THE OPERATION FOR THROMBUS OF THE
SIGMOID SINUS AND INTERNAL JUG-
ULAR VEIN, OF OTITIC ORIGIN.*FRANK ALLPORT, M.D.
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One of the most important sequelæ of middle-ear infections is phlebitis or thrombosis of some of the venous drains of the head, and particularly when such pathologic conditions occur, as they usually do, in the sigmoid bend of the lateral sinus. Disease of this nature is found not only in the sigmoid sinus, but also in the lateral sinus proper, the superior and inferior petrosal sinuses, the cavernous sinus, the jugular bulb, the internal jugular vein and its connections, etc. The sigmoid sinus is, however, its favorite location on account of its vascular connections with the tympanic cavity and adjoining cells and its close contiguity to these frequently infected structures. As the jugular bulb is located directly beneath the tympanic cavity, an unusually high dome to the bulb, or necrosis of the tympanic floor, or congenital dehiscences in the floor, will assist in the conveyance of infection. This will occur through the vessels and lymphatics connecting the tympanic cavity with the bulb, and may produce a primary phlebitis or thrombosis of the bulb, which has not proceeded through the usual channels of the antrum, mastoid cells and lateral sinus. These conditions are usually found in children, develop rapidly, and generally demand immediate operation with excision of the internal jugular vein.

I do not believe that actual intravascular phlebitis and thrombosis of the sinus and vein occurs as frequently as might be supposed from a perusal of much of the available literature of the day, because a fairly large experience in mastoid work for many years has not disclosed this to be the case. Nevertheless, the disease occurs with sufficient frequency to demand the most careful study in order that prompt and skilful action may be taken whenever its existence is actually disclosed.

RISK IN SINUS OPERATIONS.

The surgery of otitic phlebitis and thrombosis has made great progress of late years and many lives have been saved thereby that must otherwise have been inevitably lost. I fear, however, that overenthusiasm along these lines may have led some thoroughly competent and trustworthy observers to overestimate the frequency and importance of the subject and to underestimate the dangers of operative interference. The opening of the sigmoid sinus, for instance (first seriously proposed by Zaufal in 1880), with its possibilities for infection, especially when done through an already infected mastoid cavity (which is, of course, usually the case), is an operative procedure of importance and danger. Yet some surgeons practically advocate its performance for diagnostic purposes where any reasonable suspicion points to an intrasinus involvement. In my opinion the sinus should usually be opened in the face of mastoid disease, either acute or chronic, accompanied by characteristic phlebitic symptoms, such as chills, sweats and wide excursions of temperature and pulse. It should also be done in the presence of a virulent infection, especially of the streptococcus type, a significant differential blood test, etc. Nevertheless, I have seen a number of such cases cured

by the removal of necrosed bone, granulations¹ and pus from the sinus neighborhood. I should, therefore, be inclined to wait a few hours after the removal of such debris, before opening the sinus itself, unless the patient's condition and symptoms are reasonably decisive and urgent in character, and unless an inspection of the exposed sinus renders the presence of a thrombus exceedingly probable.

It must have been the experience of most surgeons that phlebitic symptoms frequently and permanently may be relieved by a removal of neighboring necrosis, granulations, pus, etc., which perpetually infect and re-infect the sinus walls. This fact is especially emphasized by Bergman in his writings and can certainly be substantiated by all operators of experience. In this observation lies an earnest warning against too energetic operative procedures, without quite positive indications. It is sometimes the case that septic symptoms following a mastoid operation are due to pneumonia, typhoid, malaria and other coincident conditions which should be duly considered and properly weighed before proceeding to a sinus operation. It should not be forgotten that, while lives may occasionally be sacrificed by proper conservatism, it is probable that more lives would be lost by injudicious and hasty surgery.

The provisional determination to open the sigmoid sinus is usually formed before the mastoid has been operated on, or after an operation has been performed and several days have perhaps elapsed, during which time the condition of the patient has not materially improved. This resolution is, of course, liable to be changed by existing intramastoid conditions, after the mastoid cortex has been removed, at the time of the primary operation. In all cases where sinus symptoms are clearly present, the bony covering should be freely and carefully removed and the soft sinus exposed for inspection, whether the osseous partition is necrosed or not. Should the inspection reveal an apparently healthy sinus, operative procedures may be suspended (unless the patient's condition is too grave), as sharp sinus symptoms are sometimes produced by a beginning absorption or phlebitis. This may originate in an infected mastoid cavity, relief from which is not infrequently noticed after a thorough exposure and cleaning of this space.

After this has been accomplished and the patient carefully watched for some hours or perhaps one, two or three days, and the sinus symptoms remain the same or grow worse, the sinus should be unhesitatingly opened, even if its local appearances are apparently healthy. Much the same procedures should obtain in case necrosis, granulations and pus are found in the sinus region, for such pathologic products continually bathing the soft tissue tend to become absorbed and to produce the characteristic danger signals. Such debris may be carefully removed and the sinus amply inspected. Should it be found of healthy appearance, one may stay operative procedures a little, unless the symptoms are quite urgent. Many patients have recovered and will recover under such conservative management, and this fact points a significant lesson.

THE APPEARANCE OF THE UNCOVERED SINUS.

Of course, the entire subject of opening the sinus hinges on the probable existence or non-existence of a

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1. The existence of granulations on the soft sinus wall is regarded by many as beneficial, in that it is nature's obstruction to the invasion of micro-organisms, and many surgeons carefully refrain from disturbing them during the course of an operation.

thrombus, and this can not always be easily determined. A discussion of this topic is too prolonged for the present article, and is apart from the specific subject under consideration.² As the physical appearance of the uncovered sinus, however, must be observed while operating on a patient suffering with sinus symptoms, this phase of the subject may with propriety be here considered, and it may be said that even a physical examination of the sinus does not always clear up the pathology. The sinus is usually bluish-white in color and easily compressible. Nevertheless, the neighboring necrotic bone, etc., may stain and darken the outer coats of the vessel, without the existence of any intramural clot, or a perfectly normal color may characterize a sinus, in whose interior a thrombus may be found.

A sinus may be thoroughly compressible and yet contain a parietal clot, where the obstruction is not yet complete, but a solid, resisting sinus is, of course, a reasonably positive sign of an obstructive clot. The emission of pus from the mastoid foramen is a significant symptom, as it may then be assumed that extradural pus is present in the cerebellar fossa, around the sigmoid groove. I am opposed to the insertion of an aspirating needle into the sinus in order to ascertain the fluidity of its contents. If nothing is withdrawn it is safe to assume the presence of a thrombus, but blood may escape in case of a partially organized clot, and if the vessel is healthy the operator may easily regret having punctured and probably infected a normal sinus; if the sinus is to be opened at all, it is much better to make a complete incision rather than a puncture. The stroking and compression test of Whiting can not be commended, for, while it may facilitate the diagnosis, it can easily displace infected thrombotic particles and set them into circulation with disastrous results.

THE PROBLEM OF DIAGNOSIS.

It will thus be seen that making a diagnosis in cases of otitic sinus thrombosis is beset with some difficulties and perplexities. Yet a correct conclusion can usually be reached, especially when a consideration of the general subjective and objective symptoms has been aided by an operative exposure of the sinus itself through the mastoid cavity. Fortunately this (the mastoid operation) is a procedure which should be performed primarily and, therefore, nothing is lost and everything gained when a mastoid operation is advised in a suspected otitic sinus thrombosis, for the cells, etc., may be thoroughly opened and cleaned and the sinus inspected and perhaps opened during one operative procedure.

Should an operation, or at least an inspection of the sigmoid sinus be decided on, in a case of otitic origin, it is only necessary to consider the operative steps in connection with a thorough exposure of the mastoid cavity, for this is at the same time the easiest as well as the best avenue of approach. The mastoid operation should first be completed in all its details, for, in case troublesome hemorrhage occurs, it might be extremely difficult to continue further operative procedures on the bone. In addition, the work on the sinus should be prosecuted under the most aseptic conditions possible, and this can be best accomplished after the mastoid interior has been thoroughly cleaned. As has been previously said, the bony covering of the sinus may be in a

necrotic, softened and fistulous condition, surrounded by granulations and bathed with pus.

THE REMOVAL OF GRANULATIONS.

The removal of such pathologic products can be accomplished with comparative ease by curette, chisel, bur or rongeur, extreme care being exercised in all such manipulations to avoid injuring the soft dural covering of the vessel. Some authors advocate the non-removal of granulations, believing them to be Nature's obstruction to the invasion of the sinus interior by micro-organisms. However this may be in theory, I believe that such tissue is best thoroughly removed, not only to place the parts in as clean a condition as possible, but also to facilitate a careful examination of the sinus, which can not be satisfactorily accomplished through a granular mass. In most instances I accomplish this work by means of a strong, narrow rongeur, one blade of which is inserted inside and the other outside of the bony sulcus, being careful to avoid pressure on the underlying vessel and only removing small fragments of bone at a time. Objections have been made that the slight pressure on the sinus may induce a fracture of its possibly thrombotic contents, which will be swept into the circulation and induce migratory infection. This objection seems like a refinement of technic and a magnifying of possibilities, for, while such an accident might possibly occur, it is altogether unlikely. It certainly would seem to be a better instrument than the chisel, with its possibilities of bone fracturing and splintering, with perhaps a sinus puncture and an embarrassing hemorrhage.

All the necrosed bone should be removed, no matter how far it extends, either in the direction of the torcular or the bulb, and it is well to remove even some healthy bone in order to insure complete elimination of all necrosis (Fig. 1). The sinus should then be minutely inspected, and if its opening is determined on the operation should be continued after the parts have been thoroughly cleaned and irrigated with antiseptic solution. If it is deemed best to await developments the wound should be cleaned, irrigated and dressed as after other mastoid operations.

In case a primary opening of the sinus is determined on either at the original mastoid operation or at a later date, it should be remembered that an ample exposure is absolutely essential to correct surgical manipulations. The sinus must be exposed, therefore, for at least a short distance above its knee and as far downward in the direction of the jugular bulb as possible. This free exposure may be accomplished by a removal of the necrosed bone alone, where such necrosis is extensive in character, or it may be necessary to remove considerable healthy bone in order to render the sinus easily accessible.

LOCATION OF THE SINUS.

Unless the situation of the sinus is indicated by a fistula, its position is uncertain. In children it is located more superficially and further forward than in adults, and even in the latter its location is by no means fixed. It is usually, however, to be found at a point about one-half an inch behind the posterior bony meatal wall, just back of the antrum, and a thorough mastoid operation will usually disclose its convex outlines. The sinus should first be exposed by chisel, bur or curette, after which the bone is best removed with a strong, delicate and narrow rongeur, as previously described. The bone should be carefully removed in small pieces

2. A tolerably complete analysis of the symptomatology of sinus thrombosis, etc., can be found in my communication in the *Chicago Medical Recorder*, January, 1906, and in other books and periodicals.

and the operative field examined after each bite of the forceps, care being taken not to wound the sinus, either by perforating its covering by a sharp fragment of bone or by rupturing an already softened dura by carelessly pulling away adherent osseous chips. The latter accident may be averted by, from time to time, passing a small spatula between the soft sinus and its bony covering and gently separating the two.

After the sinus has been fully uncovered all debris, etc., should be thoroughly removed and the operative field abundantly flushed with antiseptic. The hands and instruments of the operator should be recleaned and every effort made to prevent sinus infection. In opening the sinus there is danger of a fatal aspiration of air occurring, to prevent which the patient's head should be dropped low and the operative area flooded with sterile water. The sinus should now be opened by a free incision along its length, being careful not to pass through both walls of the sinus into the cranial cavity, an accident which is by no means impossible. If there is a flow of blood, two tight rolls of gauze or cotton held in fixation forceps (which should be previously prepared) should be placed one above and the other below the incision, remembering that brain substance and not

some iodoform gauze, rolled into a cylinder long enough to cover completely the sinus incision, should be firmly placed over the vessel and supplemented by layer after layer of gauze carefully held in place. The other portions of the mastoid cavity should then be packed with gauze and the entire mass of packing held in position by a firmly applied bandage which may usually remain in position for three, four or five days, when it should be carefully soaked off (to prevent hemorrhage) and more packing and a bandage applied.

The danger of hemorrhage is usually past by the time the second or third dressing is done. In case there is hemorrhage from below and not from above, the sinus should be further incised in the direction of the torcular, and more of the bony sulcus removed if necessary, in order that adequate room for further operative procedures should be afforded. In considering thrombi, which extend from the sigmoid sinus back toward the torcular, it should not be forgotten that clots extending in that

Fig. 1.—Exposing the sinus. A, mastoid antrum; B, sigmoid sinus; C, mastoid emissary vein.

bone lies beneath the sinus, and that the amount of pressure should, therefore, be limited (Fig. 2). Such pads may be held by the operator, or by his assistant, or both operator and assistant may each hold one; they should not be applied, however, until after the sinus has been opened and an opportunity has been given for a burst of hemorrhage to occur and possible thrombotic particles to become expelled. These pads may be lifted alternately and accurate information obtained as to whether the hemorrhage occurs from above or below.

If free hemorrhage occurs from both directions it is proper to assume the absence of a clot, or at least that any existing loose clots have been expelled by the force of the escaping blood. If the hemorrhage is slight or absent from either direction, a clot in that direction is to be assumed. If the vessel is assumed to be healthy,

Fig. 2.—Compression of the sinus to arrest hemorrhage, and to ascertain the presence of a thrombus.

direction are not usually so infective in character as those spreading in the direction of the bulb. The venous current, of course, naturally flows from the head downward, and, while infectious particles may easily pass down with the blood current, they do not so easily pass upward and backward against the current. It should not be forgotten, however, that blood currents in valveless veins seek the direction of least resistance and may easily become reversed on contact with intravenous obstructions. It is, therefore, quite possible that, while a thrombus in the immediate vicinity of the antrum may be highly infectious in character, yet as it extends backward toward the torcular it may gradually become perfectly innocent, and be composed of benign accretions of normal blood clots that form a natural and healthy obstruction to the passage of infectious micro-organisms.

TREATMENT OF THE THROMBUS.

It is, therefore, questionable just how much such a thrombus should be disturbed, and some authors strongly advocate leaving it alone. I believe that if the clot is hard and apparently extensive, it should be gently curetted at its visible portion, in order to remove its infectious layers, and then sprinkled and packed with iodoform powder and gauze. In case, however, the clot is

Fig. 3.—Curetting the sinus. A, mastoid antrum; B, sigmoid sinus; C, mastoid emissary vein.

small, or soft and unhealthy in its appearance, it should be completely removed by the curette until free hemorrhage occurs (it being remembered that quite free hemorrhage may occur, even with a considerable parietal thrombus, from, for instance, the superior petrosal sinus, though the sigmoid sinus is more or less blocked

Fig. 4.—Initial incision for exposing internal jugular vein.

with thrombotic accretions) even if it becomes necessary to remove more and more of the bony sulcus with a corresponding extension of the sinus incision. A small sized curette should be employed for the removal of thrombi, small enough to allow of intrasinus manipulations, and its spoon may, of course, be carried considerably beyond the limits of the bony opening (Fig. 3).

It should not be forgotten that a sinus infection of several days' duration may soften the sinus walls to such an extent as to render their perforation by a curette exceedingly easy; curetting should, therefore, be carefully performed, lest brain infection be thus produced. Ease of manipulation may be much facilitated in all sinus curettements by not only incising the sinus, but by excising a large piece of its outer dural wall, and diagnosis and surgical precision will be greatly aided by exposing the intrasinus openings of the mastoid emissary vein and the superior petrosal sinus. The former will be found in the posterior wall of the sinus at a point about on a level with the floor of the ordinary radical mastoid operation when finished. The latter enters the sigmoid sinus from the cavernous sinus at a point about on a level with the roof and posterior wall of the ordinary radical mastoid operation, when completed; in other words, at about the junction or the

Fig. 5.—Exposure of platysma myoides muscle and external jugular vein. A, sternocleidomastoid muscle; B, external jugular vein; C, platysma myoides muscle.

It will be observed in Figures 4, 5, 7 and 9 that the incision in the neck is continuous with the incision over the mastoid process. This point has been brought out in the pictures because in neck surgery where the internal jugular vein is to be removed, owing to a previous mastoid infection, the incision in the neck should be secondary to and continuous with the incision over the mastoid process.

lateral with the sigmoid sinus, and passes into the sigmoid sinus.

In endeavoring to get as close to the jugular bulb as possible the surgeon should not press too far forward, as he is liable to injure the facial nerve, as it passes down through the posterior meatal wall on its way to the stylomastoid foramen. Bleeding may easily be stopped by carefully applied gauze rolls. In case free hemorrhage does not proceed from the bulbar direction of the sinus, a very serious condition confronts the operator, for, the blood current of the inferior petrosal sinus entering the anterior portion of the jugular bulb,

on its way from the cavernous sinus, constantly playing on the septic end of the thrombus, naturally carries the infectious micro-organisms down into the bulb, internal jugular vein, etc., toward the heart, lungs, liver, etc., thus readily producing sepsis, pyemia, metastatic abscess, etc., which usually result fatally.

It is, therefore, necessary that this end of a thrombus, or a thrombus located in this portion of the sinus, should be as thoroughly removed as possible, in order that the further or general spread of infection may be stopped. This may probably be best accomplished by the curette, which should be gently manipulated until free hemorrhage from below occurs, which may be controlled by the rolls of gauze, bandage, etc., as previously described. It must not be forgotten, however, that it is usually quite impossible to successfully curette the jugular bulb by simply proceeding downward by way of the sinus. The curette can reach practically as far as the bulb and is then stopped by an intervening wall, an abrupt curve, etc., so that if a complete thrombus extends downward as far as the bulb or further, free hemorrhage will not usually be produced by sinus curettement.

Under these circumstances the operation of Grunert, Voss, Iwanoff and others has been proposed for the thorough exposure of the bulb. Owing to the complications and great danger of producing facial paralysis, hazardous hemorrhage, etc., however, it has never become popular and it is generally thought better to expose, ligate and partially remove the internal jugular vein and then clean out the bulb. It must not be forgotten that this does not always prevent the spread of infection by other channels, and that the sudden stoppage of the venous circulation may force infective particles backward into the meningeal and cerebral veins. While the internal jugular vein is, of course, the main avenue through which infection spreads from the sigmoid sinus to the heart and other organs, nevertheless, even with this principal channel ligated, infection may proceed through the posterior condylar vein, the occipital sinus and the mastoid emissary vein, all of which communicate indirectly with the subclavian and innominate veins, irrespective of the internal jugular. It will be remembered that the posterior condylar vein passes through the posterior condylar

foramen and connects the lowest level of the sigmoid sinus with the deep veins at the back of the neck.

LIGATION OF THE INTERNAL JUGULAR.

Some surgeons invariably operate on the internal jugular before proceeding to open the sinus; others only ligate when free bleeding can not be established from the bulbar end of the sinus; others open and curette the sinus and then wait for a continuance or exaggeration of the symptoms, when the jugular operation is performed. Certainly but few, if any, surgeons would sympathize with the views of Horsley, who only ligates after metastases have occurred, for then it would almost surely be too late. Favorable reports of jugular ligation in sinus thrombosis need not necessarily be attributed to the ligation, as, for instance, Körner reports 43 per cent. of recoveries without ligation. Still, it is probably true that in septic and pyemic cases sinus operations with jugular excision yield better results than when the jugular is not disturbed.

My method of procedure is as follows: The sinus is opened, the head always having been previously lowered, the upper portion is curetted if necessary. If hemorrhage occurs freely from below the operation is finished; if not, the lower end of the sinus is carefully curetted and if free hemorrhage occurs nothing further is done. If free hemorrhage does not occur, pressure pads and a bandage are quickly applied and the jugular is ligated and excised, the bandage then removed, the sinus, bulb, etc., curetted and cleansed and the entire operative field, both in the bone and neck properly dressed and bandaged. The necessity for

Fig. 6.—Showing the course of the sigmoid sinus, jugular bulb and internal jugular vein. A, external auditory meatus; B, sigmoid sinus; C, facial nerve; D, jugular bulb; E, digastric muscle; F, internal jugular vein; G, spinal accessory nerve; H, sternocleidomastoid muscle.

the operation is greatly emphasized if the cervical tissues just below the mastoid are swollen and painful, and if any hardness and pain can be detected along the course of the vein in the neck, and if general pyemic symptoms are present.

I am convinced that excision of the jugular is not an operation which should be undertaken hastily, as grave circulatory and other disturbances are liable to ensue, and other methods of relief should first be tried, unless the patient's condition is very urgent. The literature furnishes many instances where sudden optic neuritis, edema of the brain, with hemorrhages

and softening, thrombosis of other cerebral sinuses, etc., have followed jugular ligation, and it should not be forgotten that a small and insufficient jugular on the other side, totally unable to assume double duty, may be present and precipitate most unfortunate results. As a deduction from these observations Eagleton urges that in cases of sinus thrombosis, with optic neuritis, it should be concluded that the return venous flow is already seriously obstructed and that great caution should be observed in adding to such conditions by ligation.

EXCISION RATHER THAN LIGATION.

In case it is concluded to operate on the jugular vein it is better to excise most of it rather than merely to apply a ligature, as, if the jugular operation is necessary at all its septic or pyemic contents should be eliminated as much as possible and its poisonous contents removed. Before operating on the jugular the shoulders should be elevated on a sandbag or something of the kind and the neck and head allowed to drop down, the latter turned away from the field of operation in order to place the neck well on a stretch, so that the anatomy of the parts is well defined and the tissues easier to operate on.

If the patient is a male the beard should be shaved and the skin antiseptically cleaned, care being taken not to disturb and break up a possible clot by rough handling. In the case of a male where it is at all suspected that a jugular operation will have to be performed the beard should be shaved before the mastoid operation is commenced. The neck should now be placed on a stretch and the anterior border of the sternocleidomastoid muscle clearly located and an incision (Fig. 4) made along its edge extending from its sternal attachment to the mastoid tip.³ Bleeding vessels should, of course, be compressed at all stages of the operation so that a clear view of the operative field may always be obtained. The skin and other tissues should be kept stretched

apart by blunt retractors. After the skin and superficial fascia have been completely severed the platysma myoides muscle with its oblique fibers can be plainly seen and should be fully exposed and incised along the anterior border of the sternocleidomastoid muscle, which can now be distinctly seen, and which should be fully uncovered by holding back the overlying tissues by retractors (Fig. 5).

The external jugular vein runs down the neck in a line drawn from the angle of the lower maxilla to about the middle of the clavicle and lies between the platysma and the sternocleidomastoid muscle. It crosses the latter muscle at an oblique angle, but does not cross the anterior border of the muscle except at its upper third at the angle of the jaw, where it may be seen, twice

ligated, cut between the ligatures and gently retracted from the operative field. If ligation of the internal jugular were the only object to be attained it would not be necessary to touch the external jugular, for the ligature would be applied much lower down, near the cricoid cartilage, but as the intention usually is to excise practically the entire vein, it may be advisable to get the external jugular out of the way. It should be preserved if possible, however, as it performs an important part in caring for the venous blood after the internal jugular is removed.

Retractors should now be placed around the anterior border of the sternocleidomastoid muscle, and the muscle pulled back in order to expose to view the carotid, jugular, etc. This object may be facilitated by tearing and pulling the tissues apart by blunt instruments or the fingers, as care should be exercised that ves-

sels and nerves are, as far as possible, uninjured, a thing difficult to prevent if knives and scissors are employed. The exposure should be made throughout the entire length of the sternocleidomastoid muscle from its mastoid to its sternal attachments, for it will be the object of the operation to remove practically all of the vein, and it should, therefore, be completely exposed (Fig. 6).

The deep fascia of the neck will be seen on retracting

Fig. 7.—Exposure of the internal jugular vein, etc.; the vein is about ready for removal. A, posterior belly of digastric muscle; B, spinal accessory nerve; C, occipital artery; D, facial vein; E, hypoglossal nerve; F, lingual vein; G, sternocleidomastoid muscle; H, superior thyroid vein; I, communicantes hypoglossi nerves; J, common carotid artery; K, phrenic nerve; L, middle thyroid vein; M, stylohyoid muscle; N, descendens hypoglossi nerve; O, anterior belly of omohyoid muscle; P, sternothyroid muscle; Q, sternohyoid muscle.

3. Crile and others sometimes cut down on the sternocleidomastoid muscle and expose the vein, by separating the muscular fibers.

the sternocleidomuscle, and on opening this and throwing it back the common sheath of the jugular, carotid and pneumogastric nerve may be seen. The utmost care should, of course, be taken to avoid wounding these structures, and as far as possible all sharp instruments should be eschewed in performing the delicate dissection. The internal jugular vein, the common carotid artery and the pneumogastric nerve are all encased in a common sheath. At the superior carotid triangle (the usual center of operative procedures) or at a point about midway between the angle of the jaw and the clavicle, the vein lies to the outer side of the artery, with the nerve between and posterior to both (Fig. 8), resembling, as Deaver says, the ramrod to an old-fashioned double-barreled shotgun.

ANATOMIC RELATIONS.

It should be remembered that while the relative location of these different anatomic constituents differs slightly in various portions of the neck, the vein always lies to the outside of the group and can be distinguished by its bluish-white color, by the fact that it becomes full and prominent on expiration and almost collapsed on inspiration or by pressing on it in the lower portion of the neck, when it will expand with blood (unless thrombosed) and quickly disclose its identity. The common sheath of the vein, artery and nerve should now be

Fig. 8.—Cross section of the neck (after Deaver). A; pneumogastric nerve; B, internal jugular vein; C, common carotid artery; D, descendens hypoglossi nerve.

opened and also the septum which separates the vein from the artery and nerve, and the vein carefully dissected out, practically throughout its entire extent. The artery is, of course, easy to identify, both from its color and its pulsations, but the nerve may, unless considerable care is taken, easily be raised and ligated with the vein.

All enlarged and diseased glands should be removed. After the vein has been thoroughly liberated from its surroundings, the lower ligature should be placed as far down in the neck as possible, and the upper one high up, as close to the mastoid process as possible, using either ten-day chromicized catgut, black silk or Pagenstecher linen, preferably the first, as there is practically no danger nowadays in the use of catgut prepared by modern methods. Two ligatures are applied at each extremity by means of an aneurysm needle and the vein cut between each pair of ligatures, being careful to include nothing but the vein in the ligatures.

In order to check the breaking off and floating of small thrombotic particles toward the heart, etc., which may easily occur from the necessary surgical manipulations of the operation, the lowest ligature should be placed around the internal jugular vein as early as possible and as soon as a low exposure can be made, after which the regular steps of the operation may be proceeded with. This lowest ligature can usually be best applied at a point just below the angle of the omohyoid muscle. The tributary veins should be ligated, and they may be enumerated from below upward as follows (Fig. 7):

The middle thyroid in the lower third of the neck (Fig. 7, L); the superior thyroid (Fig. 7, H), a little higher up; the lingual (Fig. 7, F), a little below the lower jaw; and, lastly, the common branch of the temporal and facial (Fig. 7, D) veins. Sometimes these veins are so small as not to require ligating, with the exception of the common branch of the temporal and facial veins, which always requires careful attention. In removing the internal jugular it should always be

Fig. 9.—Closure of the wound showing scheme of drainage.

severed above the posterior belly of the digastric muscle (Fig. 7, A) and above the common trunk of the facial and temporal veins, but the ligation need not extend more than half or three-quarters of an inch higher than this junction, as no more cervical veins enter the jugular above this point.

All of the veins which may require ligation enter the internal jugular (practically) in its anterior portion which if borne in mind will simplify their finding. After all connections are severed the vein may be removed and the parts thoroughly irrigated and cleaned preparatory to closing the wound, remembering that the operation should be performed with all the speed that is compatible with correctness and safety, as such patients should not be kept under anesthesia any longer than is necessary. Sometimes inflammatory adhesions will so firmly unite the vein to its surroundings that its release will necessitate the expenditure of too much time, to say nothing of the danger of rupturing the carotid artery. Under these circumstances the vein and its trib-

utaries should be split open, cleaned, and the neck wound dressed without permanent sutures.

It is not advisable to undertake to irrigate the sinus and what is left of the jugular, either from below upward or the reverse, as infection can easily pass into the inferior petrosal sinus. It sometimes happens that even after the jugular has been resected the upper ligature removed, and the sinus thrombus removed by curettement, there is no return flow of blood from the bulb, which indicates a thrombus of the inferior petrosal sinus. This is an infrequent complication, as is also a similar condition of the superior petrosal sinus, and should be met by following up the sinus and curetting it. The sinus should be cleaned of all possible thrombotic material by the curette after the jugular ligation, but forced flushing should not be attempted.

It is a good plan after the jugular has been resected to remove the upper jugular ligature and give the inferior petrosal sinus an opportunity to send its blood down through the opened jugular vein, in hopes of flushing away thrombotic debris that might be present. The vein should then be resutured, or, as suggested by A. Knapp, "on the day following the operation thrombosis having occurred in the jugular vein, below the bulb, this vein should be slit up, so that we have access to the bulb from both directions, thus preventing a purulent disintegration of the thrombi in the contributory veins and sinuses." Knapp recommends this procedure, especially in the severest cases.

TREATMENT OF WOUND.

The wound should now be drawn together except at its upper and lower extremities, which should be left open for drainage. The lower opening need only be very small, just large enough to admit of a round rubber or cigarette drain, which should extend inside the wound for perhaps two or three inches, and which should be gradually shortened from day to day until it is withdrawn altogether (Fig. 9). The opening in the upper portion of the wound should be larger and should be either packed with iodoform gauze or drained with a round rubber or cigarette drain to be likewise gradually removed until compact healing occurs. Many surgeons do not suture this large neck wound, but draw the parts together with adhesive strips, feeling that the patient should be given every chance for his life by an open wound and free drainage. This, of course, involves an enormous scar but, nevertheless, is justified in bad cases, and possibly always. The jugular operation having been completed, the surgeon should now return to the sinus, on which work had been temporarily suspended.

The compress should be removed from the bulbar end of the sinus and all possible clot removed by means of a curette, after which narrow iodoform gauze should be gently but firmly packed into the interior of the sinus as far as possible. Pressure should, of course, be retained on the torcular end of the sinus and the entire mastoid wound dressed as usual, endeavoring as much as possible to separate the sinus from the mastoid packings. The neck should be abundantly dressed with gauze and cotton and the mastoid, head and neck enveloped in a voluminous and firm bandage, which it is best not to disturb for at least three days. Ordinary dressings at intervals of two or three days should follow until complete hearing occurs.

TREATMENT OF SHOCK.

Should symptoms of shock occur during the steps of the sinus or jugular operation relief may be obtained by

injections of physiologic salt solution into a vein, the breast or abdominal tissues or the bowels. If an intravenous injection is made, from sixteen to eighteen ounces of the solution should be used at a temperature of about 106 F. If the injection is made into the tissues or bowels from one to two pints should be used at a temperature of about 112 F. At all sinus and jugular operations appliances for making these injections should always be ready for instant use. In case the patient is in a very grave condition it is a wise precaution to give an intravenous infusion of physiologic salt solution before beginning operative procedures. Such infusions are also valuable in cases of general infection to counteract and combat the potentiality of migrating microorganisms.

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TREATMENT OF CHRONIC TRACHOMA.*

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The original scope of this paper did not include the surgical treatment, but it has been suggested that mention be made of treatment of entropion, and such surgical measures as may be used or endorsed. This makes a broad subject—too broad to be encompassed in a short paper—and for this reason I will confine myself to what seems to me of especial merit. This will leave the subject open for discussion by those who may favor Roentgen-ray treatment, electrolysis, or other lines which may be intentionally omitted, and the omission is not made with the purpose of ignoring other methods, but because of an insufficient amount of actual experience to enable me to express a judgment which may be deemed of value.

It will be presupposed, for the sake of argument, that the disease is contagious, and if so, due to a germ. This is based on personal observation relative to the contagiousness of the disease.

GERMICIDES.

The principal considerations are: First, select a germicide which is effective; second, prepare the infected surface in such a manner that the germicide may act; third, combat corneal complications (pannus and ulcers); fourth, correct the condition of the lids, which may cause relapsing inflammation (entropion, cysts, etc.).

The remedies used are copper sulphate, mercuric oxid, tannic acid, silver nitrate, boric acid, jequirity. In the empirical use of drugs to combat chronic trachoma, perhaps no remedies have been so extensively used as copper sulphate and silver nitrate, the former in the absence and the latter in the presence of secretion. Of these, copper sulphate deserves special attention. It may seem almost presumptuous to more than mention a remedy, the use of which is so familiar to all. My excuse for so doing is based on the following incident. A former patient came to my office and related his experience, which set me to thinking. In former years I had repeatedly treated him. Each time he would improve, but after returning home, he would relapse, until finally he found an old woman who effected a permanent cure at the cost of a dollar. Inquiry evolved the fact that the medicine used was in a small vial (half ounce), and that

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