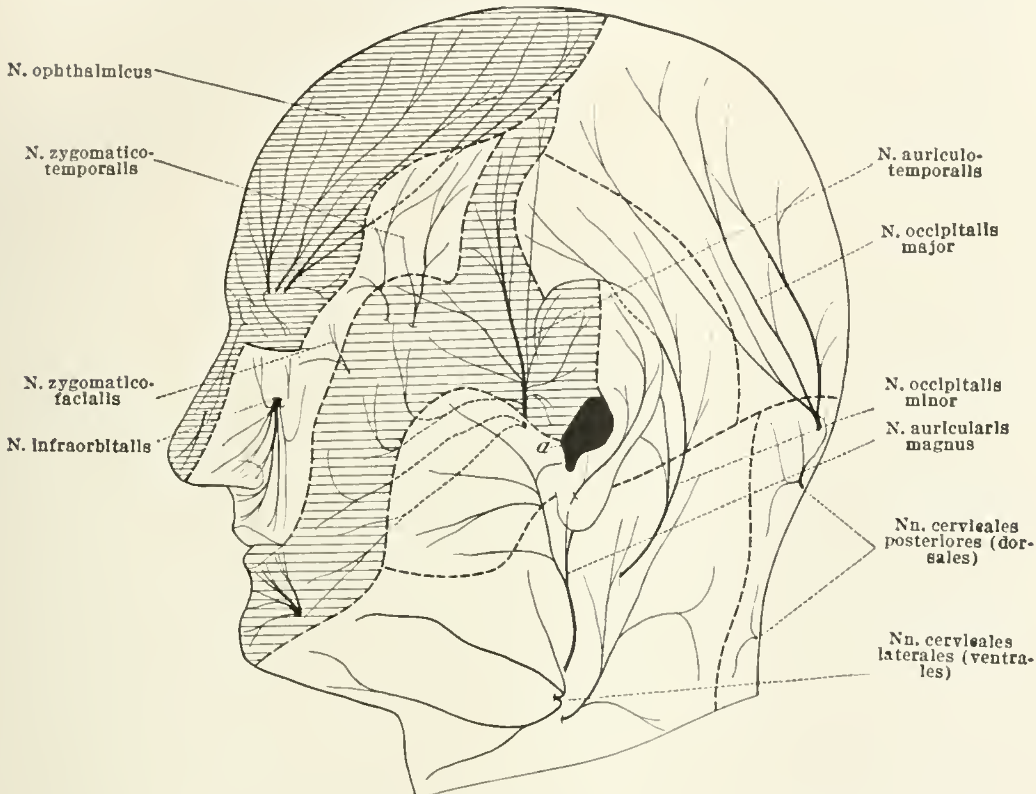

Fig. 234

Scheme of the Distribution of the Sensory Nerves of the Head, After Fritz Frohse (From F. Krause, Die Neuralgie des Trigeminus, etc., Leipzig, 1896, p. 57)

The areas supplied by the 1st and 3d divisions of the trifacial are shaded. a — the black area, represents the distribution of auricular branch of the vagus in the concha.

course where the nerve fibres may be encountered. Moreover, regard must be paid to the fact that according to our present anatomical knowledge the area of distribution of single branches is not by far so clearly and regularly outlined as we have been accustomed to believe. The investigations of F. Frohse have indeed modified our opinions not only as to the branches of one and the same division, but also as to the relations of the three divisions to each other. Furthermore, one must have proper regard for the findings of Zander, according to which many areas are covered by several nerves. In spite of the diffi-

culties which these anatomical facts give rise to, they give us a basis for the fact known to every person who has had experience, that the area of distribution of single nerves is poorly definable.

Exceptions occur when branches of both trifacials are affected, as occurs very early in certain general diseases, such as diabetes, influenza or certain intoxications (mercury and lead), or if the neuralgia passes over from one side to the other. We naturally except here all cases in which the neuralgia is caused by central disease, or is only a symptom.

ACCOMPANYING MANIFESTATIONS

During the attacks there appear irritative symptoms on the part of the secretory, vasomotor and trophic branches of the trifacial: for instance, reddening of the conjunctiva, increased secretion of tears, nasal mucus and saliva, reddening and swelling of the skin of the face, secretion of sweat and an increased sensation of warmth. Among the trophic disturbances is to be considered herpes, which occurs on the forehead. The facial nerve may partake in the disturbance and set up fibrillary contractions and twitching, more rarely clonic spasm. In certain cases the motor portion of the trifacial is stimulated, causing contraction of the muscles of mastication and of the muscles of the tongue.

At the same time as the pain in the face there may appear neuralgic symptoms in other portions of the body, such as intercostal neuralgia and sciatica. Pains in the occipital region which are observed in trifacial neuralgia should not be assumed at once as being due to occipital neuralgia, for frequently they may be referred to irradiation.

In severe cases practically the entire body may be involved. The patient trembles, cardiac activity is stimulated and the general sensitiveness is increased. There is nausea and often vomiting. At times one observes slowing of the pulse.

THE TERMINATION OF NEURALGIA AND RELAPSES

Trifacial neuralgia ends, if recovery occurs without operation, usually not all at once, but as a rule the pains disappear gradually after fluctuations up and down. After successful operative procedures also the neuralgia does not disappear at once, but usually the attacks recur at times in the first few days, growing less severe and of shorter duration until they finally disappear. This property is observed only in peripheral nerve operations; in extirpation of the

Gasserian ganglion the neuralgic pains always disappear with the awakening from the anesthetic.

Trifacial neuralgia tends to relapse and recurrences are common, particularly after all peripheral nerve resections, no matter by what method they have been carried out. As a rule these affect the original nerve distribution, but at times they include other branches of the same division, or even the entire division. The severity of the pain in recurrences is usually decreased, and this fortunate circumstance may spare us further operative procedures. In other cases the severity equals that of the earlier attacks, and they may reach a frightful degree and irradiate out into an ever-increasing area.

DIAGNOSIS OF NEURALGIA

In diagnosis one considers the picture as a whole and is not swayed in his judgment by one or another isolated symptom. The beginning of the disease is to be investigated closely, because at this time the symptoms are much more clearly defined than after the condition has long continued. Attention should be directed in every case as to whether or not any disease of the accessory sinuses or teeth, tumors in the peripheral course of the nerve, or within the cranium in the region of the trifacial may be present and cause the neuralgia, which will then be only a symptom of the underlying disorder. In the same way aneurysms in the arteries of the head, particularly the internal carotid near the Gasserian ganglion, or syphilitic disease of bone and periosteum may set up or imitate neuralgia.

Mention should also be made of neuritic processes, neuralgia in hysterics, headache and migrain, which may offer considerable difficulty in differentiation from idiopathic neuralgia. Each of the three divisions of the trifacial sends a branch to the dura mater to supply it with sensory fibres. It does not seem improbable that these branches also may become affected as in neuralgia, and that certain types of headache result therefrom.

PROGNOSIS OF NEURALGIA

Trifacial neuralgia in itself is not dangerous to life, and one is ever astonished that people who suffer from a severe form of the disease seem reasonably well and in a good state of health. But as a result of insufficient nourishment, it is not infrequent that a severe cachexia develops. Those in whom attacks occur at night, preventing sleep, suffer much more than others. Death, so far as we know, has never

been observed in a neuralgic attack, except in the presence of some organic disease of the brain; but these cases cannot be classified with pure neuralgia. Loss of strength makes the organism on the whole less resistant to intercurrent affections and increases their danger, but nevertheless many patients in spite of the severest suffering reach an advanced age.

Prognosis depends entirely on the cause of the neuralgia. If this may be removed, one may under skilful treatment in many cases induce a cure. Commonly the prognosis is more favorable if the neuralgia is of short standing and if it occurs in a young, well-nourished person. The outlook for cure is poorer if the disease is well settled, the attacks frequent and severe, and the patient exhausted and frail.

Under operative treatment the prognosis as a rule is better in many respects. But one is still frequently met with the opinion that operation should be considered only after all other means have been exhausted. This point of view should be strongly opposed. Likewise one frequently comes in contact with patients who, after they have been left in the lurch by all methods of internal medication, have descended to the frequent use of morphine by advice even of well-known nerve specialists, who hesitated to turn them over to the surgeon. The morphinism is about as bad as the disease itself; and, above all, morphine supplies only temporary relief in severe cases.

ETIOLOGY OF NEURALGIA

A neuropathic taint, exhausting disease with the resulting anemia and cachexia, premature old age, and above all, arteriosclerosis, play a rôle in the etiology of this condition; men and women in the prime of life are equally affected. Many infectious diseases may induce neuralgia, particularly intermittent fever, which does not infrequently give rise to supraorbital neuralgia. Of the acute infectious diseases, influenza is most frequently followed by typical neuralgia, and this affects usually the supraorbital and less frequently the infraorbital nerve; facial neuralgia is also observed after typhus fever and smallpox.

Certain poisons after long absorption work the same result; among others, mercury, lead, alcohol, nicotine. The neuralgia which develops in diabetes and gout may be referred to a faulty blood and lymph circulation. In diabetes the third division is particularly affected, and frequently on both sides.

Among the chronic infectious diseases syphilis should be considered, especially in so far as it gives rise to periosteal thickening. In the bony canals the nerves are crowded rather closely, and there is room besides for only the nerve sheath, the accompanying vessels and the thin periosteal layer. Under these conditions even the slightest swelling must result in pressure. This refers particularly to the smaller canals, such as those for the dental nerve, the zygomatico-temporal and the zygomatico-facial canals, etc. Moreover, the nerve itself or its sheath may be attacked by the specific inflammation, and at times, particularly in the beginning of the disease, it is impossible to make any other diagnosis than that of neuralgia. Indeed, it has not yet been determined whether a true neuralgia may occur as a result of syphilis. Syphilitic inflammation of the membranes of the brain should also be mentioned.

Rheumatism and exposure play a rôle in the etiology, and also disturbances of digestion and chronic constipation. Finally, among the causes should be named chlorosis, diseases of the pelvic organs in women and mental emotion. In many patients the neuralgia is laid to injury of the bones of the face or skull.

CENTRAL OR PERIPHERAL SEAT OF THE NEURALGIA

It is very important to know whether the cause of the neuralgia has its seat in the brain or in the periphery. If changes are to be observed in the periphery which we know empirically to induce pain, such as scars, foreign bodies, tumors, one is justified in seeking here the cause. If the neuralgia has come on in a definite portion of the face after a severe cold or injury, and it limits itself to this region, one may determine in favor of a peripheral location. But one must always remember that nerve changes once instituted may advance along the nerve to the brain itself.

Ordinarily, in accordance with the law of eccentric manifestations, the cause is to be sought the higher up, the more branches of a division are really affected, excluding, of course, the area of irradiation. Accordingly, in the unusual event that all three roots were affected from the beginning, it may be stated with some certainty that the disturbance exists within the cranium. Here it may be located near the anterior portion of the ganglion, where the three trunks lie close to each other, or in the ganglion itself, or still further centrad, in the course of the sensory root from the nucleus. The same effect may be pro-

duced by periostitic processes which occur in the middle fossa and involve all three roots.

But in case as ordinarily the neuralgia is limited to one or a few branches, one cannot always determine definitely that the cause is peripheral. Even when tumors or aneurysms of the internal carotid compress the trifacial in its intracranial course, only certain branches may show neuralgic symptoms. The motor root resists the injurious pressure longest, and even the sensory fibres are not affected equally, for at times in such cases instead of neuralgia, anesthesia develops in the trifacial region.

If at the same time a patient shows signs of cerebral disease, one frequently refers the neuralgia to a central cause; but this assumption is often ungrounded, for there may be no connection between the neuralgia and the brain disease. In other cases, in spite of the absence of all cerebral symptoms, even if the condition has lasted for years, the cause may, nevertheless, exist within the cranium. This short consideration demonstrates how difficult is the localization of the seat of the causative agent, and how frequently it is really impossible.

GENERAL TREATMENT OF NEURALGIA

Before instituting treatment, one should attempt to determine the cause in each case. If successful, treatment should be directed along this line. To determine the cause, the history is of some value, but of more importance is a careful investigation of all the organs from which we know empirically that the disease may originate. To this group belongs the teeth, the ear, the eyes and the accessory sinuses. Even in teeth which are externally sound, exostosis of the root may be present and give rise to neuralgia. The neuralgia which originates from the sclerosis of toothless gums may be relieved by resection of the alveolar process. If supraorbital neuralgia is caused by frontal sinuitis, relief may be obtained by the regular use of nasal douches (lukewarm 7/10 per cent. salt solution or 3 per cent. boric acid solution). Chronic inflammations of the nose and catarrh of the middle ear must be submitted to the regular form of treatment.

If splinters of bone are left after extraction of teeth, or if foreign bodies, scars or tumors are present in the course of the nerves, attention should be directed at once to their removal.

The use of morphine should be avoided entirely in chronic cases. The danger of habit formation is particularly great in long-standing cases. One should not delude one's self with the purpose of giving a

few hours of peaceful sleep to the unfortunate sufferer. The drug in really severe cases of neuralgia gives relief for only a short time, and even large doses rapidly lose their effect, and then as a permanent sequel the morphine habit persists. Surgery possesses, even if medical treatment fails, a series of procedures which offer aid to the patient, and in the worst cases the final and most serious operation, the removal of the Gasserian ganglion, is always to be given consideration prior to the continued use of morphine.

ALCOHOL INJECTIONS

As in sciatica, we have attempted to relieve trifacial neuralgia by means of the injection of anesthetic agents. In the first and second divisions of the trifacial Lange injected 30 to 50 cc. of salt solution under strong pressure into the nerve sheath or the immediate neighborhood, in order to cause separation, stretching or mechanical tearing of the fibres. The proportion of cures was small, and so Schlosser employed 80 per cent. alcohol and injected 2 to 4 cc. directly into the diseased nerve trunk with the purpose of killing it by inducing degeneration and absorption of all but the neurilemma. This method offered a substitute for nerve resection.

The enthusiastic adherents of this method believed that all peripheral trifacial resections could be satisfactorily replaced by alcohol injections. There can be no longer any question of this; for in the last few years many patients have come with the urgent request for operation, in whom alcohol injections have been made by experienced men, at first with result, but after repeated relapses with less result, and finally without any effect. True neuralgia can be treated effectively only by operative methods, and frequently only by very radical methods; for many patients who have been under treatment for years, and in whom all methods have been employed, come to the surgeon with the determination finally to be rid of a disease which is driving them to suicide. Of 134 patients operated upon up to April, 1907 (Krause), not less than 17 had made previous attempts at suicide.

The Schlosser method is indeed a great advance, and after its employment many neuralgics have doubtless experienced lasting relief from pain. The method should be practiced more frequently, in so much as it renders the peripheral branches readily accessible without danger. Somewhat more difficult is the basal injection of the second root at the foramen rotundum, and of the third root at the foramen ovale. Whoever knows anatomy may find these places with the

cannula without difficulty (see p. 42). To inject alcohol into the Gasserian ganglion is, however, too rash a procedure, and likewise the branches which run through the orbit must be excluded, since the eye muscles and probably the optic nerve might readily be injured.

PERIPHERAL OPERATIONS

GENERAL ANESTHESIA AND LOCAL ANESTHESIA

Neither in peripheral resection of the branches of the trifacial nor in extirpation of the Gasserian ganglion is general anesthesia unconditionally necessary. All the operations under consideration may be carried out by means of novocain and adrenalin anesthesia with complete success, and for the region of the trifacial it is to be particularly recommended. For the technic see the chapter on Anesthesia, page 42.

Nevertheless, there are many patients who earnestly request general anesthesia, since through this most painful of all diseases their capability of resistance has been so decreased that they can no longer stand the psychic excitement which any operation, even if carried out painlessly, induces. In such cases we have never exercised any pressure, but have always given general anesthesia the preference, excluding only cases in which it is contraindicated by the presence of uncompensated heart disease or lung or kidney affections. Just the most severe type of neuralgia is often accompanied by arteriosclerosis, and according to accepted opinion it is even caused by this condition, so that general anesthesia is not infrequently contraindicated. With the aid of local anesthesia one can consistently extend the indications for radical operation on the branches of the trifacial, and particularly also for extirpation of the Gasserian ganglion, much further than in the time when we were limited to general anesthesia alone.

INDICATIONS

Operative treatment should not, as so commonly happens, be considered the last refuge. There is no question but that as a result of this attitude many patients who could have been cured at the beginning by comparatively simple procedures lose, in great measure, their chance of relief through long continuance of the disease. The neuralgic changes which at first lie peripherally in the nerve steadily advance centrally, and finally in deep-seated cases no extra-cranial operation can be of lasting value. We can expect cure earlier if the origin of

the neuralgia can be located in the region of the peripheral distribution.

The determination as to which nerve should be removed is not always simple. Irradiating pains may render the question a difficult one to solve, as we have already shown. A good knowledge of anatomical relations, a careful consideration of history, as well as an exact observation of the attacks, are unconditionally necessary before the decision should be made. As a general rule it may be stated that the peripheral branches must be followed up from the smallest to the place where all the branches which are affected by the neuralgia have united into one trunk; and at this point the division should be made as early as possible.

EXTRACTION OF NERVES

The extirpation of nerves centrally as well as peripherally is the object of the nerve extraction introduced by Thiersch. The affected nerve is exposed in its surroundings, and without being divided is seized crosswise by a clamp, which will grasp the nerve securely and not allow it to slip. A clamp ridged longitudinally is satisfactory, provided the ridges are not sharp enough to cut through or crush the nerve fibres. The nerve being securely grasped, the clamp is rotated slowly on its long axis, according to Thiersch, about a half turn every second, but it may be slower still with advantage. This procedure causes the peripheral section to be twisted out down to the finest terminal branches. Of the central portion one usually gets a piece about 3 or 3½ cm. long if it runs through soft tissues and is not closely attached to a bony canal; it usually tears after this much has been removed. It is to be observed that centrally only those nerve fibres are pulled out by the slow drag which are tightly seized in the clamp; branches which are given off higher are only torn, but are generally not divided. The best rule to follow is to remove centrally as much of the nerve as possible. Moreover, all the nerve branches which run through long bony canals must be exposed to a point behind these and removed.

How great an extent of nerve may be removed by this method is shown by the Figs. 235 and 236. Since the anastomotic fibrils of the facial nerve are removed also in their terminal portions (see *a* in Fig. 235), it is not unusual at times for paresis to appear, particularly in the muscles of the upper lip and the alæ of the nose, but this disappears rapidly.

The advantages of the method are clear. Insignificant incisions are sufficient for the exposure and extraction of extensive portions of the nerve, and the operation is attended with very little danger or sacri-

Fig. 235

I. Frontal Nerve; II. Infraorbital Nerve. Removed after the method of Thiersch, from a 78-year-old physician. Natural size. In II above and to the left may be seen the beginnings of the Superior Dental nerves pulled out at the same time. *a* shows anastomosis of terminal branches of Infraorbital with filaments of Facial.

fice. Theoretical discussion has little place here: the best evidence as to permanent cure is offered by the considerable number of patients who come repeatedly to operation to be freed from their sufferings for a time at least. Every active surgeon has had such experiences,

and W. W. Keen, of Philadelphia, has reported a case in which a dentist had undergone fourteen operations for trifacial neuralgia during the space of thirteen years.

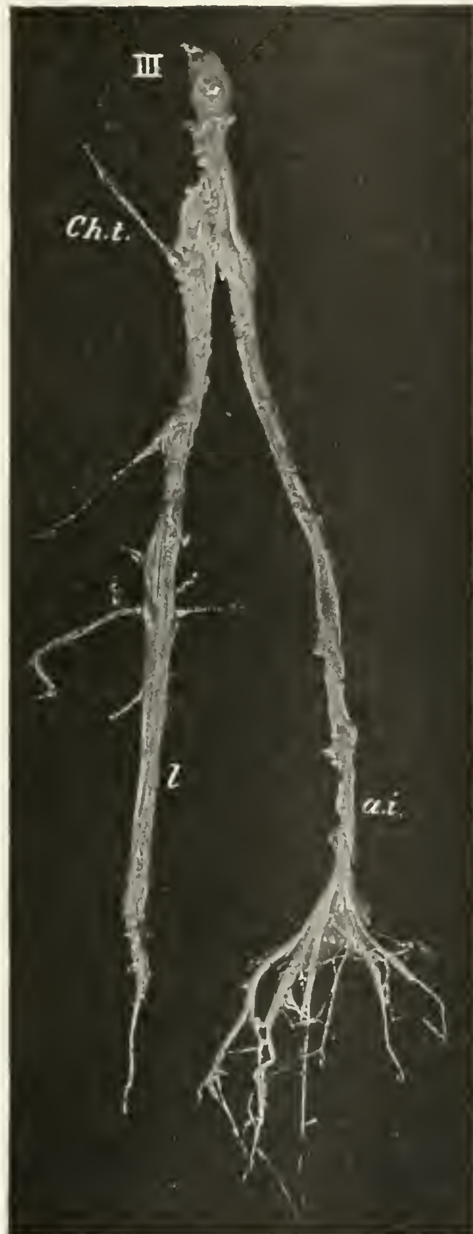

FIG. 236

Inferior Maxillary nerve exposed by dividing the ramus of the jaw, and twisted out after the method of Thiersch, from a 43-year-old man. Natural size. Ch. t. = chorda tympani nerve. l = lingual nerve. a. i. = inferior dental nerve.

RESULT AND PROGNOSIS OF PERIPHERAL OPERATION

After the peripheral operation—this includes all methods—the neuralgic pains do not always disappear so completely that the patient on awakening from anesthesia only feels the pain of the wound. Often enough in the first few days after operation attacks recur, which soon, however, decrease in number and severity and finally disappear entirely. Clearly the cause of this lies in the injury which the nerve has suffered during the procedure, and particularly in its separation. One should advise the patient of these possibilities before operation in order that later it may not give unnecessary anxiety.

In a few cases, luckily infrequent, the neuralgic pains remain unaffected by the peripheral operation. This we have personally observed twice.

Peripheral resection, although used extensively, is in many cases only a palliative operation. But the early as well as the later recurrences are after all much more mild than the original disease, so that the patient is satisfied with his condition, and does not demand further operation. According to the statistics worked out by Dr. Dege up to April, 1907, of 134 cases operated upon by one of us (Krause), 14 per cent. remained free of recurrence. The average painless period, according to these statistics, lasted two years and two months; there was, however, one recurrence after eight years. On the other hand, several old persons have died without ever having recurrence of pain, and the longest painless interval observed lasted seventeen years, until death (infraorbital and mandibular). All these facts refer to the resection of peripheral trifacial branches. In 27 per cent. of the cases the recurrence was slight, so that no further operation was necessary. More than half the patients had to be operated on again, and in not a few the Gasserian ganglion was later extirpated.

As regards the immediate prognosis of peripheral nerve operations, the majority, including those which were carried out after the method of Thiersch, were trivial procedures. The wounds healed rapidly and left insignificant scars; the stay in the hospital was limited to few days. The anesthesia which resulted bothered the patient little, and moreover in the course of time the area grew smaller and smaller, with the exception that once after extraction of the supraorbital nerve we observed severe keratitis, which healed, leaving a corneal opacity.

Extra-cranial procedures which are carried out at the base of the skull are, on the other hand, to be considered serious operations. Even

Resection of the frontal nerve.

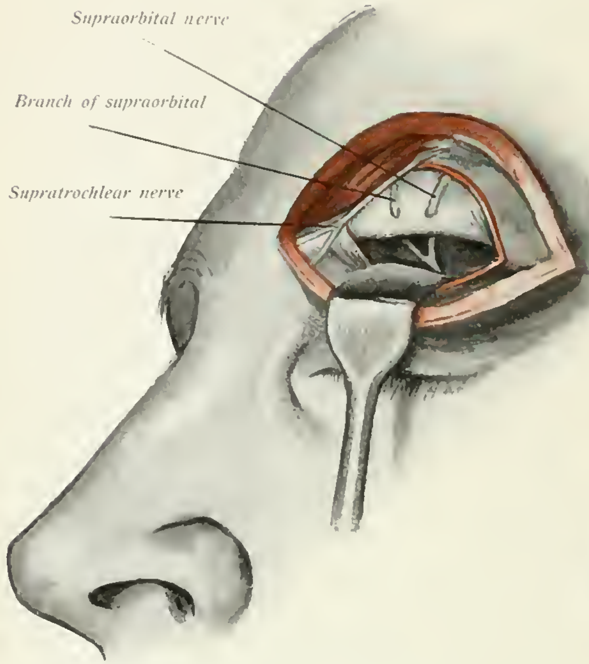

Fig. 237. The frontal nerve is exposed.

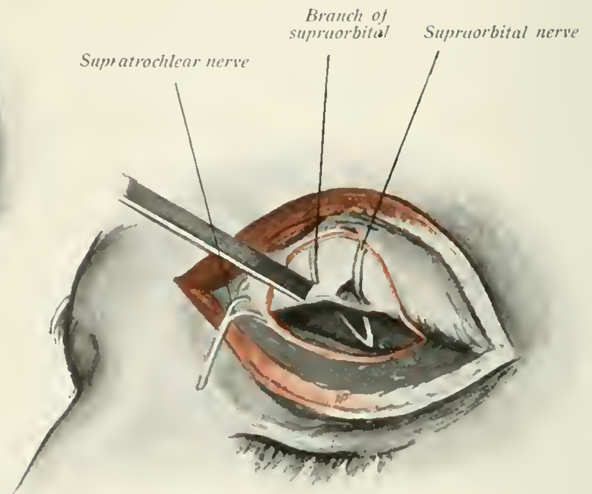

Fig. 238. The margin of the orbit over the foramina is chiseled away.

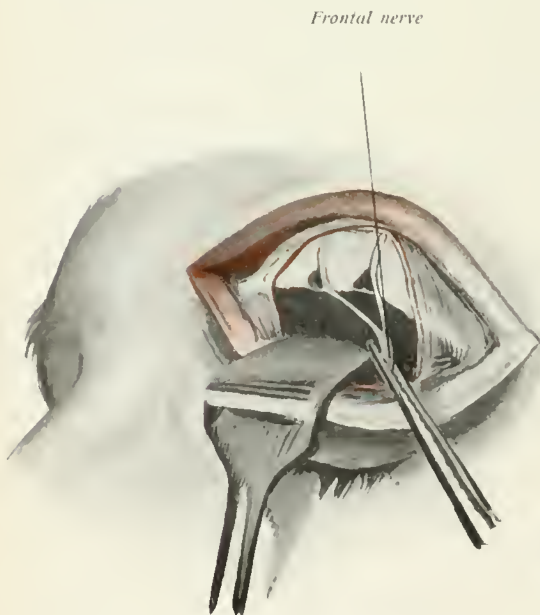

Fig. 239. The trunk is seized and torn out.

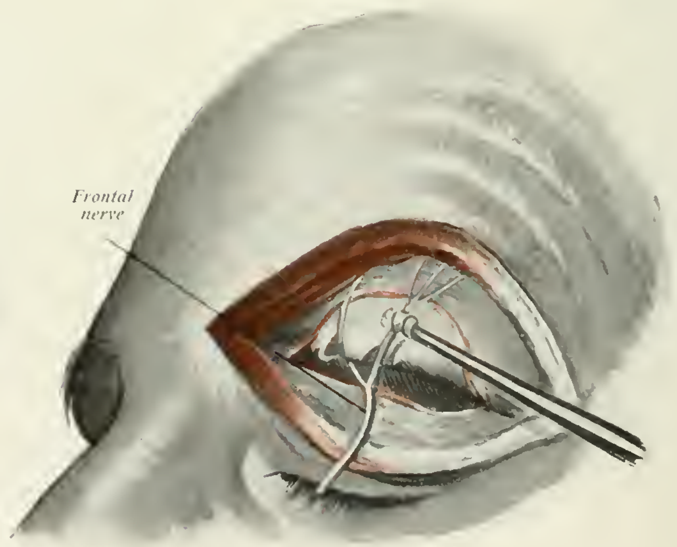

Fig. 240. The terminal branches are twisted out.

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though life is only exceptionally endangered, nevertheless extensive scars and at times interference with the movement of the lower jaw result.

Of the great number of methods devised and employed we shall give only the most practical. One should always be familiar with several methods for the severe operations on the base of the skull, as the scars of previous operations may make one or another impracticable.

During all resections of the trifacial the patient is held in the half-sitting posture.

FIRST OR OPHTHALMIC DIVISION OF THE TRIFACIAL

RESECTION OF THE FRONTAL NERVE

A fifty-eight-year-old woman suffered for several years with severe neuralgia in the region of the supraorbital nerve, due in all probability to arteriosclerosis. Injections of alcohol had brought temporary relief, although when repeated they showed themselves to be useless for a permanent cure.

A skin incision $3\frac{1}{2}$ or 4 cm. in length (Fig. 237, Plate 44) was made along the upper edge of the left orbit through the middle of the shaved eyebrow. The supraorbital notch, which could be palpated through the skin, lay about in the middle of the incision. After division of the skin and a few fibres of the orbicularis palpebrarum muscle, a few fine twigs of the supratrochlear nerve came into view, which were carefully preserved, so that by following them up one could the more easily reach the trunk; they were freed for a short distance. (Since the branches of the facial which run to the orbicularis and the frontalis muscles enter these muscles from the outer side, they were not met in this incision.) Below these peripheral branches the periosteum was now incised down to bone. The supraorbital nerve was found to lie in a supraorbital foramen; the fine twigs already mentioned were given off from the supratrochlear nerve, which likewise came out through a small canal at the edge of the orbit. In both places the small bridge of bone was removed with a fine chisel and hammer (Fig. 238, Plate 44), until a notch remained in which the nerve fibres lay free. (Ordinarily the supraorbital notch is bridged over only with stout connective tissue, which has to be cut away.)

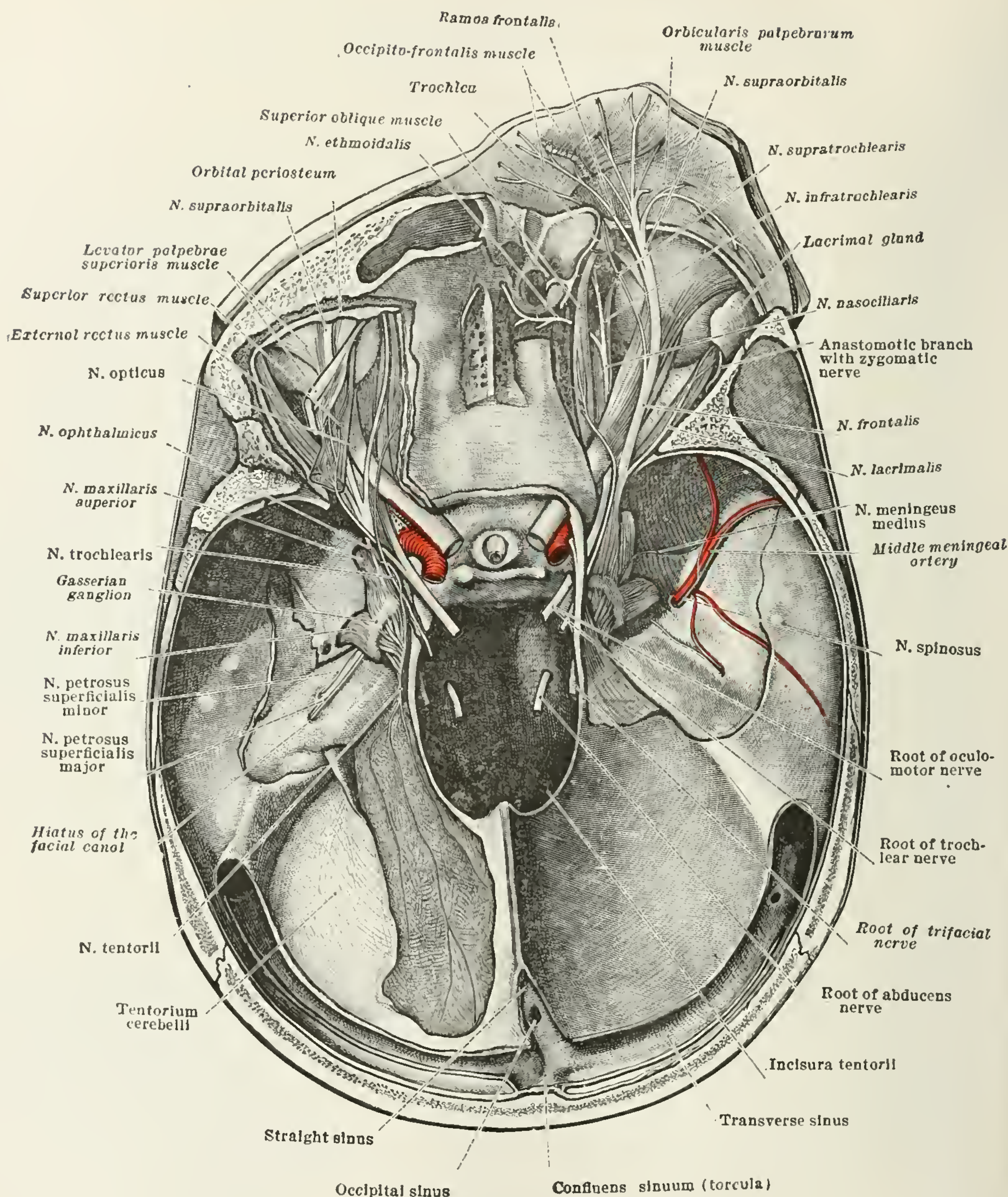

FIG. 241

THE FIRST OR OPHTHALMIC DIVISION OF THE TRIFACIAL NERVE, WITH THE SUPERIOR BRANCH OF THE OCULOMOTOR, AND THE TROCHLEAR, AS THEY APPEAR AFTER REMOVAL OF THE ROOF OF THE ORBIT

The nerves supplying the dura mater: the tentorial nerve (from the ophthalmic division of the Trifacial), the meningeal (from the superior maxillary division), and the recurrent spinous (from the inferior maxillary division).

(On the left the upper margin of the orbit is left; the levator palpebrae superioris and the superior rectus muscles are divided at their origins, and turned over, to show the branches of the oculomotor entering them.)

(From Toldt, Anatomischer Atlas, 7th edition, 1911, Fig. 1299, p. 860.)

The periosteum was stripped back from the roof of the orbit by means of small sponges of gauze held by forceps, until the trunk of the frontal nerve was exposed for a considerable distance (Fig. 239, Plate 44). While the orbital contents were carefully held downward out of the way by a retractor—one carefully refrained from tearing periosteum, because then the orbital fat would fall apart and interfere with vision—the nerve trunk was readily loosened from its surroundings by blunt dissection. It was grasped with the nerve clamp as far proximally as possible, and torn out by a slow, strong pull. The peripheral branches were extracted down to the finest termini by very slowly rolling them up on the clamp (Fig. 240, Plate 44). From this manœuvre, through the tension on the fine branches, there resulted deep folds in the skin of the forehead. Hemostasis was attained by temporary pressure with gauze. A small drainage tube was kept in the middle of the incision for two days in order to anticipate the formation of hematoma in the orbit, the rest of the skin wound being sutured. After four days the patient was discharged without pain and with the wound healed.

OTHER BRANCHES OF THE OPHTHALMIC DIVISION

The branches of the frontal nerve do not always come off in the same way. If one of them is left behind relapse may readily occur. Therefore, as a rule the frontal nerve should be sought far back in the orbit, before it has given off the supratrochlear branch. One may succeed in freeing the ophthalmic trunk even to the point of origin of the lachrimal branch by going back far enough into the funnel of the orbit after lengthening the incision somewhat externally, but not to the origin of the nasal nerve.

We can expose one of the terminal branches of the nasal, the anterior ethmoidal nerve, where it passes through the anterior ethmoidal foramen at the inner upper wall of the orbit, to reach the upper surface of the cribriform plate. For this purpose the incision is carried to the inner edge of the orbit; the stripped up periosteum together with the contents of the orbit are shoved downwards and outwards. If the lachrimal gland interferes it must be pulled out from its recess. In lifting up periosteum the ethmoidal nerve is put on the stretch, and is visible about 2 cm. behind the medial end of the supraorbital margin; one can grasp it in the clamp and twist it out.

In operations on the medial half of the orbit the trochlea or pulley must be carefully avoided, in order to prevent disturbance of function

in the superior oblique muscle and diplopia. The arteries which accompany the nerves are only to be isolated if the two structures lie

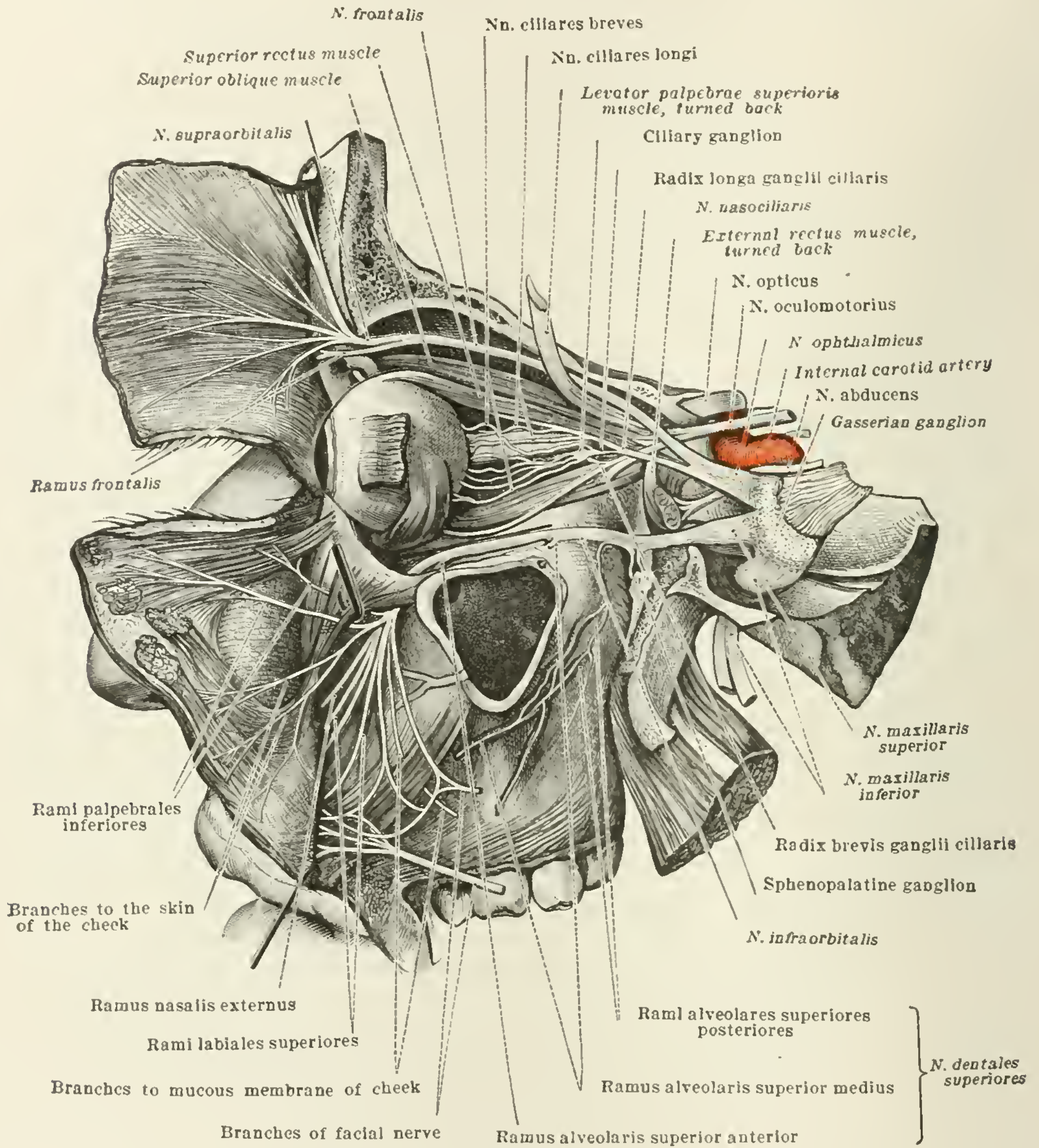

Fig. 242

The Second or Superior Maxillary Division of the Trifacial, With Its Anastomosis by Two Sphenopalatine Nerves With the Sphenopalatine Ganglion, the Superior Dental Nerves. The Infraorbital Branch of the Superior Maxillary Distributing Over the Face, After Leaving the Infraorbital Foramen. The Frontal Nerve and the Ciliary Ganglion, With Its Branches Going to the Eye-ball, Come Off From the First Division. Left Side of the Face, From the Left

(The skin of forehead and cheek with the superficial muscles of expression is divided behind and turned forward. The lower jaw is taken off, and the lateral wall of the antrum as well as the lateral wall of skull down to pterygopalatine fossa is removed. Levator palpebrae superioris and external rectus muscles are divided and the posterior portions turned back. The quadratus labii superioris muscle, which hides the branching of the infraorbital nerve, is lifted away on a hook.)

(From Toldt, Anatomischer Atlas, Fig. 1300, p. 861.)

Resection of the infraorbital nerve.

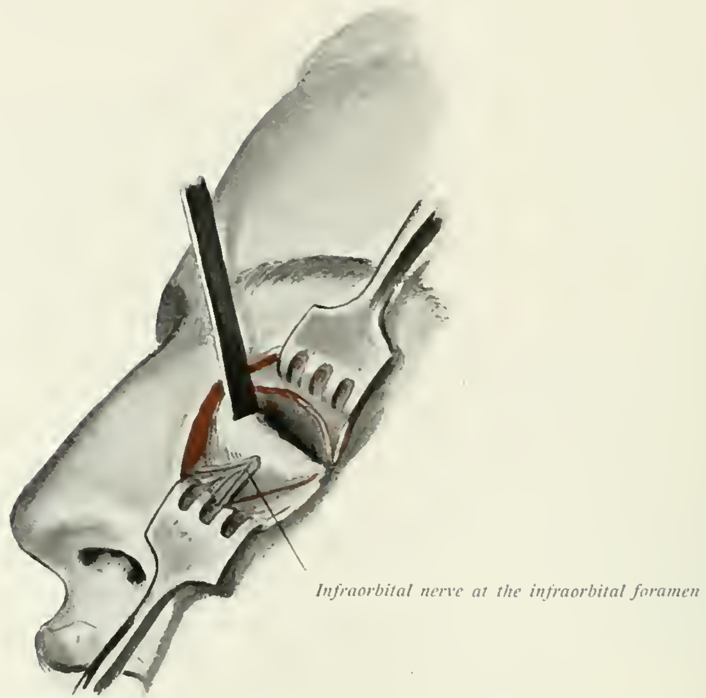

Fig. 243. The branches of the nerve are exposed, and the bony bridge chiseled away.

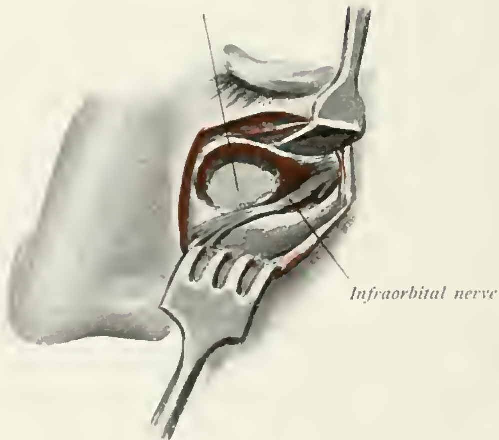

Fig. 244. The nerve is exposed within the orbit.

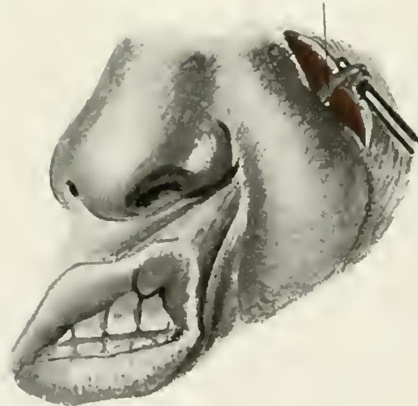

Fig. 245. The peripheral branches are twisted out.

some distance apart, so that one can assume that no nerve fibres remain attached to the vessel. If there is any suspicion of this, one should grasp both artery and nerve in the clamp and twist them out together. Bleeding always stops under compression.

In mild cases of neuralgia one can employ the technique of Thiersch for the exposure of the external nasal branch of the ethmoidal nerve. He locates it where it comes to the surface through the pyriform aperture between nasal bone and cartilage.

After extensive extra-cranial resection of the frontal nerve and its branches in the manner described, relapse in the region of the first division rarely occurs alone; if it comes at all it is practically always in connection with pain in the second or third divisions, or in both. Therefore if in such recurrences peripheral operation on these divisions remains also without permanent effect, extirpation of the Gasserian ganglion will have to be considered.

SECOND OR SUPERIOR MAXILLARY DIVISION OF THE TRIFACIAL

RESECTION OF THE INFRAORBITAL NERVE

A thirty-year-old female patient suffered for two years with severe neuralgia confined to the left infraorbital distribution, for which she had tried numerous methods of treatment without avail. Exposure of this nerve, which is the one most frequently affected by neuralgia, was obtained through the incision originated by Kocher, in order so far as possible to avoid injury of the fibres of the facial nerves (Fig. 243, Plate 45). The incision began ½ cm. below the inner end of the lower margin of the orbit, ran obliquely outwards and downwards to the posterior lower edge of the malar bone. Beginning and termination of the incision lay in about the same vertical plane as the corresponding points of the supraorbital incision (see p. 213). The length was about 4 cm. Avoiding the facial branches, it was carried first only through skin and fascia down to the quadrate muscle of the upper lip, the fibres of which were pulled downwards, crossing the direction of the incision. Thereupon the upper branches of the infraorbital nerve (the inferior palpebral and the subcutaneous nasal nerves) came into view, since they ran to the upper wound edge. They were avoided, as shown on page 213, and left in connection with the trunk, while the peripheral branches were pulled out with the

forceps, so that they did not interfere with the retraction of the wound edges.

After this was accomplished the infraorbital foramen was exposed. It lay in the uppermost portion of the canine fossa about 1 cm. below the margin of the orbit and a bit internal to its middle point. Since the upper outer segment of the foramen possesses a sharp projecting edge, it was readily found on palpating the bone in the depths of the wound by running the finger tip upwards and outwards. The incision then proceeded along the lower edge of the orbit through the origin of the quadrate muscle of the upper lip and periosteum down to the bone, but remained above the infraorbital foramen. Then the periosteum was stripped downwards with the raspatory until the branches of the infraorbital (pes anserinus minor) were clearly visible. This was isolated from the infraorbital artery and a section was shelled out by blunt dissection from the surrounding fat tissue and grasped provisionally with a hemostat. We were careful to leave behind no small nerve branches, and therefore did not forget that at times a second and less frequently even a third opening was present, through which single minor branches of the infraorbital nerve appeared.

The periosteum of the margin and floor of the orbit were stripped backward as far as possible. Then with a broad retractor the orbital contents and periosteum were carefully lifted and one could see the nerve, after the slight bleeding had ceased, as a white stripe through the translucent upper wall of the canal, and further back, lying free in the sulcus. As the periosteum had not been injured, the orbital fat did not interfere with vision; the insertion of the inferior oblique muscle did not have to be disturbed, as there was plenty of room.

The canal ran practically straight backwards and forwards; its bony walls were thin up to about ½ cm. of the foramen, where the wide inferior edge of the orbit formed its upper wall with a thickness of about 1 cm. At this place a wedge of bone was removed with a narrow, straight chisel. Further backwards the thin bony roof could be broken away with smooth forceps (Fig. 244, Plate 45). This method when possible is to be preferred, because in this way the exceedingly thin upper wall of the antrum of Highmore cannot be injured. If, as exceptionally happens, in addition to the canal proper there exists a second smaller one, which may be readily recognized in following back the freed-up nerve ends, this also must be chiseled open. Infrequently one finds the upper wall of the bony canal thickened throughout; then the nerve cannot be seen through it and one must carefully

chisel open the entire canal from the foramen backwards without opening the antrum. In this case the bony canal lay so deeply that the mucous membrane of the antrum was exposed here and there, resembling a bluish bladder (Fig. 244, Plate 45).

The entire contents of the infraorbital canal was lifted up out of the bony channel on a blunt hook as far back as the orbital fissure; the bundle was composed of the nerve, infraorbital artery and vein. The artery lay to the inner side and below. This is to be isolated only if it can be done readily, and when one is assured that no nerve fibres remain attached to the artery. The nerve forceps were introduced as far back as possible into the orbit, and, to accomplish this conveniently, from the outer side, and the nerve was drawn out proximally by a slow, constant pull. Although the artery was seized together with a nerve, there was no hemorrhage to mention. The peripheral nerve fibres were rolled up on the clamp by a very slow twisting, until the finest terminal branches came out from cheek, upper lip and ala of nose. This caused this region to be pulled up into deep folds (Fig. 245, Plate 45), inducing a complete anemia, which, after removal of the nerve branches and the sudden disappearance of the folds, was replaced by a strong hyperemia.

The wound was sewed up. For two days a thin drain was kept in down to the chiseled canal. After healing a small perceptible scar remained.

Once in a sixty-six-year-old man we found no nerve in the orbit. In following back the nerve from the pes anserinus minor by chiseling the surrounding bone it developed that the nerve ran outwards between the mucous membrane of the antrum and its bony wall to the malar bone, and did not enter the orbit. In this way it reached the spheno-maxillary fossa and foramen rotundum, as was demonstrated in twisting out the central end.

In this described manner one may remove the infraorbital nerve to a point behind the origin of the middle superior dental, and sometimes the posterior, which usually comes off within the inferior orbital fissure, that is, behind the orbit. Frequently we are able to demonstrate its inervation area to be anesthetic after the operation. On the other hand, the orbital nerve, or even the palatine and spheno-palatine nerve, can hardly be reached; to remove these we must use other operative procedures (Fig. 246).

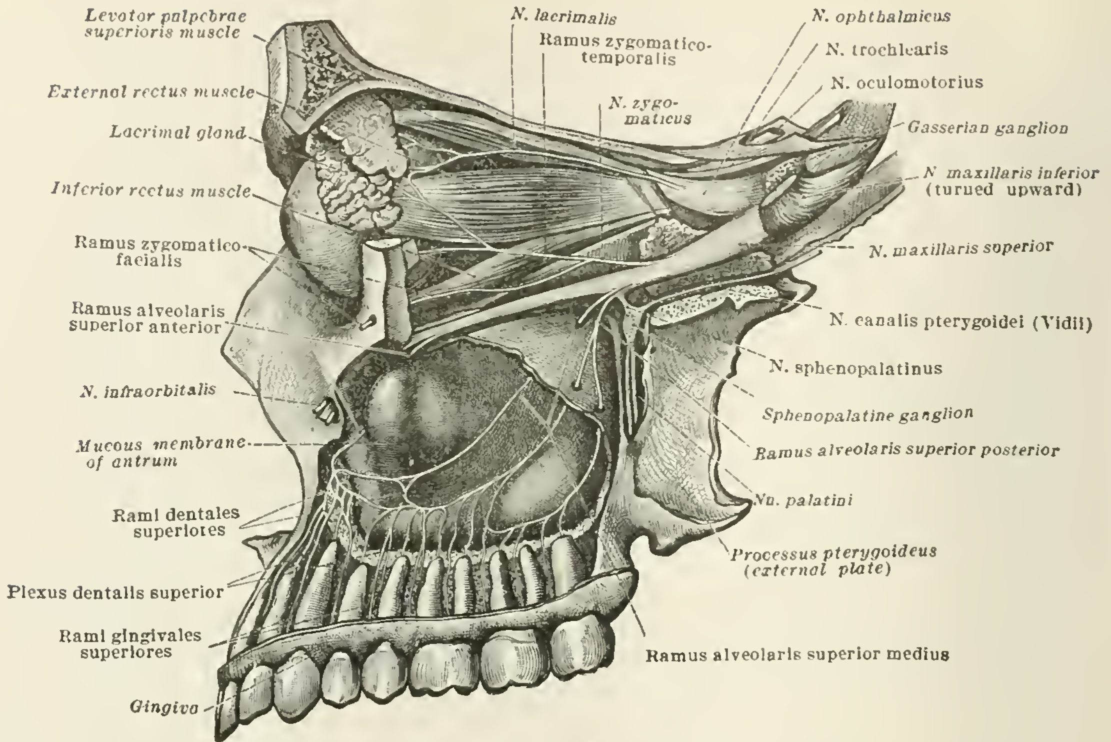

Fig. 246

The Dental Branches of the Superior Maxillary Nerve

Nn. alveolares superiores, the plexus dentalis superior and the rami dentales superiores, after removal of the external plate of the superior maxilla. The *zygomatic* nerve and its anastomosis with the *lacrimal* nerve. Left side, seen from the left. (The outer aspect of the mucous membrane lining the antrum is exposed.)

(From Toldt, Anatomischer Atlas. Fig. 1301, page 862.)

RESECTION OF THE ORBITAL NERVE

The history of a forty-two-year-old man otherwise healthy showed as etiologic factors in a right trifacial neuralgia, which had existed for four years, an injury of the cranium and a moderate degree of alcoholism. The painful attacks took their origin in the region of distribution of the right superior maxillary. But they went immediately over to the right lingual, and could only be temporarily influenced by various internal methods, by injection, and by electric light baths. Recently the attacks had increased continually in severity, pain was almost constant, so that the patient was unable to work and his nutrition suffered greatly.

Since, according to our observation, the attacks limited themselves to the distribution of the infraorbital and orbital nerves, as well as the lingual, it was decided that peripheral resection of these nerves was indicated, as a more serious operation appeared dangerous on account of the patient's debility.

Resection of the orbital nerve.

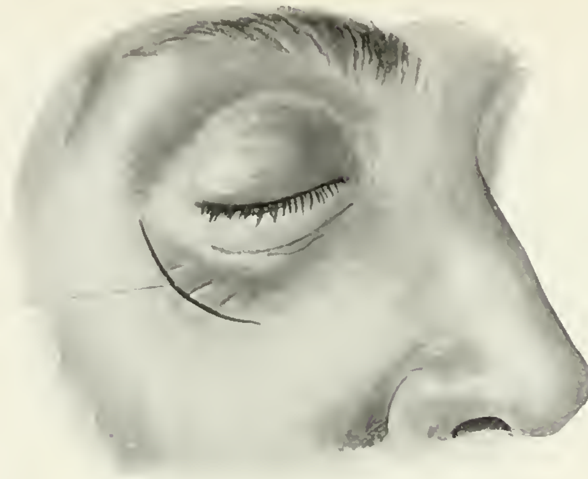

Fig. 247. Incision.

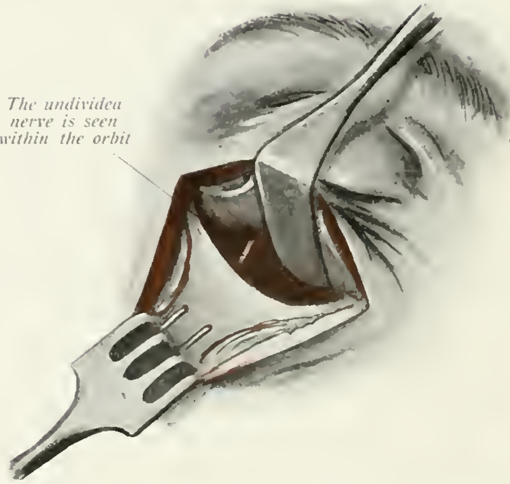

Fig. 248. Exposure of the trunk of the nerve and its two branches, the temporal and malar.

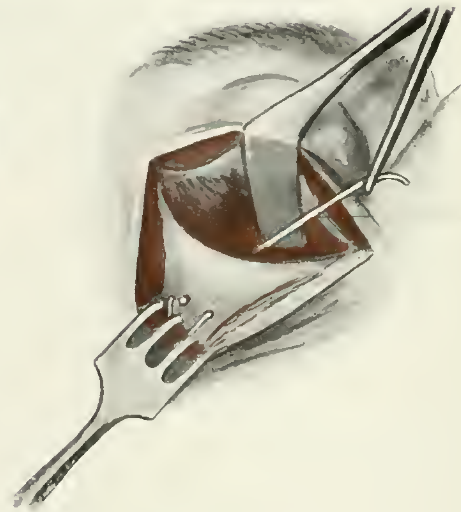

Fig. 249. The temporal branch is cut outside its foramen, and the trunk of the orbital is torn loose.

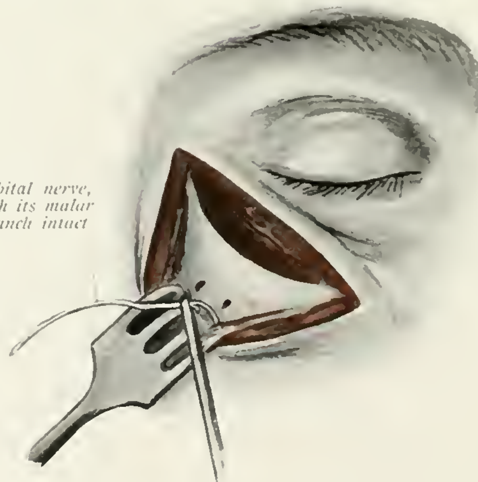

Fig. 250. The trunk is pulled out of orbit through canal.

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An incision 3 cm. long (Fig. 247, Plate 46) beginning at the outer corner of the eye was made along the outer inferior edge of the orbit through skin and orbicularis palpebarum down to bone. The periosteum of the orbit was stripped up until the undivided orbital nerve was visible above its entrance to the zygomatico-orbital canal (Fig. 248, Plate 46). The slight hemorrhage was controlled by gauze. The nerve was carefully exposed in the depths of the orbit until its point of origin from the infraorbital nerve was reached in the inferior orbital fissure. Then it was seized with nerve forceps and pulled out proximally (Fig. 249, Plate 46). Hereupon the periosteum was stripped from the outer surface of the malar bone until the nerve came into view. In this case there were, as commonly happens, two openings in the bone, and the two branches were of about equal size. As the division had taken place in the bony canal, one of the branches was cut off close to the foramen of the exit and the other was seized and pulled out together with the trunk (Fig. 250, Plate 46). Finally the peripheral branches were twisted out in the regular fashion.

If the division of the nerve into its two branches, the zygomatico-temporal and the zygomatico-facial, had taken place in the orbit instead of, as usual, in the zygomatico-orbital canal, then one would have found both branches under the periosteum of the orbit; and by investigating further backward one would always come upon the trunk itself.

In order to remove the infraorbital nerve in the same patient, the incision at the lower edge of the orbit was lengthened medially and the operation carried out as has already been described.

The skin wound was sutured. In order to prevent collection of blood in the orbit a small drain was left in for two days. Five days after its removal the wound was solid.

RESECTION OF THE SECOND DIVISION AT THE FORAMEN ROTUNDUM

The superior maxillary nerve can be exposed at its exit through the foramen rotundum only by osteoplastic resection of the zygoma, and dissection into the spheno-maxillary fossa. This operation is to be considered only in the infrequent event that nerves are affected which on account of their depth cannot be reached in any other manner, for instance, the palatine nerves, or if the pain from the beginning has covered the entire distribution of the second division.

A fifty-nine-year-old woman suffered for many years with neuralgic pains in the left upper jaw, which had developed as a sequel to root

inflammation of the wisdom tooth of the same side. Several bony operations were performed without result. Pain was felt over the entire infraorbital distribution, but was particularly severe in the region of the posterior dental, and the palatine nerves were also involved, so that resection behind their origin, that is to say in the spheno-maxillary fossa, was indicated.

The skin incision (Fig. 251, Plate 47) began a finger's breadth outside and below the end of the eyebrow, descended along the posterior edge of the frontal process of the malar bone and then ran in a flat arc, concave above, backwards and downwards to the lower edge of the zygoma and along this to the anterior origin of the articular tubercle. Here the incision turned obliquely upwards and backwards, ending just above the zygoma in front of the ear. In this case the temporal artery did not have to be divided. The temporal fascia was cut across along the upper edge of the zygoma, after retracting the skin upwards.

The zygoma was now exposed along its medial surface with the elevator, and, close to the articular tubercle, behind where the anterior root of the zygoma comes away from the temporal fossa, divided with bone-cutting forceps. Then after pulling the skin and subcutaneous tissue downwards and forwards, so that all of the facial branches which ran over the malar bone could be avoided, it was chiseled through obliquely in front.

Thereupon a Gigli saw could be pulled through under the anterior origin of the zygoma with the aid of a bent ear probe, and here it was sawed through in the line shown in Fig. 255. If the soft parts are normally movable, the zygoma, loosened from its connections, may be pulled down out of the way, together with the masseter and skin, with a strong four-pronged retractor. It is important to cut or chisel through the zygoma first at the thin place in front of the articular tubercle, and then to saw it, or, better still, to chisel it, through in front at the malar bone. If one proceeds in the reverse order, the thin and brittle roots of the zygoma may be splintered readily, which may open up the articulation of the jaw. The anterior bony incision must separate the zygoma entirely from the malar bone. It should also be made exactly from the angle obliquely downwards and forwards to end at the zygomatic tubercle, the point of junction of malar bone with superior maxilla. This technique gives plenty of room in this narrow operative field.

The approach to the spheno-maxillary fossa in our patient was now

Resection of the superior maxillary nerve at the foramen rotundum.

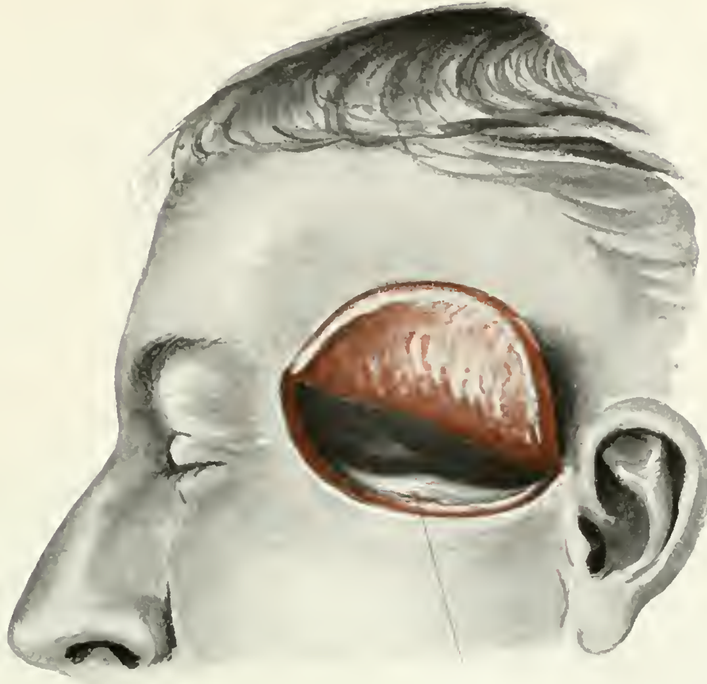

Fig. 251. Skin incision; the shallow flap is turned upward.

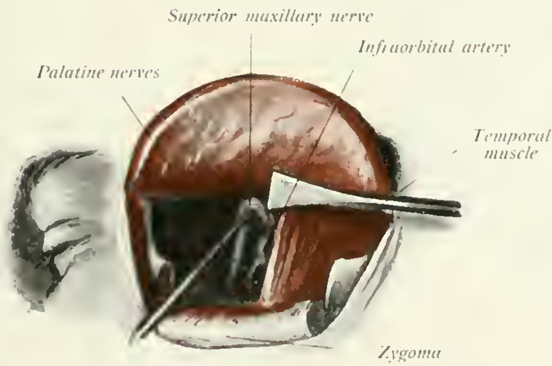

Fig. 252. With the zygoma turned downward and the temporal muscle retracted backward, the superior maxillary nerve can be lifted up on a blunt hook.

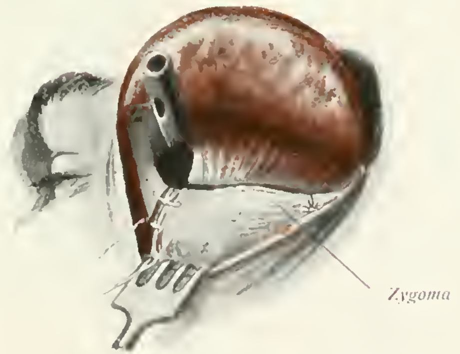

Fig. 253. The zygoma is held in place by periosteal sutures, and a drainage tube is inserted.

Fig. 254. The nerve is pulled out through the infraorbital canal.

Rebman Company, New York.

free; only the anterior fibres of the temporal muscle, which run to the coronoid process, had to be divided. Its powerful tendon was pulled backwards with a right-angle retractor (Fig. 252, Plate 47). Proceeding into the depths with small sponges and a blunt elevator, we maintained a forward course along the posterior surface of the superior maxilla, in order in this way to reach the spheno-maxillary fossa below the inferior orbital fissure. The fat and the not-to-be-depreciated venous plexus, which made up the contents of the fossa, were pushed backwards and held with a broad, blunt retractor.

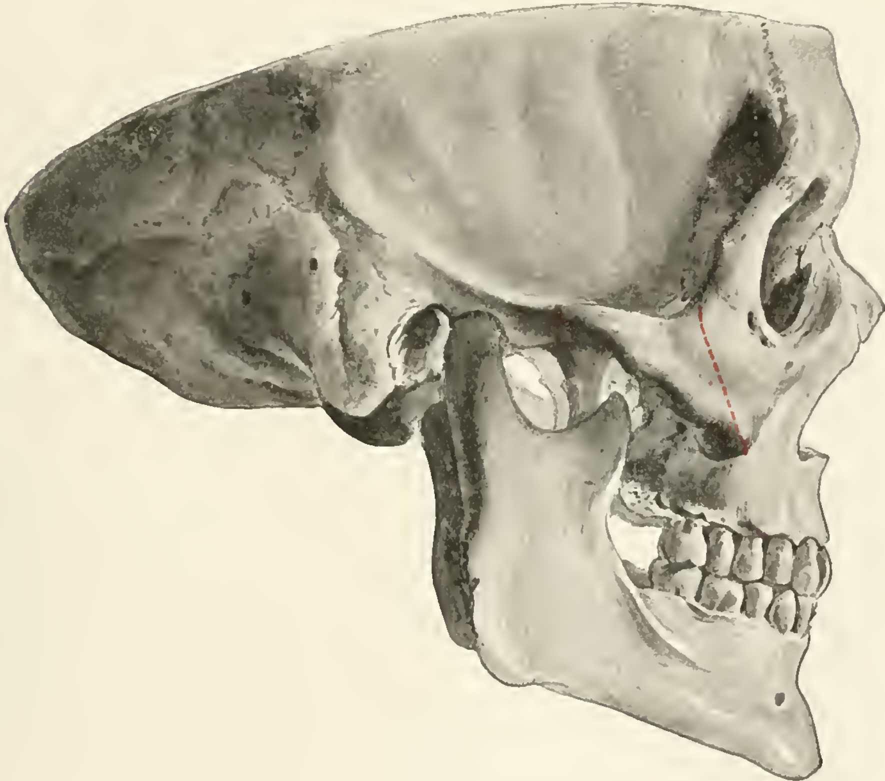

Fig. 255
Incisions through zygoma.

In order to protect the internal maxillary artery from injury, it was carefully freed with two smooth forceps from the little tabs of fat; it formed a tortuous curve and was pulled backwards with a retractor. In Fig. 252, Plate 47, one can see on its branches the infra-orbital and the descending palatine arteries, the internal maxillary itself being hidden under the retractor. We now proceeded towards the inferior orbital fissure, which could be readily located with a probe.

Any fat which interfered with the view in the depths was removed carefully with smooth forceps.

The superior maxillary nerve came into view at the narrowest portion of the funnel-shaped wound, which was about 6 cm. deep, at the point where, emerging from the foramen rotundum, it runs obliquely forwards and outwards, and a bit downwards, through the inferior orbital fissure to the sulcus, that is to say the infraorbital canal (Fig. 252, Plate 47). Here it could be hooked up with a small, sharp tenaculum, separated by blunt dissection, and lifted away from the infraorbital artery (a branch of the internal maxillary artery), which comes up from without behind and below. Now it was seized firmly in the nerve forceps, freed up a little further with the elevator under a continuous gradual pull, and cut behind the forceps close to the foramen rotundum. Thus both the superior, posterior, dental and the palatine nerves were removed at the same time.

If the infraorbital artery cannot be separated from the superior maxillary without considerable trouble, it is better to divide it, so that no nerve fibres remain behind; bleeding ceases after temporary packing.

To prevent collection of blood a drain was laid in the anterior corner of the wound down to the inferior orbital fissure and the flap containing bone and soft parts was laid back in place. The periosteum of the zygoma was drawn together with catgut sutures (Fig. 253, Plate 47), and over this the skin incision was united carefully.

The infraorbital nerve was exposed in the infraorbital foramen in the manner already described, and the entire root of the superior maxillary nerve was pulled out (Fig. 254, Plate 47). The twisting out of the peripheral branches (Fig. 245, Plate 45) ended the operation. The drain was removed on the third day, the stitches on the seventh, and the patient was discharged on the same day free of pain.

VARIATIONS IN TECHNIQUE

In this operation the exposure of the second division could be carried out at the foramen rotundum without ligature of the internal maxillary artery; but usually this is necessary, as the artery shows great variations in its position upon and between the two bellies of the external pterygoid muscle as well as in its branches, in which case it is double tied and divided between the ligatures. Ordinarily hemorrhage after ligature and division of the internal maxillary is slight, and at times it is entirely absent, which shortens the time necessary

for the operation, but there is sometimes severe hemorrhage from the pterygoid venous plexus, which is very disturbing in so narrow a field; nothing further can be done than to pack the wound with gauze and compress it tightly for a while.

Resection of the temporal process of the lower jaw is not necessary for exposure of the second division.

The avenue of approach to the depths of the spheno-maxillary fossa may be encroached upon if the maxillary tuberosity is unusually well developed. Krönlein in such a case chiseled away the bony process, opening the antrum; in this patient a fistula of the antrum persisted. We have tried another method in several cases. The palatine nerves (Fig. 246), which run down from the spheno-palatine ganglion, just before they enter the pterygo-palatine canal, lie between the posterior surface of the superior maxilla and the pterygoid process, more superficial than farther up toward the ganglion. There one may find them more readily, and if one lifts them up carefully on a hook, one can without difficulty follow them up and reach the spheno-palatine ganglion and the superior maxillary nerve.

If the approach to the spheno-maxillary fossa is particularly narrow, one may introduce a small right-angled hook in front of the readily palpable spine of the infra-temporal crest of the sphenoid down to the median boundary of the inferior orbital fissure, and pull out its entire content, consisting of fat, infraorbital artery and superior maxillary nerve. In this way the nerve may readily be isolated and resected.

The infraorbital artery may rarely pass through the middle of the superior maxillary nerve, so that the nerve appears to be split into two portions.

Lexer shortens the described incision in front and behind and carries it only along the upper edge of the zygoma. This method is good for experienced operators and for resection of the third division alone at the foramen ovale. For the second division it is not to be recommended. The narrow approach to the deep wound obstructs the view, particularly if bleeding occurs from the pterygoid plexus. Otherwise Lexer's technique is not very different from the one we have described.

Temporary resection of the zygoma to reach the second division at the foramen rotundum was first carried out by Lücke; but since his incision divides the branches of the facial nerve, we do not employ it. The same is true of the following modification of the method of

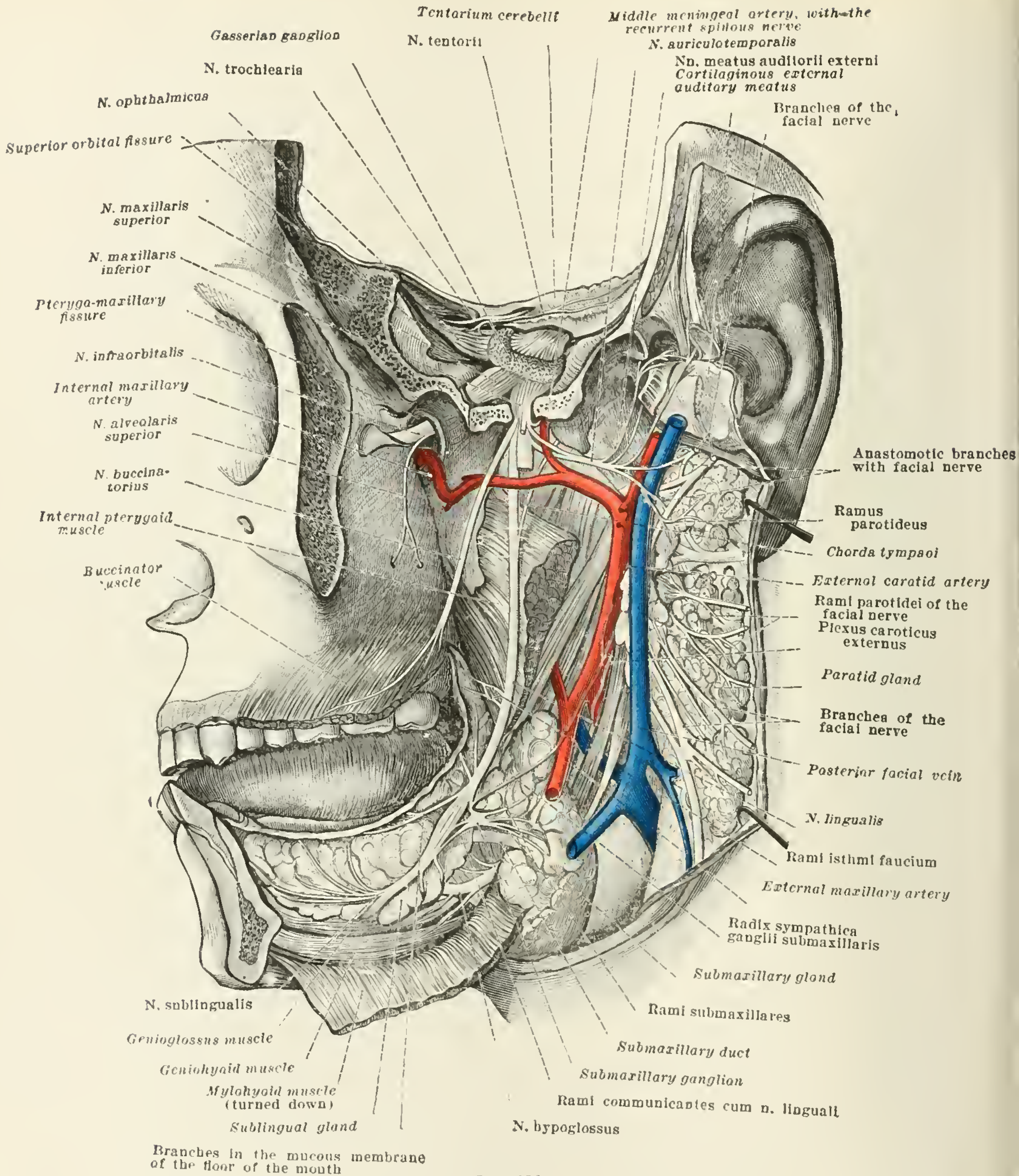

Fig. 256

The Third or Inferior Maxillary Division of the Trifacial. Its Motor Branches and the Inferior Dental Nerve are Cut Away Close to the Base of the Skull

(On the left side of the head an oblique incision has been carried down in front of the ear, through the parotid gland, the left half of lower jaw removed, and a wedge of bone removed from base of skull between malar bone and external meatus, with the apex at foramen ovale. The posterior portion of the parotid has been turned back, with the skin flap.)

(From Toldt, Anatomischer Atlas, Fig. 1304, page 864.)

Resection of the lingual nerve.

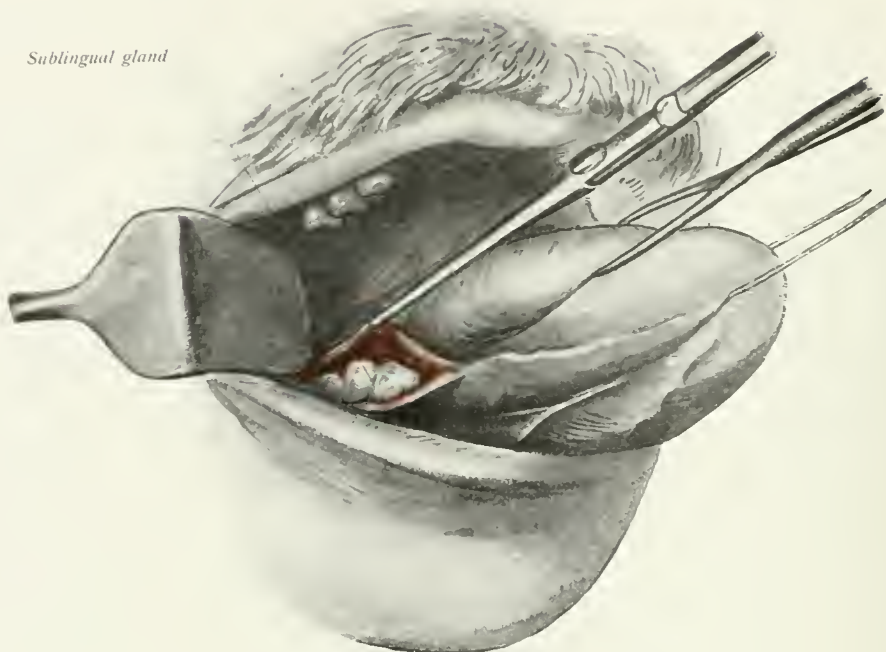

Fig. 257. Incision through mucous membrane.

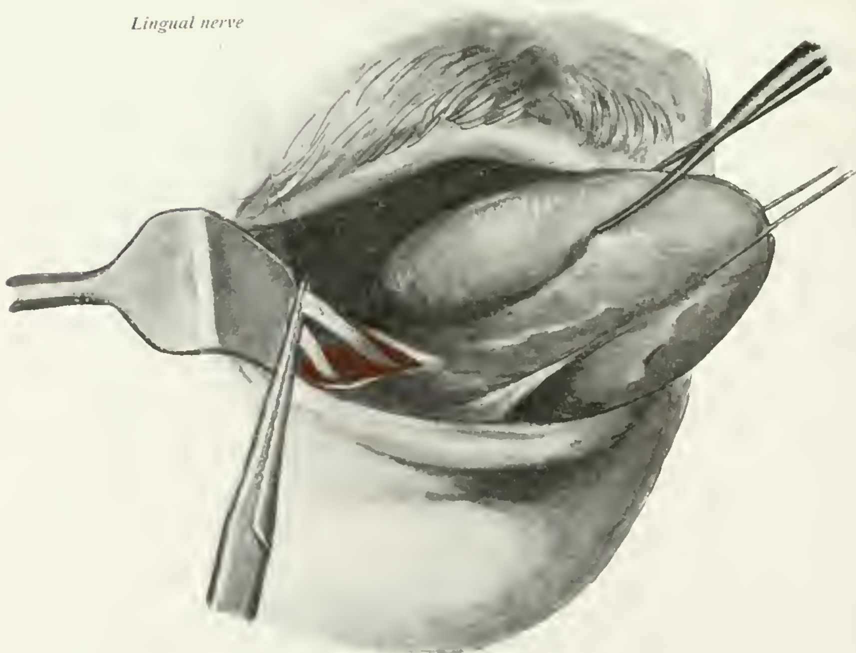

Fig. 258. Exposure of lingual nerve.

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Lossen and Braun: The right-angle incision begins 1 cm. above the outer canthus, 2 to 3 mm. from the outer edge of the orbit, and runs obliquely forwards and downwards to the neighborhood of the third upper molar to the point where the zygomatic process of the upper jaw can be felt as a projecting angle. The incision is carried through periosteum down to the zygoma; this is freed of periosteum on its medial surface and is divided in the line of the incision with a Gigli saw. The second leg of the right angle runs from the upper end of the first incision backwards to the zygomatic process of the temporal bone, and cutting skin and temporal fascia. The zygoma is freed of periosteum behind in front of the articular tubercle and divided, and the flap, which consists of skin, zygoma and masseter muscle, is turned downwards on its base and is held here with rake retractors.

This technique is to be recommended only if the previously described procedure is made difficult by scars resulting from previous operations.

THIRD OR INFERIOR MAXILLARY DIVISION

If the neuralgic pains limit themselves definitely and permanently to one branch, resection of this branch is indicated. We will discuss first the technique of operation on the single branches.

RESECTION OF THE LINGUAL NERVE

After the lingual nerve has entered the base of the tongue between the ramus of the lower jaw and the palato-glottidean fold, it lies in the neighborhood of the three last molar teeth just under the mucous membrane and exactly at the point of transition from the side of the tongue to the floor of the mouth. One may even see the nerve through the membrane.

In this case the patient was the same one mentioned on page 221. The mouth was held wide open, the cheek was retracted outward, the tongue was drawn out and upward to the left with tongue forceps, so that the posterior section of the tongue lay exposed on the right side. Then at the place described above, in the region of the last molar, at the anterior pillar of the fauces, the mucous membrane was incised not too close to the tongue, but at the point of junction with the floor of the mouth (Fig. 257, Plate 48). In this patient the nerve

was covered by the upper edge of the submaxillary gland, but after excision of a small piece of the upper segment of the gland it could be readily isolated and twisted out peripherally in the typical fashion (Fig. 258, Plate 48). Proximally it was pulled out as far as possible and cut. The small wound was sutured with interrupted catgut.

After ten days the mucous membrane of the floor of the mouth had healed under the employment of hydrogen dioxid. The tongue was freely movable in all directions. The patient, in whom at the same sitting the orbital and infraorbital nerves had been resected, remained three weeks in the hospital, and was then discharged without pain, in good state of nutrition and able to work.

RESECTION OF THE AURICULO-TEMPORAL NERVE

A sixty-eight-year-old woman had suffered for four years with severe attacks of pain in the right side of the face. The attacks at first came on daily, then as often as every hour, and as a rule lasted several minutes. Attempts at eating or talking induced attacks, so that the patient developed a distressing condition as regards nourishment. For no single week had the patient been without pain in the last five months.

According to her description, the attacks began in two centres, sometimes simultaneously and sometimes following each other closely. At times it was the outer lower edge of the orbit from which the pains radiated into the region of the right upper jaw, sometimes a point just in front of the right tragus, from which the pains radiated somewhat forward and upward to the region of the temple. Since the pains, apart from the infraorbital, definitely had their situation in the auriculo-temporal region, and operative procedure had to be limited to the utmost, on account of the great weakness and advanced arteriosclerosis, the auriculo-temporal as well as the infraorbital was resected.

The terminal branch of this nerve, the superficial temporal, which sometimes divides into two branches, may be reached by an insignificant procedure at the point where it emerges from the upper angle of the parotid and together with the superficial temporal artery runs upwards in the loose connective tissue in front of the auricle to the temple (see Fig. 256). More centrally the nerve is covered by the articular process of the lower jaw, and here it can only be reached by an operation which exposes the base of the skull from below.

A vertical incision (Fig. 259, Plate 49) was made directly in front of the tragus, beginning at the upper edge of the zygoma and running

Resection of the auriculo-temporal nerve.

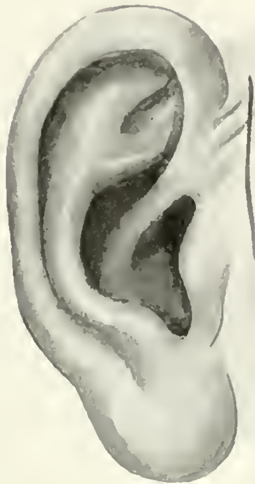

Fig. 259. Incision for exposure of the auriculo-temporal nerve.

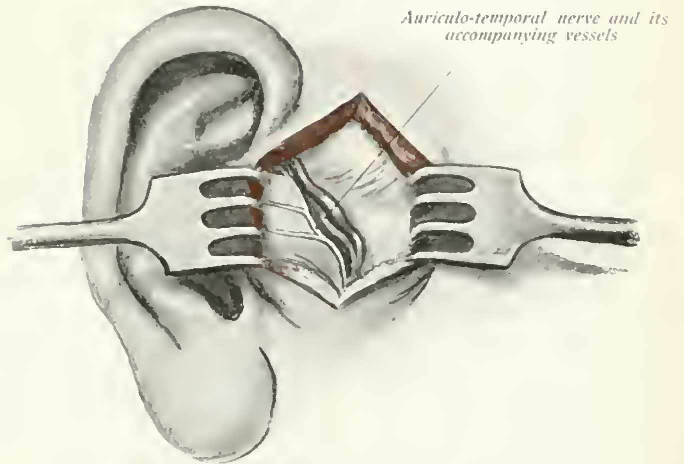

Fig. 260. Nerve and vessels exposed.

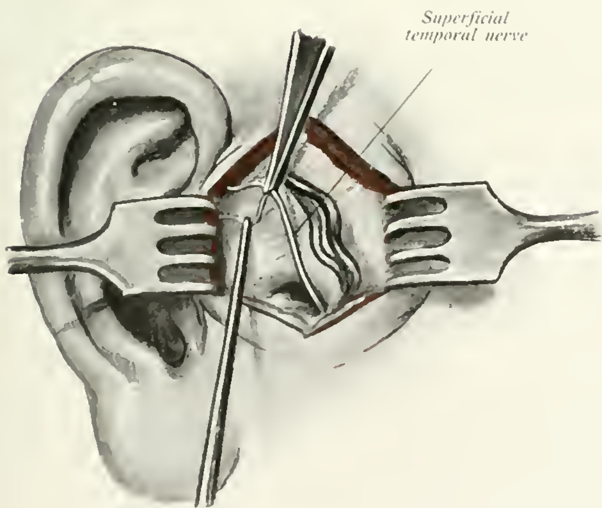

Fig. 261. Isolation of the superficial temporal nerve.

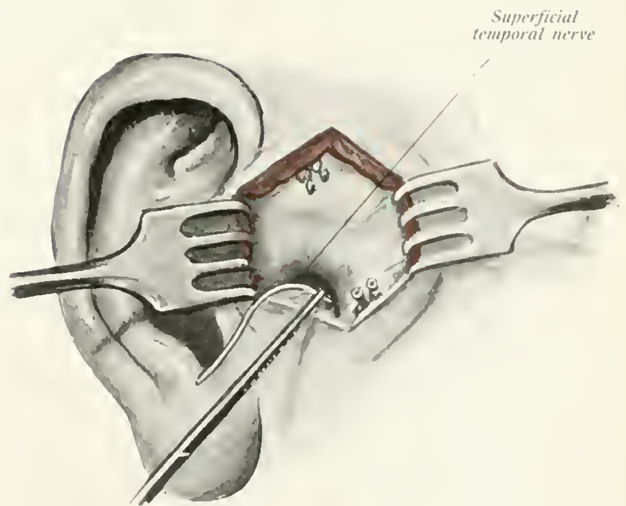

Fig. 262. Vessels are double tied and divided; the nerve is seized and pulled out centrally.

upward about 2½ cm. In this region of the face it is allowable to make a vertical incision, because from the lower edge of the zygoma upwards there are no fibres of the facial nerve of any significance. The incision separated skin and fascia down to the temporal fascia, but this does not have to be incised. Upon this lay the bundle consisting of temporal artery and the accompanying veins, and behind toward the ear the superficial temporal nerve, which sends many branches to the concha (Fig. 260, Plate 49). In this case two could be isolated and pulled out with the forceps (Fig. 261, Plate 49). Thereupon artery and vein were ligated as far above and below as possible, and excised, so that no nerve fibres might remain behind in connection with them. The trunk of the auriculo-temporal nerve could be followed until it disappeared behind the head of the mandible; it was seized in the depths and slowly twisted out (Fig. 262, Plate 49).

The wound was closed by clamps without drainage. The second day after operation the patient got out of bed; the wound healed per primam. No further attacks occurred.

The branches of the auriculo-temporal nerve running to the external meatus were not met in this procedure. They ordinarily leave the trunk of the auriculo-temporal nerve at the medial or posterior side of the articular process. This nerve, rising by two roots from the third division, close under the foramen ovale, and enclosing the middle meningeal artery, passes at the medial side of the neck of the articular process backwards in a horizontal direction over the internal maxillary artery and comes to the surface behind it (Fig. 256).

RESECTION OF THE INFERIOR DENTAL AND LINGUAL NERVES

Ordinarily for exposure of the inferior dental and the lingual nerves we employ a modification of the technique of Mikulicz.

In a fifty-year-old patient who suffered from neuralgia of the inferior dental nerve, repeated injections of alcohol were made into the trunk of the inferior maxillary at the foramen ovale. The first time the anesthetic effect lasted four months, the second, six weeks. As further injections were without result, the nerve was exposed in the inferior dental canal from the mental nerve up and resected. But after six months the pains returned and spread to involve the tongue. The patient coming to us, we carried out resection of the nerve in the following manner (Fig. 263):

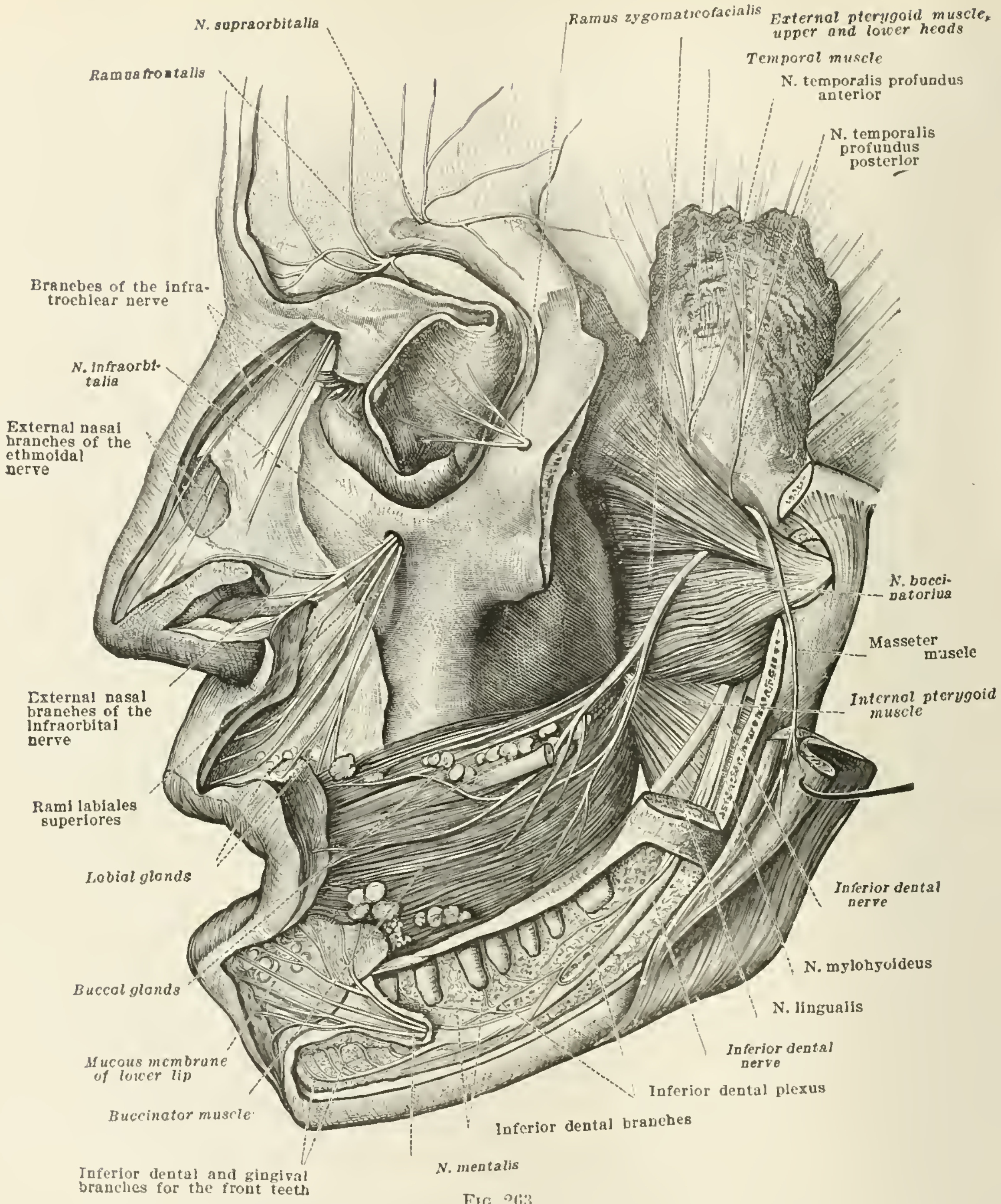

Fig. 263

The Inferior Dental Nerve, Its Course Through the Canal in the Lower Jaw, Its Branches, With the Inferior Dental Plexus, and Its Terminal Branch, the Mental Nerve. The Buccinator Nerve

Of the motor branches of the third division the deep anterior and posterior temporal nerves, and the masseteric. The zygomaticofacial branch of the zygomatic, the superior labial branches, and the skin nerves of the external nose. The branches of the first division to the region of the forehead.

(After removal of the zygoma, the proximal portion of the ramus of lower jaw, and the anterior plate of the body of the jaw. The lower portion of the temporal muscle has been removed, to expose the deep temporal nerves.)

(From Toldt, Anatomischer Atlas, 7th edition, 1911, Fig. 1305, page 865.)

Resection of the inferior dental and lingual nerves.

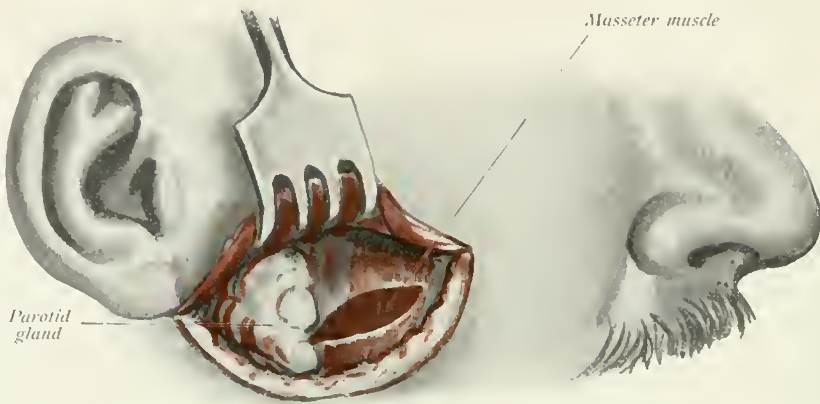

Fig. 264. Incision, through skin and masseter.

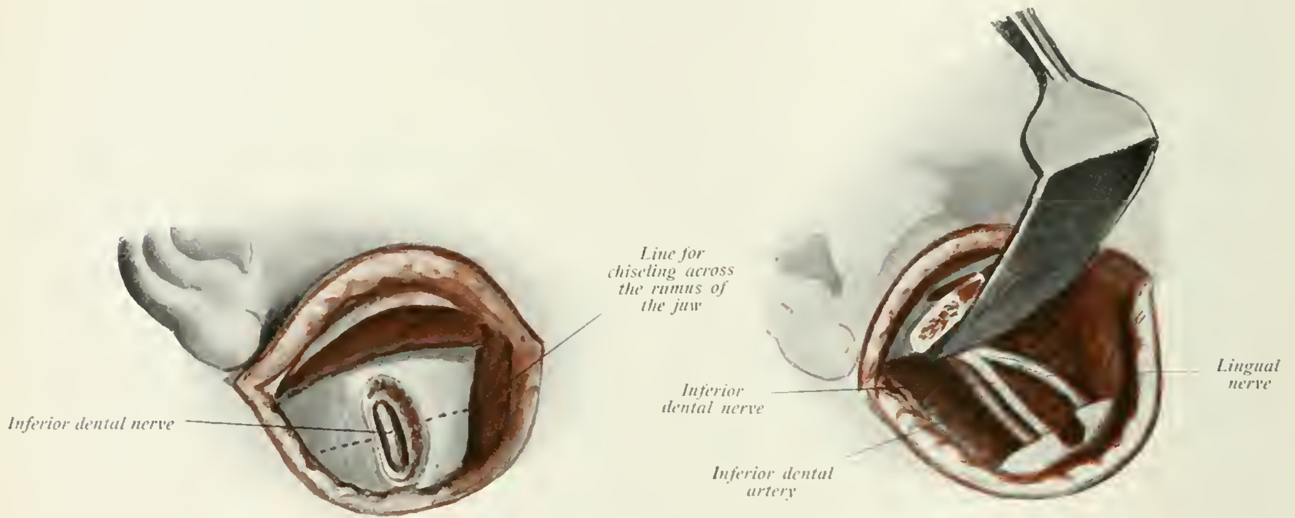

Fig. 265. Exposure of the ascending ramus of the jaw, and chiseling open of the inferior dental canal.

Fig. 266. The divided ends of the ramus are drawn apart, showing the nerves and vessels.

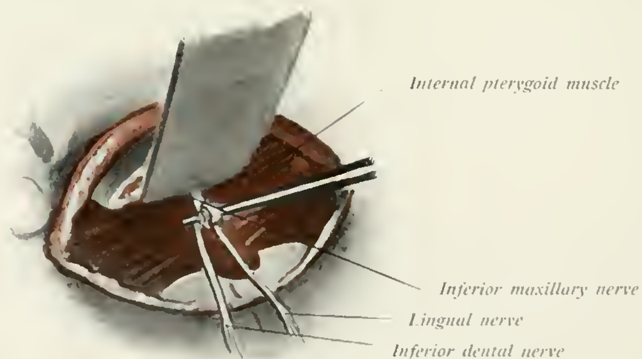

Fig. 267. Twisting out the inferior dental nerve, after its two terminal branches have already been pulled out.

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The head was laid upon one side, the affected side up, and was well lighted. The incision through skin and subcutaneous tissue began 1 cm. behind and under the lobe of the ear, curved around this (Fig. 264, Plate 50), and proceeded horizontally forward to the anterior edge of the ramus of the jaw. Its length was 6 cm. The incision running horizontal and parallel to the fibres of the facial nerve, their injury could be entirely avoided provided the small fibres which were met in the incision were avoided and retracted to one side. In the posterior corner of the wound the parotid gland came into view. Its uppermost section was exposed and carried backwards and downwards. The gland was accordingly not injured, nor was the duct of Steno, which ran below the incision.

The exposed masseter was divided transversely with a knife and the periosteum of the ramus of the jaw was divided in the same line. The periosteum was stripped back to expose bone. As a resection had already been performed on the inferior dental nerve, we had to look for adhesions in the inferior dental canal, and so this nerve was first exposed.

The internal orifice of the inferior dental canal lies about 3 cm. above the corner of the jaw and about equidistant from the anterior and posterior edges of the ramus. In front the opening is somewhat covered by a projecting bony process, the lingula. The canal itself runs through the bone somewhat closer to the medial surface than to the external. Accordingly, in the middle of the ramus an oval-shaped area of bone was chiseled out to expose the canal (Fig. 265, Plate 50), and it was extended upward until it reached the internal orifice. The artery lay above to the posterior side of the nerve, and further down to the medial side.

If no operation had been performed previously in the region of the inferior dental, this exposure would not have been necessary; in chiseling the lower jaw through transversely, the nerve may easily be protected from the injury, and it can be pulled out in its entire extent as far as the mental foramen. One may obtain the same result if with the Gigli saw he almost completely divides the ramus, and uses a chisel to complete the cut.

After exposure of the nerve in this case the ramus of the jaw was freed from soft parts on the medial surface with a bent elevator and chiseled through horizontally 1 cm. below the sigmoid notch. The upper portion could be brought almost horizontally upward and out-

ward, the body of the jaw was pulled downward and forward (Fig. 266, Plate 50).

The fatty body of the cheek (corpus adiposum malæ) lying along the anterior edge of the masseter does not have to be removed in this operation, but the deeper fat layer, which contains the nerves and vessels upon the external aspect of the internal pterygoid muscle as far up as the external pterygoid, does. After luxation of the upper portion of the lower jaw, the inferior dental nerve ordinarily can be pulled out of the canal at the lingula.

In the funnel-shaped space between the ramus of the jaw, the internal pterygoid muscle and the parotid, the apex of which was directed toward the foramen ovale, upon the freed-up internal pterygoid was found the inferior alveolar nerve, which had been divided at the previous operation, and, medially, the lingual nerve (Fig. 266, Plate 50). Along these nerves we proceeded upwards to the lower edge of the external pterygoid and met the muscle branches. The chorda tympani nerve was rendered visible by careful blunt dissection with smooth forceps (see Fig. 236) as well as the internal maxillary artery as it bridged over the two large nerves (inferior dental and lingual). This artery, however, did not have to be tied, as it could be readily displaced forward and held under a blunt retractor.

The common trunk of the lingual and the inferior dental nerves could be exposed slightly higher still. By careful blunt dissection the inferior maxillary could be freed from the surrounding soft parts for a considerable distance toward the base of the skull. From the ovale we were separated only by the external pterygoid muscle; therefore the origin of the auriculo-temporal nerve did not come to view. The inferior maxillary nerve was seized in the nerve clamp as high up as possible, under careful isolation (Fig. 267, Plate 50), taking particular care, on account of the depth of the wound, that only the nerve was caught in the clamp. The root was then pulled free from the base of the skull by a pull which at first was very weak and then increased in strength until it became quite powerful. If this had not been successful, the nerve could have been pulled down at least 1 cm. and then divided with scissors high up above the origin of the branches. Finally the lingual nerve with its peripheral branches was twisted out in the forceps; from the inferior dental nerve also, in spite of the antecedent resection, a considerable segment could be obtained.

After completion of the operation, the upper bony fragment was replaced; three muscle-periosteum stitches sufficed to hold it in posi-

tion. Bone sutures are not necessary in this operation. At the posterior corner of the wound a drain was kept in for three days, the skin wound being sewed up. One week after operation, the patient was discharged without pain. This favorable result persisted for two years; at the same time it was demonstrated that there was no paresis in the distribution of the facial nerve or any limitation of the motion in the healed lower jaw.

In the method described for dividing the lower jaw injury of the mucous membrane of the mouth is avoided because the internal pterygoid muscle lies for the most part external to it. The incision described runs above the branching of the facial, and near the division of the internal maxillary into inferior dental and lingual. Also the parotid is encountered only in its uppermost section or not at all, and can be shoved to one side. Moreover in chiseling through the ramus of the jaw, one does not have to approach closely to the sigmoid notch; sometimes in old people the bone may splinter through into the notch.

If the internal maxillary artery obstructs the view, it can be tied and divided between the ligatures, but we have found this only exceptionally necessary. Usually it is preferable first to twist out the inferior dental nerve and then the lingual peripherally; then keeping the long nerve ends under tension to proceed upwards along them. In order to follow the nerve centrally to the origin of the auriculo-temporal and the foramen ovale it is necessary to pull the external pterygoid muscle strongly forward and upward after the fibres which run from before backwards across the nerves have been torn so far as necessary with forceps or elevator. One also finds the auriculo-temporal nerve behind the lingual and inferior dental, forming a loop about the middle meningeal artery (see Fig. 256). In this way it is possible to follow all the branches of the third division to the base of the skull. In tearing out the entire third division from the foramen ovale by the method described, one occasionally sees attached to the upper end of the white nerve a grayish red mass in which on microscopic examination ganglion cells are to be found; in this case extirpation has been carried into the Gasserian ganglion.

MODIFICATIONS IN TECHNIQUE

The technique described resembles closely that of Mikulicz who originated the temporal extra-buccal resection of the lower jaw. His incision runs from the mastoid along the anterior edge of the sternomastoid to the level of the hyoid and curves forward and upward to

the lower edge of the jaw which it mets at the anterior boundary of the masseter muscle. Here the incision goes down to bone; the periosteum is stripped up all around, just at the toothless portion of the body of the jaw behind the wisdom tooth, but the oral cavity is not opened. Ordinarily this is successful; at times, however, the mucous membrane is torn and necrosis of the sawed surface results, particularly in old persons, as even the most exact suture of mucous membrane does not always hold securely.

Mikulicz divides the jaw transversely at the anterior insertion of the masseter with the Gigli saw, and separates the insertion of the internal pterygoid from the bone with scissors. After the ramus of the jaw is luxated as far outward as possible, the procedure is continued as given above. Finally the bone is sewed together with aluminum bronze wire, which is unnecessary in the technique we have given.

RESECTION OF THE THIRD DIVISION AT THE FORAMEN OVALE

In a forty-six-year-old patient the inferior dental and lingual nerves were removed on account of right-sided neuralgia. A severe recurrence made resection of the third division at the foramen ovale necessary. The incision (Fig. 269, Plate 51), in order to avoid the branches of the facial, began near the outer end of the eyebrow and proceeded along the posterior edge of the frontal process of the malar bone and the lower edge of the zygoma. At the posterior end it ran upwards and backwards obliquely in front of the ear, down under the bone. Temporal artery and veins were divided and ligated. In front a few fibres of the orbicularis palpebrarum were divided and the skin together with the facial branches was pulled down with retractors.

After the strong temporal fascia had been separated along the upper edge of the zygoma, the zygoma was chiseled through according to the method of Lücke (see pp. 222, 235) first behind, in front of the articular tubercle, then in front in the oblique line already described. The skin flap was turned upward and the zygoma in connection with skin, the parotido-masseteric fascia, and masseter muscle were dislocated downward, so that after removal of the covering layer of fat the temporal muscle with its insertion into the coronoid process of the lower jaw was exposed (Fig. 270, Plate 51).

This was freed up from muscle, the masseter without and the internal pterygoid within, by an elevator and cut off at its base with bone-cutting forceps exactly in the line which runs from the deepest portion of the sigmoid notch obliquely downward and forward to

Resection of the inferior maxillary nerve at the foramen ovale.

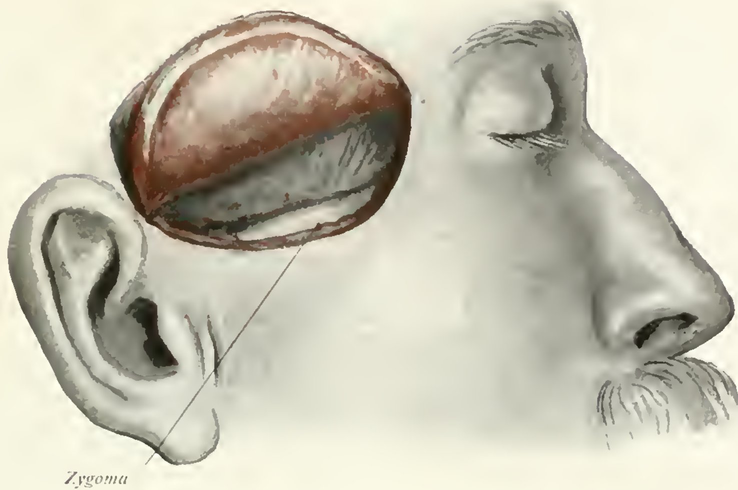


Fig. 269. The incision is made, and the shallow flap turned upwards.

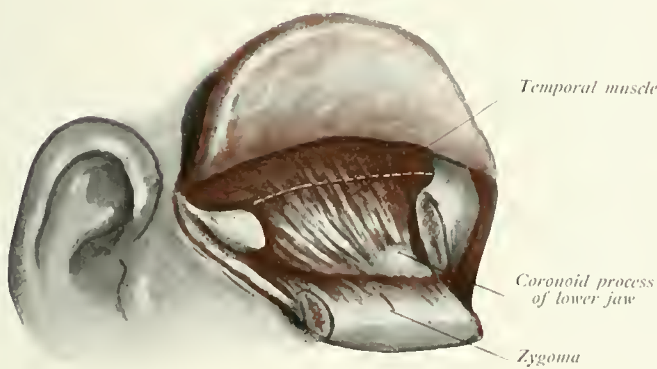


Fig. 270. The zygoma is turned down, showing the line of incision of the temporal muscle.

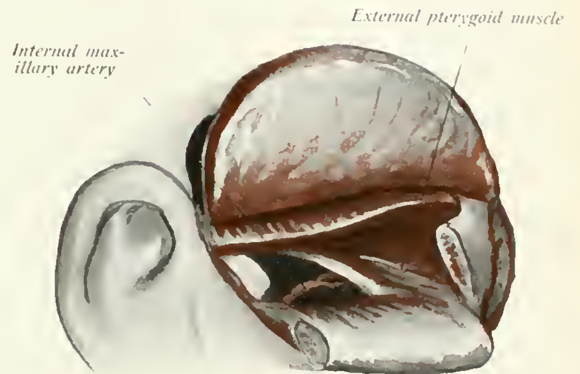


Fig. 271. The lower portion of the temporal muscle together with the coronoid process have been excised.

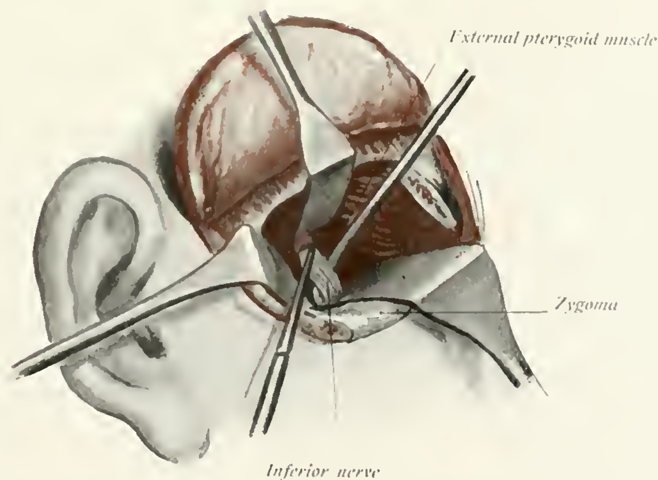


Fig. 272. The inferior dental nerve is lifted on a director and seized with a nerve clamp just below the foramen ovale.

the internal oblique line (Fig. 268). The loosened up process was turned upward together with the attached temporal tendon and was cut away with the lower portion of the temporal muscle. This exposed the infratemporal fossa and at the same time the external pterygoid muscle (Fig. 271, Plate 51). Between its two points of origin ran the internal maxillary artery, which sometimes also lies upon the muscle.

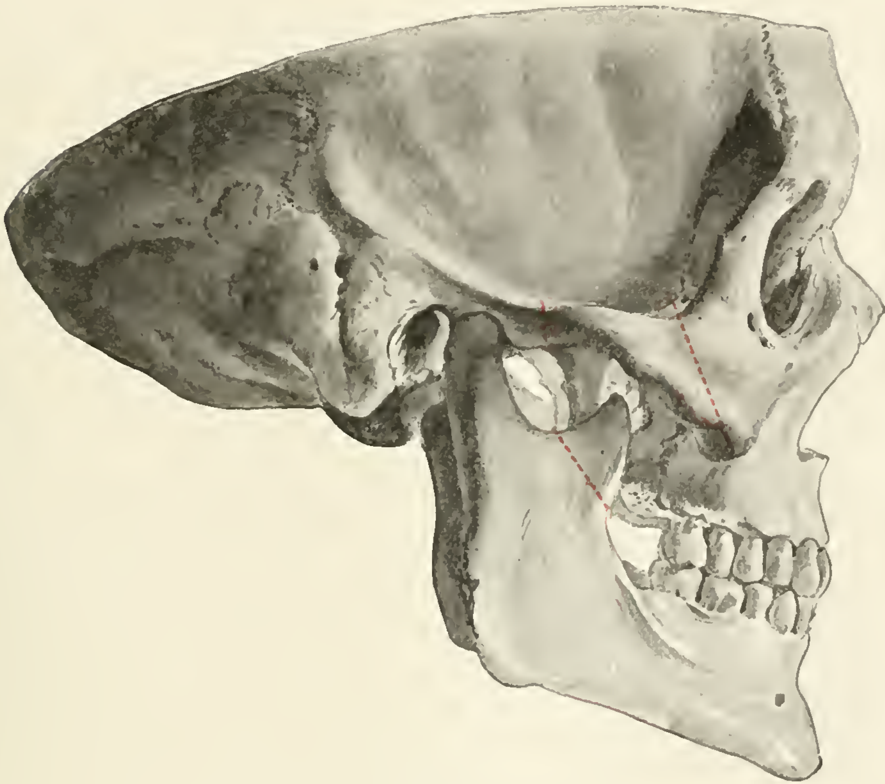


Fig. 268
Incisions through zygoma and coronoid process of jaw.

In exposing the external pterygoid muscle a large vein came into view which had to be double-tied and divided. The muscle was pulled upward and divided, and by blunt dissection with anatomical forceps the internal maxillary was further exposed, double-tied and divided. Then we proceeded down to the external plate of the pterygoid process, cleaned it up with a raspatory and gauze, and finally reached the posterior edge of the pterygoid just where its roots went over into the base of the skull at the foramen ovale. This occasioned strong venous bleeding from the pterygoid plexus. This could not be controlled by

compression with gauze but it ceased under pressure with sponges which had been dipped in adrenalin solution. The large nerve trunk coming out was exposed by blunt dissection (Fig. 272, Plate 51), seized in the nerve clamp and torn out from the cranium according to the method described on page 224. At the same time the otic ganglion was removed.

A drain was laid in the depths down to the foramen ovale and carried out above the zygoma. A few catgut sutures fastened the zygoma to its original site (see Fig. 253, Plate 47) and the skin wound was sewed up. The drain was removed in three days and six days later the patient was discharged without pain.

In isolating the third division at the foramen ovale, one should remember that a few millimeters behind it the middle meningeal artery, surrounded by the two portions of the auriculo-temporal nerve, runs through the foramen spinosum into the cranial cavity (see Fig. 256). Since it arises from the internal maxillary, after tying this off one is rid of it, and for this reason it is advisable, even in resection of the third division, to double tie and divide the internal maxillary artery. For itself this ligature is not necessary in order to reach the foramen ovale; the artery may be pulled to one side readily by a blunt retractor.

One must further give attention to the fact that just medially of the foramen ovale lies the Eustachian tube which if opened accidentally may cause not only damage to the ear but also trouble with asepsis. Accordingly as soon as one has exposed the third division so far as to be able to seize it, toward the middle line, one should not continue further in that direction.

The foramen ovale may be divided into two compartments by a bridge of bone.

REMARKS ON THE RESECTION OF THE SECOND AND THIRD DIVISIONS AT THE BASE OF THE SKULL

The essential principles of the methods described go back to Krönlein: but the incision is different. Krönlein's temporal method for the simultaneous exposure of the second and third divisions, using the Pancoast method of resecting the coronoid process, represents a development of the operative scheme of Lücke (see p. 225), and to-day stands as the best of its kind. He cuts out a semicircular skin flap in the region of the temple and cheek, the base corresponding to the upper level of the zygoma, extending forward to within a

finger's breadth of the outer edge of the orbit and backward close in front of the tragus: its vertex lies in the line drawn from the nasal orifice to the lobule of the ear. The flap is freed up from the parotido-masseteric fascia, the zygoma, and the lowermost section of the temporal fascia, care being taken to avoid the branches of the facial nerve, the duct of Steno and the temporal artery.

Then the temporal fascia is freed transversely from the upper edge of the zygoma, the periosteum is divided in lines corresponding with the two oblique incisions in front, and in back is shoved backwards slightly with the elevator. After the double division of the zygoma Krönlein proceeds as previously described. Only he frees the upper head of the external pterygoid muscle from its origin on the infratemporal crest and the lower surface of the greater wing of the sphenoid by blunt dissection with an elevator, draws it downward, and proceeds at once from the upper edge of the muscle, directly in the depths toward the middle line, holding close to the base of the skull.

By the method of Krönlein, the facial branches are divided; such lines of incision should be avoided so far as possible. For it is not a matter of little moment to destroy the nerves which run to the muscles which shut the eye, as one cannot depend upon the restoration of their function. A half-closed eye is not only a cosmetic fault, but it involves symptoms as the result of conjunctival irritation and increased secretion of tears. If on account of recurrence, extirpation of the Gasserian ganglion is to be considered, an existing paresis of the lower lid is a source of danger to the eye (see p. 243). Kocher upholds the principle that one should avoid the facial branches as far as possible and, following him, we employ for the exposure of the second division at the base of the skull the incision which he gives for the third division and which has already been described.

If the case is one with normal tissues and if there are no operative scars present in the region of the temple, this incision, according to our experience, is satisfactory; it has the advantage that only the facial fibres which go to the frontalis muscle have to be divided. The vertical incisions of Krönlein in such a case are unnecessary; when necessity requires one can always make use of one or the other of these incisions, in the proper length.

Kocher exposes the third division subperiosteally just at the foramen ovale. After osteoplastic resection of the zygoma, he does not divide the coronoid process of the lower jaw, but pries up the temporal

muscle along its posterior edge from the cranium down, allowing it to be drawn forward considerably with a blunt retractor. Only in case this procedure does not give enough room, does he divide the coronoid process just as in the Krönlein method. Blunt dissection, according to Kocher, gives a clearer operative field than cutting through the coronoid.

Hereupon he splits the periosteum forward from the anterior root of the zygomatic process of the temporal bone along the infratemporal crest, and frees it medially from the lower surface of the skull, that is to say, the great wing of the sphenoid. In that way all the soft parts are removed at the same time from the bony base of the skull without the least injury. Thus he proceeds to the origin of the pterygoid process. In this procedure we have several times experienced strong venous hemorrhage which was controlled with difficulty, particularly on account of the limited field of operation. Now proceeding backward close to bone, the foramen ovale is found readily palpable just behind and a bit to the outside of the sharp corner of the external plate of the pterygoid, on an average 3 cm. deeper than the anterior root of the zygomatic process of the temporal bone. The middle meningeal artery is visible behind the foramen ovale, and the internal maxillary and its other branches lie in the soft parts which have been pulled outwards, protected from injury by the covering periosteum.

In many cases with scar contraction there develops an interference with the movability of the jaw which may reach a high degree. It demands the most careful treatment with the Heister mouth gag. The cause is clearly injury of the temporal muscle and particularly of the insertion of its powerful tendon into the coronoid process. This great inconvenience is always prevented by not preserving the divided bony process, but by removing it with the tendon of the temporal muscle, the method originated by Pancoast. By this procedure the function of the temporal muscle affected is permanently destroyed, but on the other hand there are no later disturbances. The removal of the third division at the foramen ovale leads to incurable paralysis of the muscles of mastication on the affected side, including the temporal muscle.

THE SIMULTANEOUS RESECTION OF THE THREE DIVISIONS

If all three divisions are affected, one may remove them at one sitting. We have found the following succession practical. After the supratrochlear nerve is resected (see p. 213), the supraorbital in-

Extirpation of the Gasserian ganglion.

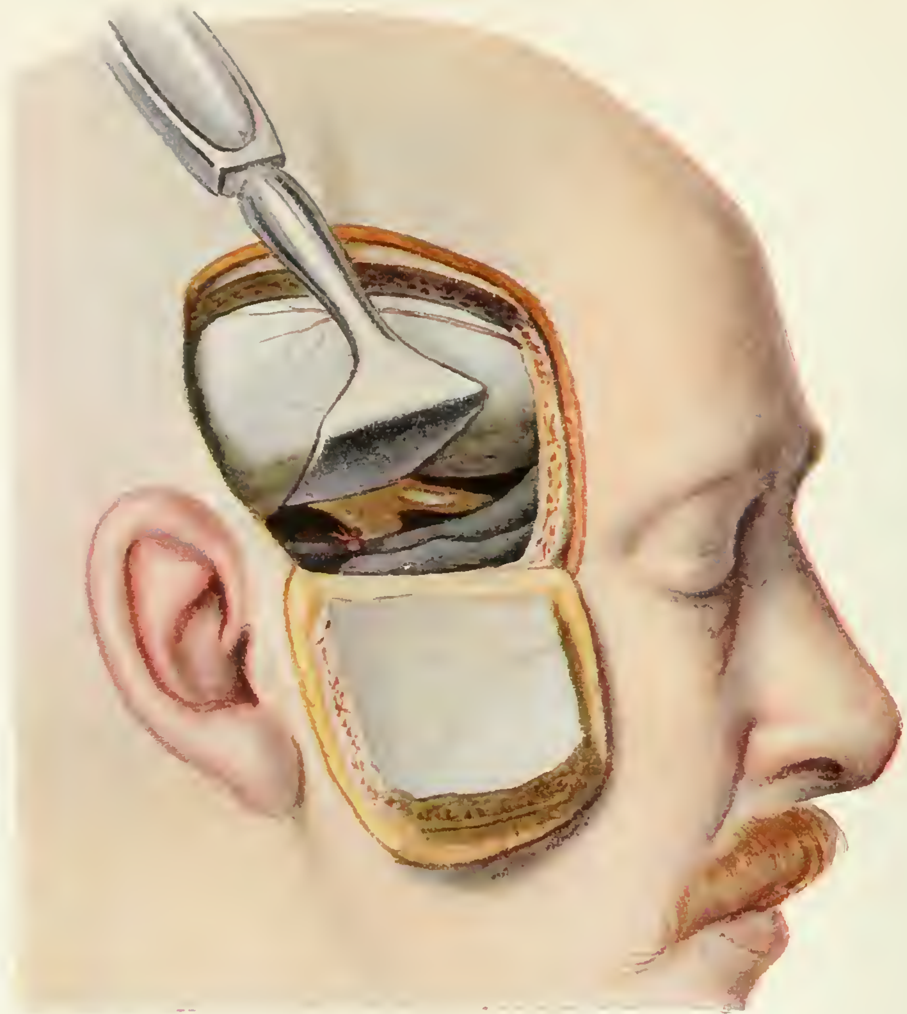
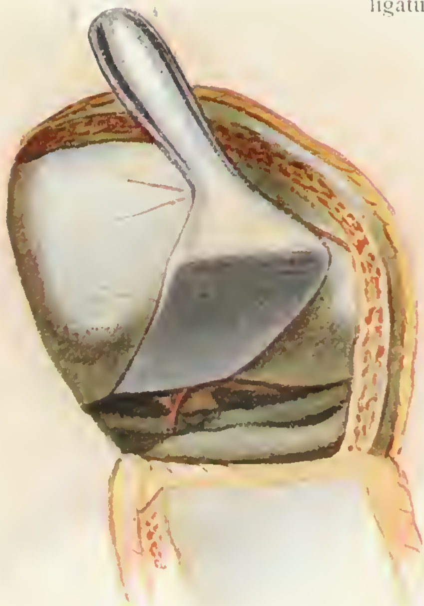


Fig. 273. Exposure of the 3rd and 2nd divisions, after ligature of the middle meningeal artery.



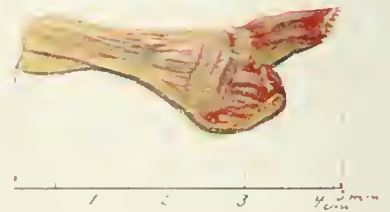


Fig. 275. Extirpated Gasserian ganglion together with the trifacial root (natural size).

Fig. 274. Previous exposure of the middle meningeal artery.

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cision is made continuing the zygomatic incision described on page 222, and the entire second division is removed in the described manner. For the exposure of the third division at the foramen ovale it is advisable first to divide the internal maxillary artery between two ligatures and to extirpate it as far as possible in front and behind, tying off each separate branch. In that way one avoids all arterial hemorrhage.

EXTIRPATION OF THE GASSERIAN GANGLION

For anatomical relations see Fig. 241, page 214, and Fig. 242, page 216.

A fifty-one-year-old man had suffered for eight years with severe right trifacial neuralgia in the region of the second and third divisions; four peripheral resections had been undertaken with temporary results. The last operation, December, 1908, was for the removal of the second and the third divisions at the base of the skull after the method of Krönlein. The scar over the zygoma was depressed a finger's breadth, as the zygoma had not healed in position, but had been displaced markedly downward. The mouth could only be opened so far as to make a narrow chink between the front teeth; the right eyelid could only be incompletely closed. The neuralgic attacks were uncommonly severe and occurred most frequently at night, so that the patient for months could not eat or sleep normally and had suffered greatly in nutrition. We decided to extirpate the Gasserian ganglion and the trifacial root, which was done on October 25, 1909.

The patient was placed on the operating table in the half sitting posture, the head lying backwards, an assistant holding it directed exactly forward, but turning it a bit as occasion required to the affected side in order that blood which collected in the depths of the wound, as well as the small amount of cerebro-spinal fluid which came away, could run out and not disturb the view. After a preliminary dose of scopolomine-morphine, under chloroform anesthesia, an acupressure needle was inserted above the zygoma through the entire thickness of the soft parts so as to surround and exclude the temporal artery, after the method of Heidenhain.

In the region of the temporal muscle a flap was formed after the method of Wagner, with a base below, which was composed of skin, fascia, muscle and bone (Figs. 273, 274, 275, Plate 52). The incision

began above the zygoma, which did not have to be injured in the least, close in front of the tragus; it ran convexly backward and upward describing a half circle, and came forward and downward in a convex fashion back to the zygoma, so that the base of the flap was 4 cm., its height 6 cm., and its widest point above 5½ cm. The incision penetrated all the layers down to bone practically without bleeding. The periosteum was stripped somewhat to each side and the skull was divided along the entire line. At the upper margin of the bony flap a hole was made in front and in back with a burr drill and starting from these the bone was cut with Dahlgren forceps, after having loosened the dura from the inner surface of the bone by means of a Braatz guide.

The flap of bone and soft parts was broken downwards with an elevator so that the dura mater was exposed (Fig. 273, Plate 52). This was very thin and had grown fast to the lamina vitrea so that great care had to be exercised in order not to tear the entire dura away from the bony opening; this would have greatly increased the difficulty of the operation. The line of fracture in the skull ran transversely in a zigzag line just above the zygoma; as is always the case, a strip of bone about 1 cm. wide had to be removed with rongeurs, to get rid of the margin of bone below, which obstructed the view, down to the base of the skull, that is to say, to the infratemporal crest. This rule should never be forgotten, the base of the skull must be freely exposed, or the procedure is rendered very difficult. The bony plate was made fast with two-toothed forceps, in order that it should not be loosened from the periosteum. Only a few vessels had to be tied. From the posterior edge of the bony opening another small strip of bone had to be removed.

The flap hung practically by skin and temporal muscle, and by freeing the latter together with periosteum from the greater wing of the sphenoid and from the temporal fossa somewhat further downwards with the raspatory, the flap could be laid down completely so that its skin surface lay upon the skin of the cheek. It was wrapped in gauze and, with the clamps which were attached, in the half-sitting position of the patient, it hung down low enough so that no pull had to be exerted on the sharp retractors which were placed in the temporal muscle. The dura mater was exposed to the point where it turned onto the base of the skull. The cerebral tension in this case was extraordinarily great, rendering the operation, which naturally proceeded extradurally, considerably more difficult.

Extirpation of the Gasserian ganglion.

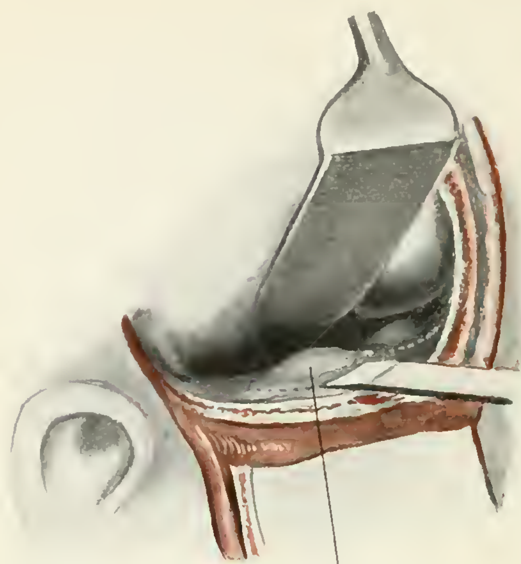

Fig. 276. Chiseling away the projecting eminence.

Fig. 277. Lifting away the dura in the middle fossa.

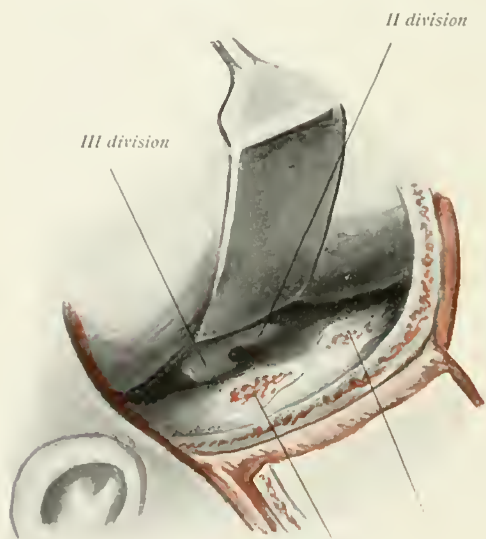

Fig. 278. Exposure of 2nd and 3rd divisions.

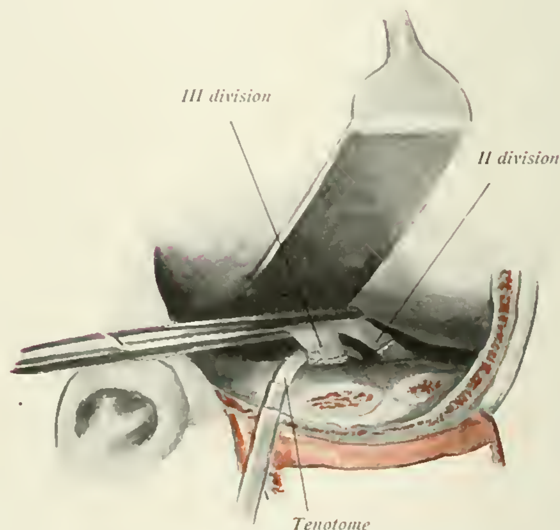

Fig. 279. The ganglion is seized transversely, and the 2nd and 3rd divisions are cut across.

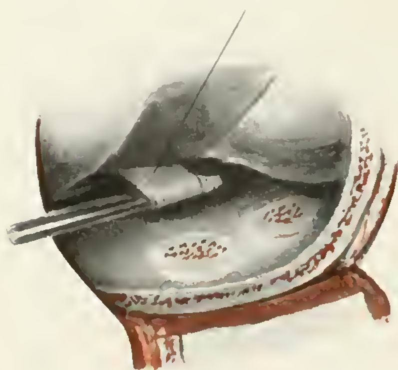

Fig. 280. Twisting out the trifacial root.

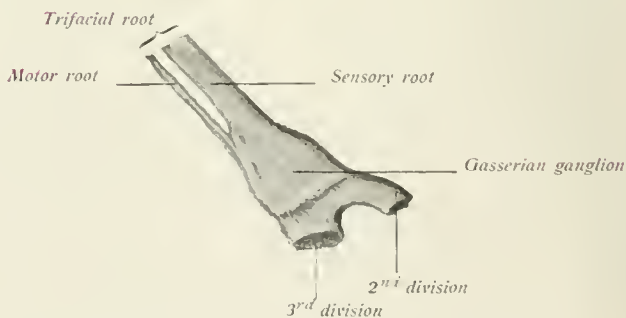

Fig. 281. The specimen removed (natural size).

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The dura was now freed up from the base of the skull in the middle fossa by blunt dissection. Difficulty developed first on account of the unusual tension, and second because the dura was remarkably thin and had grown fast to the bone and accordingly in loosening up tore in several places. Nevertheless it was successfully loosened in the typical manner by using in turn the fingers, small sponges held in forceps, and the elevator.

One of the eminentia capitata projected so far into the middle fossa that it had to be leveled off with the chisel in order not to interfere with the view in the depths (Fig. 276, Plate 53). Likewise in front the second eminentia capitata had to be chiseled off. This allowed us to proceed in the customary manner as far as the foramen spinosum. As the dura under strong tension was carefully lifted with a brain retractor, the middle meningeal artery was seen to be very small and showed no pulsation. It was torn through with the elevator without hemorrhage resulting. Clearly the earlier operator had ligated the internal maxillary artery according to the method of Krönlein and in that way had excluded the middle meningeal artery. The typical method of ligating and dividing this artery is shown in Plates 52, 54 and 55.

After disposing of the middle meningeal artery the retractor was allowed to remain and we proceeded gradually toward the middle line, lifting up the dura with an elevator or small sponge, always avoiding with the utmost care any pressure upon the brain From time to time this procedure had to be interrupted to control bleeding. We then packed the wound below the retractor to its deepest point with sterile gauze, which we pressed firmly against the base of the skull. This controlled the oozing from the bone, and if the brain within the dura was allowed to sink back into its natural position bleeding from the dural veins ceased at once.

Soon the third division came into view and, a little further to the middle line and in front, the second division (Fig. 278, Plate 53). In order to free up both in their entire extent from the ganglion to their foramina of exit, we stripped the dura back from the nerves and lifted them from the underlying bone on a blunt-pointed bent elevator. This same procedure was also performed upon the ganglion itself, with complete success, after a few thin but particularly firm strands of connective tissue here and there were divided with the points of the scissors. Ordinarily, however, blunt dissection with a sponge sufficed. The dura was torn again in one small place and some cerebro-spinal

fluid came out. Finally the ganglion was loosened up below from the bone on a bent elevator and in this way was completely freed.

While the elevator was allowed to remain in place, the nerve clamp with longitudinal ridges was shoved all the way under the ganglion near its junction with the trifacial root, and seized it firmly (Fig. 279, Plate 53). We took particular care that neither a fold of dura nor the wall of the sinus cavernosus, nor one of the motor nerves of the eye were seized at the same time in the point of the forceps medially. Then the second division was divided at the foramen ovale with a curved tenotome (Fig. 279, Plate 53). The elevator under the ganglion was removed and the nerve clamp slowly twisted on its axis so that the trifacial roots, motor and sensory, were twisted out (Figs. 280 and 281, Plate 53). Finally with the elevator the peripheral stumps of the second and third divisions were pushed as far as possible into their foramina, and once more we examined the surface of the cavum Mecklii, which was now completely emptied of its contents, and lay freely exposed in its entire extent as far as the upper margin of the petrous portion. We saw further, that the foramina ovale and rotundum were completely empty.

A strip of vioform gauze was laid in the depths of the wound down to the foramen rotundum, since there was still some venous bleeding from this point, and a gauze drain in the posterior lower corner of the wound to prevent the collection of blood. Then the periosteum and muscle of the flap were sewed up with five interrupted catgut sutures and the skin was sewed with silk. The wound healed without incident. On the fourth day the packing, and on the sixth day the drain was removed; on the twelfth day the patient was allowed to get up. Four months later the patient, who had been pensioned on account of his sufferings, gave up his pension and has remained ever since without pain.

PREPARATION

This operation, which at times is quite severe, requires certain further consideration. As regards preparation, it is important to empty the bowels before operation, in order that the patient, who is apt to suffer from constipation as a result of the use of morphine, will have no distress during the first few days. The head need be shaved only over a considerable extent on the temporal region of the affected side; in women it seems inconsiderate to remove all the hair. In such a case psychoses may follow, which will disappear only after the hair has

regrown. The external ear is cleansed mechanically, washed out with 3 per cent. boric acid solution and plugged with sterile gauze.

KERATITIS NEUROPARALYTICA

As regards preparation of the eye, we formerly considered it necessary for the prevention of neuroparalytic keratitis to give atropine; we no longer hold this view. In order that the eye shall not be irritated, it is irrigated before operation with boric acid solution. The practice of sewing up the eyelids is not to be recommended, because it interferes with the view of the conjunctiva. If suppuration of the lachrimal sack occurs, considerable danger arises. We have twice seen hypopyon-keratitis occur. Once it healed under applications of atropine and chlorine water with a hardly visible corneal opacity; in the second case, however, where lagophthalmos paralytica was present as the result of a Lücke operation carried out on the other side, the suppuration partly on account of the poor closure of the lid and the drying which resulted, progressed over the conjunctiva and resulted in the loss of the eye. Particular attention is required by patients in whom, as the result of an earlier peripheral operation, closure of the lids is hindered by paralysis of the trifacial (see p. 237); in two cases of this sort under the moist eye dressing which was still used at that time, although it was changed morning and evening, we have seen a defect develop in the epithelium of the conjunctiva across the eye in a transverse strip which exactly corresponded to the edge of the upper lid when it was closed. The weight of the bandage sufficed to determine a slough in the conjunctiva, which had been robbed of its innervation, at a place corresponding to the sharp inner edge of the lid.

Since that observation we have dispensed with dressings for the protection of the cornea and have employed a large watch glass such as is used to protect the well eye in cases of purulent inflammation. A round hole half the size of the glass is cut in a square piece of zinc oxide adhesive, which is then used to stick it down about the edge of the orbit. The moist chamber forms the best protection for the conjunctiva; also small pressure sores of the epithelium, using atropine if necessary, heal in under the watch glass without disturbance. We change the adhesive every twenty-four hours and delicately irrigate the eye, but never douche it. The protective glass is employed as long as any disposition to inflammation or irritation is seen.

It has been said that trifacial keratitis may be avoided if the gan-

glion itself is not removed and the roots alone are divided, as done by Victor Horsley as far back as 1891, but with unhappy result. Without doubt this expedient produces a lasting break in the nerve conductivity and guarantees cure of the typical trifacial neuraligia in so far as it has its cause in the Gasserian ganglion or in the periphery, but physiology teaches us that the destruetion of a sensory root is never repaired. This can no more happen after division of the root of the trifacial or complete extirpation of the Gasserian ganglion than after dividing a posterior spinal root between cord and spinal ganglion or after removal of the spinal ganglion. But the ganglion operation is less dangerous, and for that reason is entitled to the preference; nevertheless indications for division of the trifacial root may arise, and we will say something more about this later.

We have in several cases after extirpation of tumors at the cerebello-pontine angle observed neuroparalytic keratitis, and in two patients as early as twenty-four hours after operation. In all these cases the cerebellum was mechanically injured and shoved to one side, and in that way the trifacial root was torn. But we have proceeded over the upper edge of the petrous portion of the temporal bone forward to the middle fossa, that is to say to the neighborhood of the Gasserian ganglion, only a few times. These cases we will leave out of consideration here; for in them the trifacial root as well as the Gasserian ganglion may be injured. We have repeatedly observed neuroparalytic keratitis after injury or tear of the trifacial root limited to the posterior fossa. This happened, for example, in a patient thirty years old in whom a tumor of the cerebello-pontine angle was readily removed. She showed an important diagnostic sign, areflexia of the affected conjunctiva. Five days after operation a definite keratitis developed, which healed slowly under a watch glass and the use of atropine and boric acid drops. But as soon as the watch glass was left off for twelve hours the conjunctiva became inflamed again and a year later the inflammation was still present.

Our observations show the mistake of the assuming that only injury of the Gasserian ganglion causes danger to the eye, and that injury or resection of the trifacial root does not lead to neuroparalytic keratitis. Our observations have been entirely clinical, but on the other hand, Sultan has shown by experiments on dogs that cutting the root likewise causes keratitis, for of five dogs operated only one escaped inflammation.

The danger to the eyes in men is not nearly so great as in animals;

at least we have seen many cases of keratitis after extirpation of the Gasserian ganglion, often in the most severe form, clear up under suitable treatment (rest in bed, atropine, boric acid solution, watch glass). After extirpation of the ganglion the danger of keratitis is greater just after operation than later, although the anesthesia of the eye is lasting. For instance, one case operated January 31, 1893, at that time sixty-eight years old, is still living in good health. Soon after the extirpation she developed neuroparalytic keratitis, and since that time, although she has taken no precautions, has been free of any further inflammation; and we might cite many other similar cases.

REMARKS ON TECHNIQUE

If scar depression at the zygoma as the result of earlier operations endanger the nourishment of the skin and bone flap, the base of the flap may be laid posteriorly. The transverse division of the temporal muscle at its lower edge is immaterial, as resection of the third division at the base of the skull causes permanent paralysis of the muscles of mastication. However, the base of the flap should ordinarily come below, as in this way the bony plate is best nourished.

The hemostatic suture of Heidenhain prevents loss of blood; accordingly with this technique one can best preserve the bone. Moreover, if the bone is removed, in the course of time the entire temporal region becomes depressed. In operating under adrenalin-novocain, the Heidenhain acupressure method is not necessary.

In certain cases we find the dura grown so fast to the lamina vitrea that it is torn in freeing it with the Braatz guide, or it is cut with the Dahlgren bone forceps. In such case one must be very careful in turning down the bony plate not to tear the dura off over the entire opening. With a thin and friable dura one should proceed very carefully along the base of the skull.

The length of the brain retractor (see Plates 52 and 53) is about 8 cm.; the distal 5 cm. is ribbed. In ordinary skulls the end of the handle, if it is held obliquely, lies against the skull, giving the assistant a point of support. In very wide skulls it would be of advantage to have the retractor 1 or 2 cm. longer. It should lift the brain in its dural envelope upwards very slightly, but should not force it toward the middle line. In certain cases the surgeon may hold the retractor with the left hand, while operating with the right. The handle of a bent silver spoon can be readily adapted for the purpose.

LIGATION OF THE MIDDLE MENINGEAL ARTERY

In freeing up the dura from the floor of the middle fossa, one comes first to the foramen spinosum and the middle meningeal artery, which enters the cranial cavity at this point. As a rule this should be tied off and divided. For this purpose the brain in its intact dura should be lifted carefully by the operator or assistant with a right angle retractor about 3 cm. wide, but only so far as is absolutely necessary for vision.

While the dura, just after opening the cranial cavity, is ordinarily under considerable tension, it now becomes more lax and gives plenty of room for vision and for operating. In lifting up the dura the middle meningeal with its accompanying veins appears as a distinct cord, running up to it from the foramen spinosum. If one loosens the dura from the base of the skull somewhat to the middle side of the artery with an elevator so that the second and third divisions are visible, the vascular cord becomes isolated on all sides (see Plates 52, 54 and 55), and one can then expose it to the extent of about ½ cm. and without difficulty carry a strand of small catgut around it with a flexible probe or fine ligature carrier. One now applies a fine hemostat between dura and foramen, ties off below it, removes the hemostat, and cuts the artery just at the dura. The vessel is now so well freed up that even if the ligature slips off, the vessel can be seized again. The catgut, on account of the depth of the wound, may best be tied between forceps. The technique described is so simple that it may be used for typical ligation of the trunk of the middle meningeal in other cases also.

In a certain few cases the ligature has slipped off because the artery was cut too close. If the stump cannot be seized again, the bleeding is immediately controlled by finger pressure, while a fine end of gauze is packed tightly into the foramen spinosum with a blunt-pointed instrument and allowed to remain for five days. The operation does not have to be interrupted. In many cases in which on account of arteriosclerosis, the ligature has cut through, a blunt right angle wedge-shaped hook is introduced into the orifice, is packed in tightly with a raspatory, and is twisted back and forth until the bleeding has entirely ceased; or it may be allowed to remain during the entire operation. If bleeding is re-established on pulling out the hook, it stops if the foramen is packed tightly with gauze or if the hole is plugged with dental cement.

Some operators do not tie the artery. It is possible to extirpate

the ganglion without tying in case the foramen spinosum is unusually far back of the foramen ovale. But nevertheless it is safer to ligate and divide, and this must be held as a principle.

VENOUS HEMORRHAGE

Hemorrhage arises from another source as soon as one begins to free up the dura from the base of the skull. This bleeding is diffuse and generally of considerable quantity, but it is practically always venous. Its predominating source is the veins of the dura; secondarily the small emissary veins of Santorini. These are torn in separating dura from the inner surface of the skull, and they are much more numerous than the anatomical text books would give one to believe. This disturbing hemorrhage is diminished if one makes the separation between dura and the base of the skull rapidly, using at first the forefinger, and it is greater if one dissects slowly with a blunt dissector. This rapid technique can be used at first without worry, because no dangerous increase in brain pressure can result; the finger can be used until one reaches the foramen spinosum. Then the brain elevator is inserted for the first time. Often a slight alteration in the angle of the elevator or an insignificant change in its position backwards or forwards suffices to control this bleeding during the further course of the operation.

If local anesthesia is employed venous bleeding, from the effect of the adrenalin, becomes slight or is entirely absent. In general anesthesia sponges soaked in adrenalin may be used with advantage.

MANIPULATION OF THE GASSERIAN GANGLION

If one seizes the third division with a small hemostat and puts it on the stretch, the ganglion is pulled out somewhat, which makes the exposure more easy; for this reason the three trunks should be cut through first, as they hold the ganglion fast in its position. In every case expose the ganglion as far as its inner edge, and as far backwards as the upper margin of the petrous portion, so that the trifacial root is visible. The ganglion looks like a network of fibres, and is grayish-red in color. The trifacial root is practically always white and striped (Fig. 275, Plate 52).

The first division is intentionally exposed only at its point of junction with the ganglion and not in its further course, as is always necessary for the second and third divisions. For it runs forward in the wall of the sinus cavernosus, and although, as we have shown, it may

be dissected free of this on the cadaver, conditions in the living are less favorable. Moreover, in its immediate neighborhood lie the abducens and the trochlear nerves and further to the middle line the oculo-motor; all injury, tearing or crushing of these nerves must be avoided.

Twice we have injured the sinus cavernosus; in a moment alarming hemorrhage ensues, but if one packs in a small sponge, the bleeding is controlled, and the operation may be completed without difficulty. As the brain is allowed to sink back in its normal position, after the operation is over, the bleeding ceases usually without further attention; the pressure in the sinus is very low. If not, one must leave a small strip of gauze packed against the bleeding point, with the end coming out through the wound.

After the ganglion together with the second and third divisions are completely freed, in order to be assured against all eventualities, it is seized behind obliquely by the nerve clamp at the point where it goes over into the trifacial root, that is to say, just in front of the upper edge of the petrous portion and close below the superior petrosal sinus, before one undertakes anything further. This point is marked in the Figure 282 by the black wire which is passed through it.

In dividing the second and third divisions at the foramina rotundum and ovale bleeding occurs; for certain small arteries and veins go through the foramina and in addition emissary veins of a certain considerable size which connect the sinus cavernosus and the pharyngeal and pterygoid venus plexuses. This hemorrhage usually stops of itself, but in any case, since it has its origin in the neighborhood of the bony canals, it is easily controlled. One simply bores with a dull instrument into the canal or stuffs gauze into it for a time under moderate pressure.

On twisting the clamp the entire ganglion follows, and in addition a greater or less extent of the centrally situated trifacial root. The first division usually tears off close to the ganglion. Since only the peripheral portion of it remains behind, from the point of view of the organism it is completely removed, as is demonstrated by the complete and permanent anesthesia of cornea and conjunctiva that results.

If one examines the cavum Meckelii, the depression will be seen to be empty. Close behind the foramen ovale in many cases will be seen not bone, but a gray-reddish mass which clearly has been torn up from bone, consisting of the stiff fibrous or fibro-cartilaginous tissue which at times occurs just in front of the entrance of the internal carotid into

the cranial cavity, and forms the upper lateral wall of the carotid canal, and in conjunction with a thin periosteal layer alone separates the lower surface of the Gasserian ganglion from the large artery. This relation we have been able to establish definitely in three operations. For that reason one should use no sharp instrument in loosening up the Gasserian ganglion from the bone, and even the elevator should not be sharp.

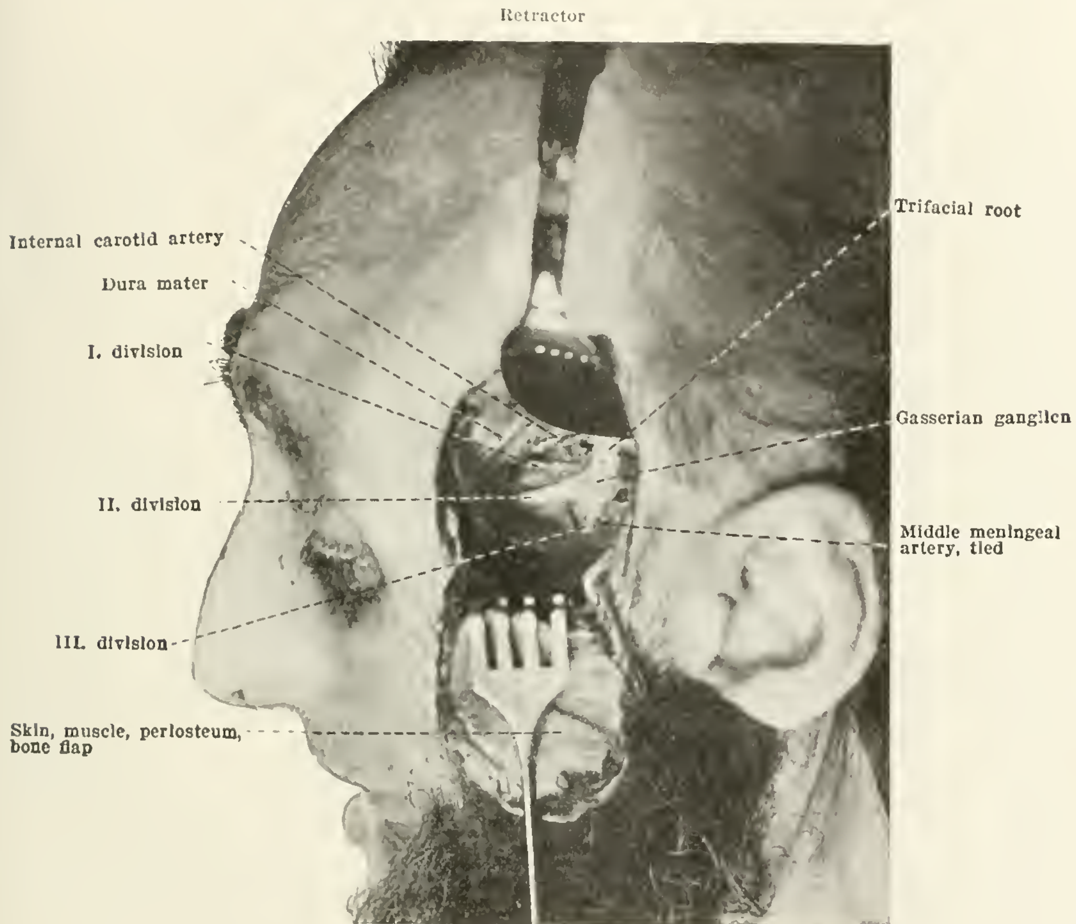

Fig. 282

Operative Field for Removal of the Gasserian Ganglion After F. Krause

Photograph about one-half natural size. On the cadaver the brain had to be lifted up, to get light into the depths of the wound, much more than is ever necessary on the living subject.

Moreover the carotid in its exit from its canal lies very close to the inner edge of the ganglion and of the trifacial root, but always far enough in order to be protected from injury if necessary care is used. At times it is surrounded by the sinus cavernosus. If one injudi-

ciously advances too far over the medial boundary of the root and of the ganglion the sinus will be torn and very disturbing bleeding will result. In none of our operations has the internal carotid been injured. If this mischance actually happened, packing the canal with gauze would have controlled the bleeding. This packing, on account of the size of the vessel and the intravascular blood pressure, should be allowed to remain at least eight or ten days. Filling the canal with cement is a safer method.

The length of time consumed by the operation depends largely on the amount of hemorrhage and the time which is required for its control. With considerable bleeding one must work slowly, and interrupt the procedure with careful sponging in order that all the necessary procedures can be carried on in the depths of the wound under direct guidance of the eye. But even if the operation takes a long while, it should be finished at one sitting, except under the utmost necessity. It is hardly reasonable to submit a person who has been rendered weak through long and severe pain to the danger of operative procedures twice within a short space of time.

Ordinarily the one stage operation with preservation of the bone takes an hour to an hour and a half. With slight bleeding it may be done in twenty to twenty-five minutes after the bone flap has been removed. The ease and expedition with which the extirpation may be performed under local anesthesia is due to the hemostatic effect of the drugs employed.

In all our cases the neuralgic pains disappeared immediately after the extirpation and only the pain of the wound, which could clearly be differentiated therefrom, persisted.

CARE OF THE WOUND AND AFTER-TREATMENT

When the operation is over and the brain has fallen back into place the bleeding ordinarily stops of itself or may be controlled by temporary compression. It is not necessary to pack the cavity with gauze, unless there is considerable hemorrhage.

The amount of cerebro-spinal fluid which comes out in the next few days from injury of the dura is usually slight, but it may be so great that the dressing will require changing daily. The secretion of the fluid gradually slows down and finally stops of itself.

The convalescence is ordinarily short. The majority of our patients get out of bed from the seventh to twelfth day after operation, and are discharged on the eighteenth to twentieth.

The two chief dangers of the operation lie in the hemorrhage and in the pressure to which the brain must be subjected. This latter depends in the first place upon the retractor upon which the brain is lifted; and secondly the general cerebral pressure is increased through secretion of cerebro-spinal fluid. This one may prevent, following the suggestion of Tiffany, by making a short transverse incision in the upper part of the exposed dura to give exit to the fluid.

OTHER METHODS OF EXTIRPATING THE GASSERIAN GANGLION

The method just described for the extirpation of the ganglion may be called the temporal method. On the other hand Doyen calls his

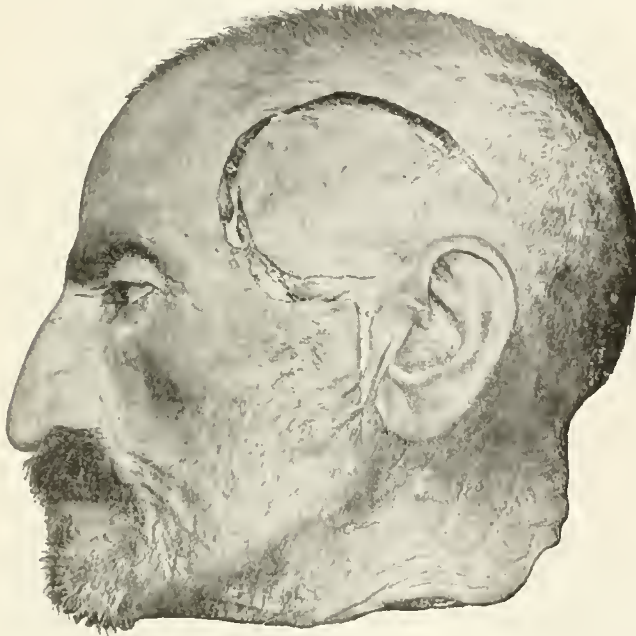

Fig. 283
Doyen's older technic. Incision.

technique, which represents a transition between the Lücke-Krönlein method and this, the temporo-sphenoidal method (Fig. 283). He performed his operation first on May 8, 1893, while this method dates from the year 1892 (intracranial resection of the second division), and the first real extirpation of the Gasserian ganglion was done by one of us (Krause) on the 31st of January, 1893. The patient, who is now eighty-seven years old, is still alive and without symptoms.

According to the technique of Doyen the skin incision should not go more than 15 mm. below the zygoma and should avoid all the facial

branches. The accompanying pictures will explain the technique. After separating the soft parts the zygoma and coronoid process are temporarily resected. The inferior dental and lingual nerves are

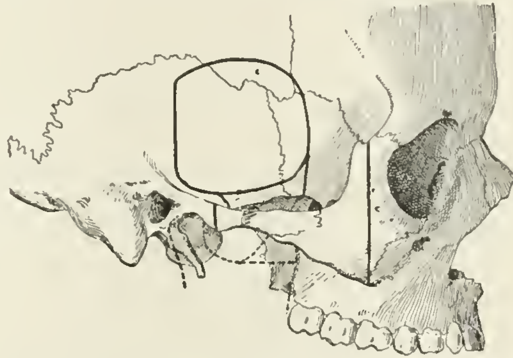

Fig. 284
Doyen's older technic. Bony incision, from the side.

found, divided, and the central ends are seized in a clamp. After the internal maxillary artery is tied, the third division is exposed to its point of exit from the foramen ovale. Then the temporal portion of

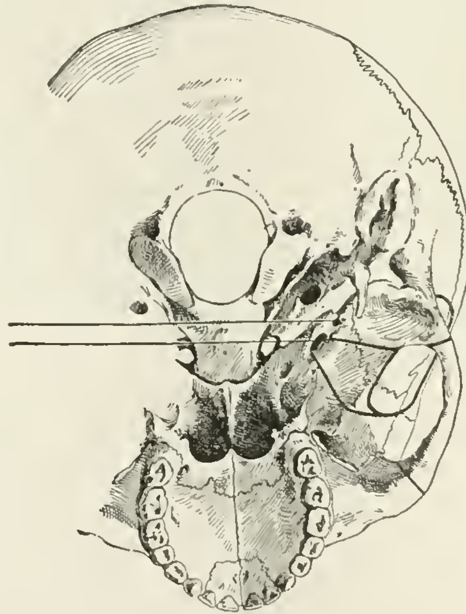

Fig. 285
Doyen's older technic. Bony incision, from below.

the cranium is temporarily resected, the base of the flap being placed behind. Now Doyen removes from the base of the skull, that is to say the horizontal portion of the greater wing of the sphenoid and the

neighboring portion of the temporal bone, little by little with rongeurs, as much as is shown in Figs. 284 and 285, so that finally the foramen ovale represents the apex of a triangular opening.

The third division is now put on the stretch by means of the clamp, which is attached to the inferior dental and lingual nerves and the dural sheath which surrounds the ganglion is opened. With the aid of this pull, one may free the anterior and posterior surfaces of the ganglion with the elevator, then the second division as far as the fora-

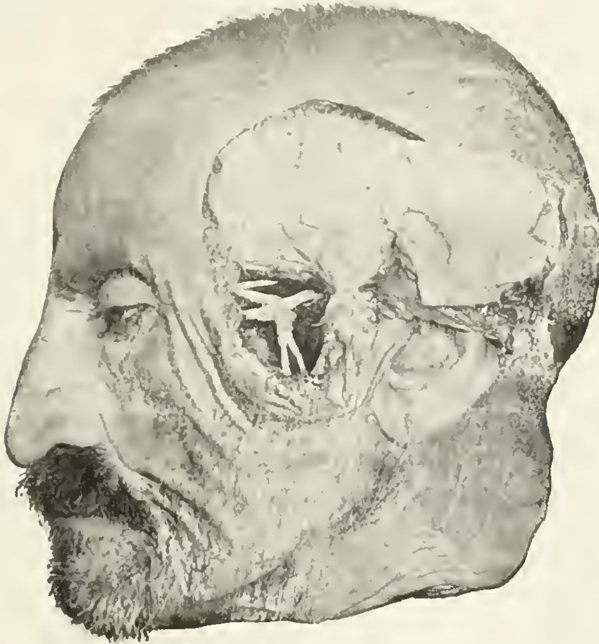

Fig. 286
Doyen's older technic. Exposure of the ganglion and its branches.

men rotundum and the first division as far as the orbital fissure, where they are divided. Hereupon the ganglion is isolated all around, while one mobilizes it through pull on the nerve trunks, and the upper edge of the petrous portion and the dural sheath which surrounds the trifacial root itself are exposed below the petrosal sinus. The trifacial root is isolated and divided centrally on the posterior surface of the petrous portion under the petrosal sinus.

More recently Doyen sacrifices the bone flap which he formerly preserved, and carries the vertical incision farther upward through the temporal muscle instead of forming a flap with a pedicle behind. He also makes the opening in the skull much smaller than before (Fig. 286).

The first technique of Doyen has been modified in many respects, thus Lexer makes a narrower temporal flap in order to avoid the facial branches going to the upper eyelid. Its base lies in a line joining the outer end of the eyebrow and the origin of the lobule of the ear; the apex in a line joining the upper edge of the orbit and top of the concha. The zygoma is chiseled through without injury of the soft parts covering it, the coronoid process is not resected, the divided portion of the temporal muscle is turned downward. Lexer sacrifices the piece of temporal bone and like Doyen removes the base of the skull till he reaches the foramen ovale. The brain retractor is used only in freeing up the ganglion. Cushing (Jour. Amer. Med. Assn., March, April, 1905) proceeds in a similar fashion.

COMPARISON OF THE VARIOUS METHODS

The technique of Doyen has the advantage in that the brain does not have to be lifted up so high as in our method, but this necessity does not always arise. The third division can be exposed without disturbing the dura, but this is only the beginning of the operation itself and up to this point the brain has only to be lifted slightly. Every one who has done the operation on the living knows that the difficulties begin only after ligation of the middle meningeal artery. From this point on one must always have an unobstructed view over the entire operative field. In order to proceed in the depths between the base of the skull and the dura which covers this and to be able to expose the cavum Meckelii completely the temporal lobe of the brain must always be lifted in its protective coverings, but only as little as is absolutely necessary. This can be entirely avoided by no method, otherwise one works in this very dangerous region by sense of touch, and may injure the sinus cavernosus, the internal carotid which lies within it, and the three motor nerves of the eye, occurrences which happen in spite of all; but in the method which we have given, they need not be frequent. Moreover with this procedure there can be no question about true extirpation of the ganglion; partial extirpation, like the employment of curette and similar instruments, should be condemned.

In order to limit the elevation of the brain to the slightest degree possible, the lateral wall of the skull should be removed down to its point of transition to the base of the skull, that is, to the infratemporal crest. Nevertheless resection of the zygoma, particularly in the Caucasian race, is not necessary for this purpose. Study of a skull sawed open teaches that in our race the upper level of the zygoma is located

at the same level with the intracranial opening of the foramen ovale, and accordingly it does not limit our operative field.

We have practiced every modification of the temporal and of the sphenoidal technique, as well as combinations of the two methods, on the cadaver and several of them also upon the living, but we have never been persuaded that any of them exposes the operative field so completely as our temporal method. Anatomical investigations upon the cadaver do not shake our point of view. For the one thing which renders the operation so difficult in the living is venous bleeding from the dural veins, and in a narrow approach this works naturally much more disturbance than if the deep wound is under clear view. On the other hand ligation of the trunk of the middle meningeal artery according to our technique is so safe that we recommended it in 1892 as a typical operative method and it has been repeatedly performed with result in hemorrhage.

Only in the occasional cases in which the intradural pressure is particularly high, so that the dura and its contents cannot be lifted, it may be found necessary to remove the base of the skull in the described manner. One must then first cut through the zygoma subcutaneously with a chisel from the lower ends of the incision, first behind and then in front. It is a matter of no moment whether or not the bony plate is high or low. We, therefore, always begin the extirpation of the Gasserian ganglion with the incision shown in Figure 282.

After some experience, which now includes eighty-one extirpations, we have been led, under conditions of normal brain tension, to prefer the temporal method over others. In increased brain tension one can puncture the dura and allow the cerebro-spinal fluid to flow out. The procedures of Doyen, Lexer and Cushing are of value in extirpating tumors from the middle fossa, as well as for tying off the trunk of the middle meningeal artery in injuries. Cushing and Lexer make the temporal flap lower and sacrifice the bone; but the maintenance of this guarantees a level and hardly noticeable scar.

INDICATIONS

If on account of the severity of the pain an intracranial operation becomes necessary, extirpation of the ganglion and of the trifacial root is alone to be considered. As a rule one does not resect intracranially the single divisions, as this, like peripheral resection, empirically allows more chance for recurrence, and from the point of view of danger they do not stand far behind the radical operation.

Ordinarily the extirpation of the ganglion should be undertaken only if alcohol injections and the less extensive operations are without result. But as advances in technique lessen the danger more and more, we will undoubtedly come at some time to the point where we will undertake the radical operation first of all. For it is unsatisfactory to advise peripheral resection in severe cases, when we can expect only temporary relief.

If the cause of the neuralgia can be placed in changes in the Gasserian ganglion or the trifacial root, a diagnosis which may be established, naturally the intracranial operation must be considered from the first.

In considering diagnosis we have already mentioned the neuralgias which occur in the region of the recurrent branches which supply the dura mater with sensory fibres. The recurrent nerve from the third division alone comes off in the foramen ovale or just below it, and so can be extirpated by one of the extracranial methods, which we have described, for finding the third division at the base of the skull. One may succeed in this way even in removing a small portion of the ganglion from below.

But on the other hand the recurrent branches of the first and second divisions have their origin within the cranial cavity and may be reached only by the intracranial technique. To be sure, in the extraordinarily severe one-sided and deep-seated headache, such as is observed in severe trifacial neuralgia, not alone the three recurrent branches, but at times also the meningeal branch of the ethmoid nerve which inervates the dura mater in the region of the anterior fossa and the forehead is also envolved. The ethmoidal nerve may be found in the orbit, as shown on page 215.

INTRACRANIAL RESECTION OF THE THIRD DIVISION

Very exceptionally this operation may have to be considered if in a severe recurrent trifacial neuralgia the nerve has been completely removed outside the cranial cavity and age as well as the condition of the patient do not allow of extirpation of the ganglion. Although intracranial resection of this nerve trunk is no guarantee against recurrences, nevertheless in old persons one may hope for freedom from pain for the rest of their days. If this plan is decided upon, the lateral bony plate need not be cut away so high as for the temporal method of extirpation of the ganglion. The following case will serve

Intracranial resection of the third division.

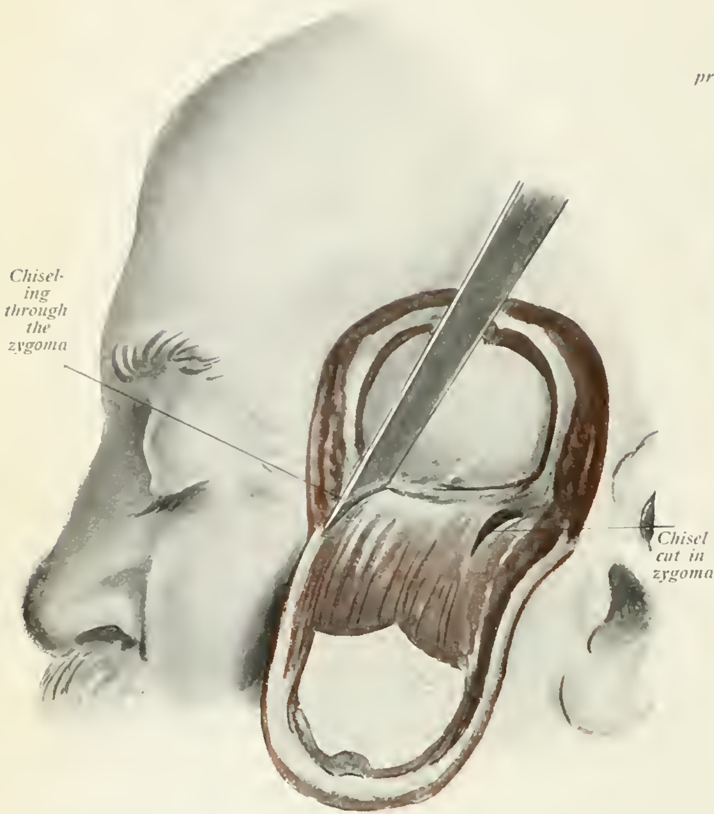

Fig. 287. The skin-muscle-bone flap has been turned down, and the zygoma is being chiseled through.

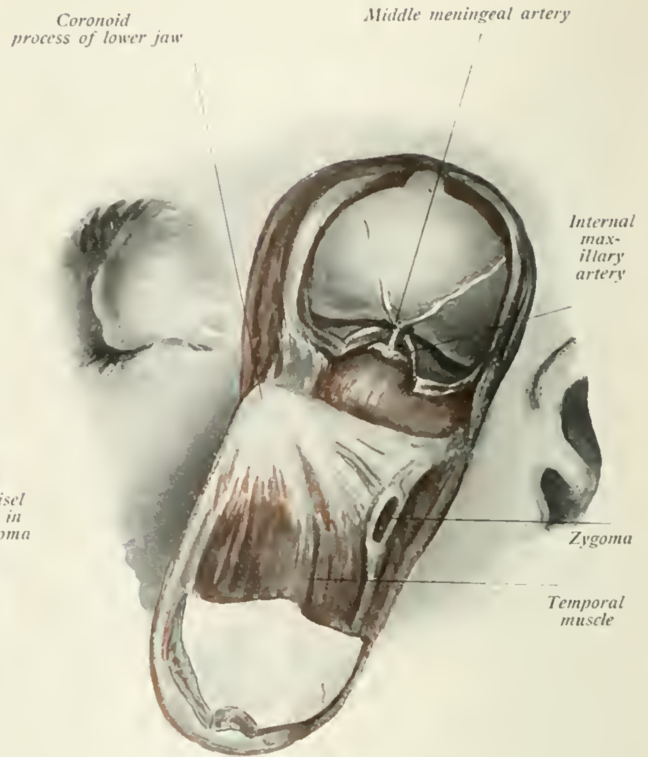

Fig. 288. Chiseling a wedge out of the base of the skull, with its apex at the foramen spinosum.

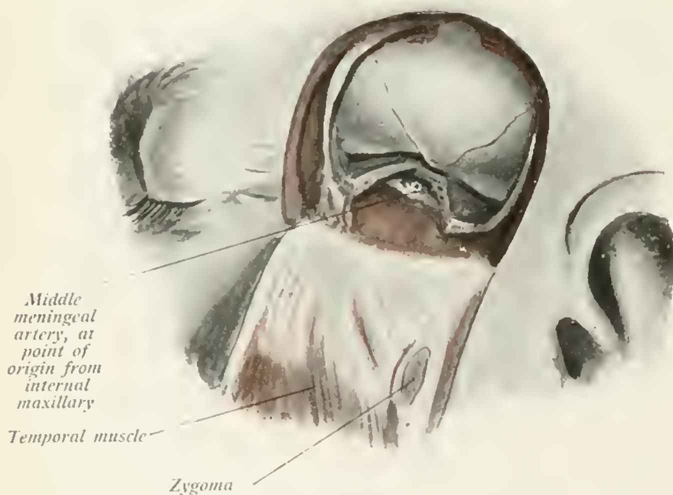

Fig. 289. Middle meningeal artery tied and cut.

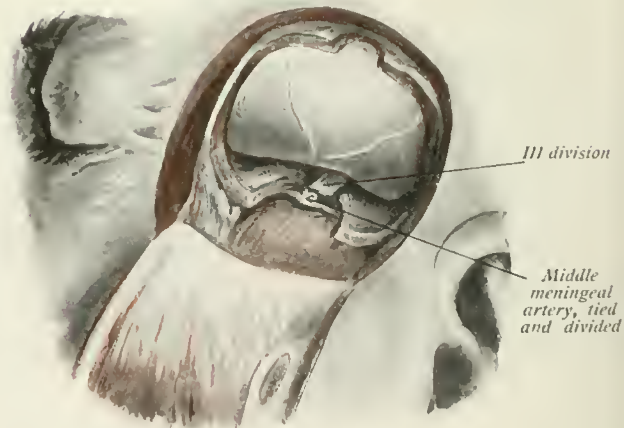

Fig. 290. Chiseling open the foramen ovale, and exposure of the 3rd division.

Rebman Company, New York.

as an example; the operation was carried out in a similar manner except for sacrifice of the temporal bone by Quenu in 1894.

A seventy-five-year-old man had been operated upon four times by others for left facial neuralgia in the distribution of the third division, and two years before had been operated on by us by sawing through the ramus of the lower jaw and resecting the third division at the foramen ovale. For a year and a half thereafter he was without pain. Then a recurrence set in which disappeared again after a few days. Six months later it came back much worse and resisted all methods of treatment. Thereupon the patient begged that he might be operated upon under any circumstances since he could not bear the suffering, and in spite of his age and the advanced arteriosclerotic heart, operation was determined upon.

We expected that intracranial resection would give relief for another two years, in case the condition of the patient did not allow of extirpating the ganglion. The zygoma was resected osteoplastically and turned downward and a three-cornered piece was chiseled from the base of the skull in the neighborhood of the middle fossa, the base of which was external and the apex at the foramen ovale (see Fig. 285).

The temporal flap was made in the ordinary way (see Fig. 287, Plate 54), not going quite so high as usual. The incision went at once through skin, fascia and temporal muscle down to bone, and the periosteum was stripped away. After a hole was made at the upper edge with a drill the dura was freed up with a Braatz guide and the bone divided with the Dahlgren rongeurs in the line of the cut.

After control of the hemorrhage the temporal muscle was divided from the anterior and posterior corners of the wound downward to the zygoma, during which procedure the temporal artery was divided, both ends seized and tied off. Hereupon a sharp retractor was placed in the temporal muscle to draw it, together with the bony plate, downward; and the zygoma was chiseled first behind, then in front in typical fashion, as in the Lücke-Krönlein operation (see page 222 and Fig. 255) and likewise pulled downward with the retractor. Then the dura was freed up inside from the base of the skull and likewise the soft parts below from the base of the skull, and the bony wedge just described was removed with the rongeurs and chiseled down to the foramen spinosum. The middle meningeal artery now lay exposed as well as the upper part of the internal maxillary artery from which it arises (Fig. 288, Plate 54).

Now with a half pointed sharply bent elevator the middle meningeal artery was lifted out of its canal, a clamp applied close to the dura and a catgut ligature placed around it below the clamp and tied. The clamp was removed and the middle meningeal artery cut through at this point (Fig. 289, Plate 54) after the bony bridge between foramen spinosum and foramen ovale was cut away with a narrow chisel, the third division lay absolutely free (Fig. 290, Plate 54), and could be pried out of the foramen ovale with a bent elevator. On account of collapse of the patient the exposure and removal of the Gasserian ganglion could not be performed. Accordingly, the third division was seized with a toothed clamp and separated from it obliquely with a tenotome, and as the peripheral portion could not be twisted out on account of the scar resulting from the previous resection, it was cut away as far as possible in the scar tissue. Fully 2 cm. of the nerve could be removed.

The hemorrhage was moderate. A drain was placed in the posterior corner of the wound. The zygoma was replaced, sewed in front and back with periosteal sutures of catgut (see Fig. 253), the bony plate was sewed above with three periosteal catgut sutures, and the skin wound was closed with interrupted silk.

The wound healed well, the drain was removed on the third day, and the patient got up on the fifth day. The operation freed him completely from pain, but he died a few weeks after discharge from influenzal-pneumonia.

RESECTION OF THE TRIFACIAL ROOTS

An attempt had been made by others one year previously in a fifty-six-year-old woman to extirpate the Gasserian ganglion by the temporal method. Microscopic examination of the removed part, as we were informed, showed only dural tissue, but no nerve elements. Since the dura should not be removed in this operation, the procedure could not have been rightly carried out.

The incision was made around the old scar, but in order not to injure the dura the skin was shoved back a bit above, and the periosteum was incised and stripped backwards from the bone. The skull was exposed around the old trephine opening and a wide elevator was laid carefully in the anterior upper edge of the old flap between dura and the bony plate, and this was pried away from the dura until the index finger could be inserted. With this the bony plate was freed from the dura and turned downward (Fig. 291, Plate 55), after the old

Removal of the trifacial root.

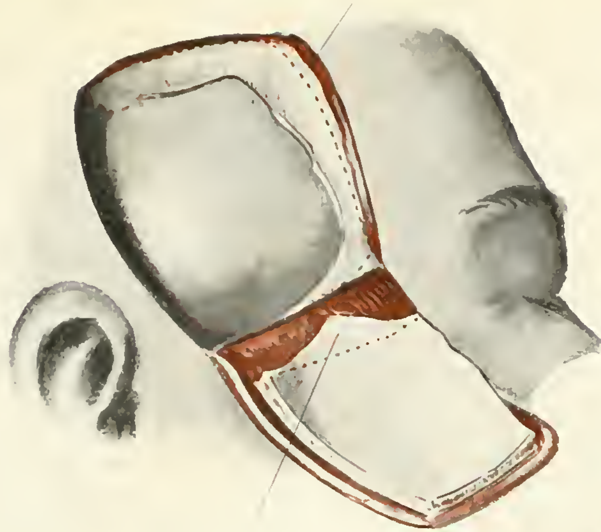

Fig. 291. The skull is opened in the old scar.

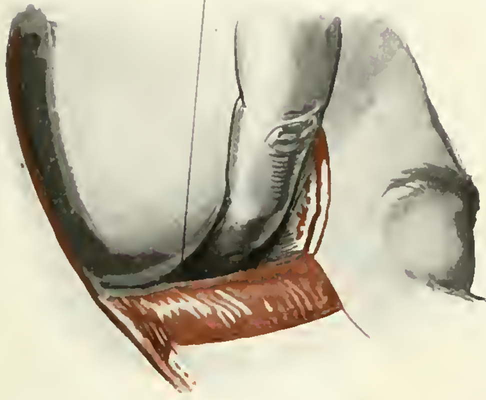

Fig. 292. The dura is freed up from the middle fossa inth the finger.

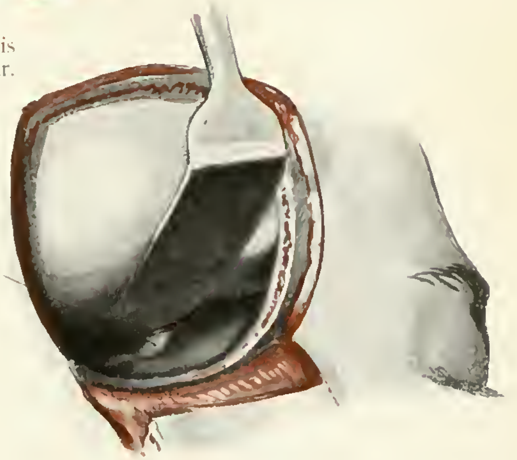

Fig. 293. The middle meningeal artery, of unusual size is exposed.

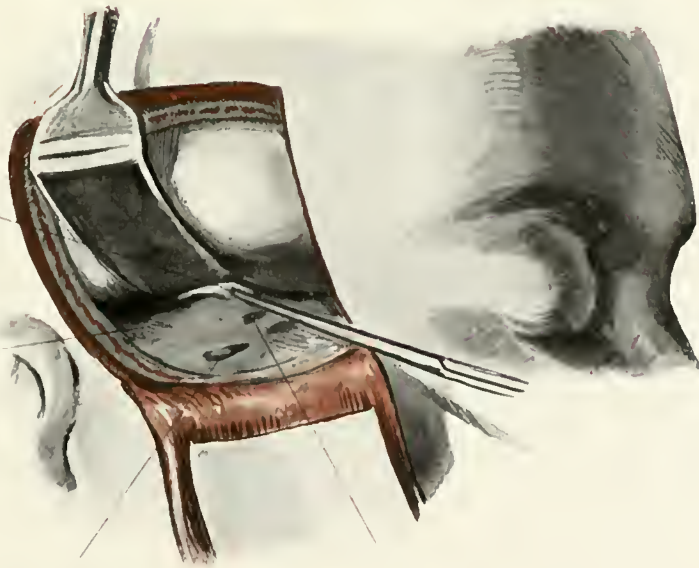

Fig. 294. The trifacial root is torn through at superior margin of petrous portion.

Rebman Company, New York.

scars in front and behind were split downward to the zygoma. In turning the flap down it appeared that the temporal fossa had not broken away low enough at the first operation and presented a considerable obstruction to proceeding into the middle fossa. The importance of this we have already shown (see p. 240). A bony strip more than 1 cm. wide had still to be removed from the lower edge of the opening with rongeurs. As the bony opening was limited in front also, a crescentic strip about 1 cm. wide was removed here. In these manipulations we succeeded in loosening away the adherent dura by blunt dissection without injury.

We made our way extradurally into the middle fossa, using small sponges held by smooth forceps (see Fig. 277, Plate 53), a wide elevator or the index finger in turn. The dura was very closely adherent to the base of the skull. After it was loosened in this manner for 1 cm., the rest of the process was carried out with the index finger (Fig. 292, Plate 55) and with some pains we succeeded in reaching the foramen spinosum. Bleeding was considerable, but could be controlled by temporary packing. In separating the dura further, which had to be done with small sponges, it showed itself to be under strong tension, so that it yielded very little. In the depths the middle meningeal artery, which was of unusual size, came into view (Fig. 293, Plate 55). In exposing it further, it tore in one small place, and a disturbing hemorrhage ensued, which was controlled by compression until the vessel could be seized with a hemostat and tied in the regular manner. As a result the patient collapsed, and the wound cavity was packed loosely with vioform gauze, the bony flap sewed into place, and the operation interrupted.

Five days later we completed the operation. Since the difficulty in loosening up the dura from the base of the skull had been great up to this point, and had increased markedly in the region of the Gasserian ganglion, we proceeded from the foramen spinosum and the ligated middle meningeal artery backward to the anterior surface of the petrous portion instead of medially to the third division. At this point the dura could be lifted up without marked bleeding, and proceeding medially and backwards along its surface we could finally see clearly the upper edge of the petrous portion. Here we met considerable venous hemorrhage, evidently from the torn superior petrosal sinus, which was controlled, however, by gauze compression with the assistance of the brain retractor. Now proceeding carefully toward the middle line along the upper margin of the petrous portion, at a depth

of 6 cm., measured from the surface of the skin, we came upon the trifacial root, exactly at the place where it passed from the posterior to the middle fossa. With the assistance of various blunt hooks it could be isolated in its canal covered by the origin of the tentorium and the dura mater, and seized with the nerve clamp (Fig. 294, Plate 55). By careful twisting a piece about 2 cm. long could be removed. No bleeding of any significance ensued, although a small branch of the basilar artery ordinarily accompanies the trifacial root.

A small drain was placed in the cavity from behind forwards in order to carry off the blood which might ooze out later, otherwise the wound was sewed tight. The drain was removed on the fourth day and healing followed without incident.

In this case we went too far backwards to expose the Gasserian ganglion, which had probably been left intact at the previous operation.

Frazier of Philadelphia advocates division of the sensory root through a small trap door just above and in front of the ear, over avulsion of the ganglion. He claims that it is attended with less hemorrhage, that it does not expose to injury adjacent structures such as the cavernous sinus and the three cranial nerves in juxtaposition to it, that in rare cases one may preserve the motor root, and thus the function of the muscles of mastication, and, finally, that there is less likelihood of ulceration of the cornea. But in our experience division of the sensory trifacial root appears to be no easier than extirpation of the Gasserian ganglion, and as this operation, as we have shown on page 244, has no advantage in regard to neuro-paralytic keratitis, the typical extirpation is always, in our opinion, to be preferred.

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