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Mastoid and Intracranial Complications of Middle-Ear Suppuration

BY

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MASTOID AND INTRACRANIAL COMPLICATIONS OF MIDDLE-EAR SUPPURATION.[1]

SUPPURATIVE otitis media is a disease with which we are all familiar. The extension of the inflammatory process either to the bony tissue immediately surrounding the tympanum or to the contents of the cranial cavity is not, however, of such frequent occurrence. Inflammation of the mastoid process, while by no means uncommon, may be considered a rather infrequent complication of middle-ear suppuration, while involvement either of the meninges or of the brain substance itself is decidedly rare. The proportion of these latter cases, however, is larger than one would at first suppose. Some time ago one of our large insurance companies tried the experiment of accepting as good risks individuals who had formerly suffered from suppurative otitis media, but who at the time of examination gave no history of recent acute symptoms. The number of deaths directly traceable to aural suppuration was so large that the company was obliged to enforce the former rules and to refuse absolutely to insure all applicants who gave a history of aural suppuration. It has been stated that in every acute inflammation of the tympanum the mastoid cells are involved to a certain extent. I am inclined to discredit this statement; if true it is certainly a refinement of no practical value.

In the present consideration of the subject I shall first ask your attention to the evidences of mastoid involvement and the operative procedures for its relief, and shall then consider in the same way the diagnosis and treatment of the various intracranial complications, either of middle-ear suppuration alone or

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of this disease associated with an inflammation of the mastoid process.

Mastoid inflammation following either an acute purulent otitis or an acute exacerbation in a case of chronic suppurative otitis media is usually ushered in by severe pain in the mastoid region; the discharge from the ear becomes less profuse, and the pain in the ear diminishes as the pain in the mastoid increases. There is marked prostration, and in some instances a decided rise in temperature. It should be emphasized, however, that the temperature is of but little value in making the diagnosis. If elevated it may be looked upon as confirmatory evidence in a doubtful case. The absence of any temperature elevation is in no way indicative that the mastoid has escaped infection. While pain, as has already been stated, is the prominent symptom, I have not infrequently seen cases in which spontaneous pain was entirely absent, although the mastoid process was extensively involved.

Otoscopy affords one of the most valuable means of diagnosis. If the deeper portion of the canal is narrowed by the sinking of the superior and posterior walls, mastoid inflammation almost certainly exists. The extension of the infection is from the vault of the tympanum through the aditus ad antrum into the mastoid antrum. Both the mastoid antrum and the passage connecting it with the tympanic vault lie immediately above the superior wall of the canal, while the postero-superior wall of the meatus forms a portion of the floor of the mastoid antrum. This explains why the narrowing of the deeper portion of the canal is almost invariably observed in the early stages of mastoid involvement. When this sign is present operation is almost certainly indicated, although occasionally I have seen the disease aborted after the sign has made its appearance.

Of almost equal value with this otoscopic picture is the tenderness of the mastoid upon deep pressure. This tenderness is usually most marked over the region of the antrum, and is of correspondingly less diagnostic value as the tip of the mastoid is approached. Tenderness at the very apex of the process is of practically little value, this sign being often observed in perfectly healthy subjects. Two points demand attention in discussing this sign: First, in palpating the mastoid the pressure should be made so as to communicate no motion to the auricle. If this precaution is not observed an error in diagnosis may

occur and a simple circumscribed otitis externa be mistaken for mastoid inflammation. The second precaution is the palpation of the opposite healthy mastoid process in those cases where the affection is unilateral. In a few instances in neurotic patients I have found the mastoid upon the affected side exquisitely tender, although the other signs of mastoid inflammation were wanting. It was only upon palpation of the opposite healthy mastoid that an inflammation of the osseous structures could be excluded with certainty.

The preceding remarks will probably serve to demonstrate clearly that there is no certain and absolute indication of mastoid inflammation. The best sign is without question local tenderness, as has been pointed out by Gruening, and, with the narrowing of the fundus of the canal, this is sufficient to warrant operative interference in the vast majority of cases.

If the case is seen early enough to warrant an attempt to abort the attack, the best measure is undoubtedly the local application of cold. The most convenient method of doing this is by the use of either the Leiter coil or the Sprague aural ice bag. This latter device is much more convenient than the coil, and is, I think, equally efficacious. It is particularly adapted for use in private practice. It should be remembered that cold is not to be employed for a period longer than forty-eight hours continuously; there is no benefit to be derived if the coil or ice bag is allowed to remain upon the mastoid for a few hours and is then removed for an interval of one, two, or three hours. The action must be continuous in order to be of the slightest benefit. If tenderness has not entirely disappeared at the end of thirty-six, or forty-eight hours at the most, the further employment of cold is useless and operation should be undertaken at once.

Regarding the gravity of the mastoid operation, I am convinced that it has been greatly overestimated. Under the proper aseptic precautions the operation is absolutely free from danger, and in doubtful cases is justifiable as a means of diagnosis. Too much stress cannot be laid upon the necessity of absolute asepsis, not only in preparing the field of operation, the instruments, the hands of the operator, etc., but also during the entire progress of the operation. The anatomical anomalies met with in this region are so varied that the most expert operator will occasionally expose the meninges in the posterior or

middle cranial fossa, or even wound the lateral sinus. Such accidents do no damage if aseptic precautions are observed, but may be fatal if they have been neglected.

Regarding the operative technique, a free incision is first made extending from just below the tip of the mastoid to a point immediately above the superior attachment of the auricle. This incision should follow the line of attachment of the pinna to the side of the head and should not lie more than one-eighth of an inch behind this line. If this rule is observed the anterior flap is easily turned forward and the upper posterior margin of the bony meatus exposed. If the incision is made further back considerable force is necessary to expose the margin of the bony meatus, owing to the thickness of the anterior flap. The structures lying immediately in front of the incision are richly supplied with blood vessels, and the tissues for this reason become greatly engorged with blood as soon as free hemorrhage has been controlled. This thickening of the anterior flap not only interferes with the actual manipulations of the operator, but often leads to considerable deformity following the operation. If the incision is made along the line advised, the blood vessels are divided so close to the cartilaginous framework of the auricle that there is no opportunity for thickening of the anterior flap from engorgement. After division of the soft parts to the bone the periosteum elevator is used to separate the anterior flap from the underlying bone; the posterior flap may also be pushed backward in the same way. Retractors are then introduced, leaving the field of operation perfectly exposed.

Even where the mastoid appears to be but slightly involved it has been my custom to remove the entire cortex and explore every pneumatic space in each case. This may seem unnecessary, but I have frequently found the cells lying at the tip of the mastoid process filled with pus, while those lying above contained no pus at all but were simply congested. The tip of the mastoid, then, is to be removed in every instance. After the primary incision has been made and hemorrhage controlled, the next procedure should be to clear the tip of the mastoid of the insertion of the sterno-mastoid muscle, so that the finger can be passed around the tip into the digastric fossa. This is best done by means of blunt scissors, curved on the flat, which are pressed closely against the bone and made to divide the inser-

tion of the muscle into the mastoid apex. After the tip has been thoroughly cleared the operator should then proceed to explore the pneumatic cells by removing the cortex, the invariable rule being to gain access to the antrum as the first step. If the cortex has been perforated spontaneously the antrum may be entered by enlarging this opening. If the probe does not pass freely through this perforation into the mastoid antrum, but takes the opposite direction and passes downward toward the tip of the process in the direction of the digastric fossa, the rule is still the same, and the first aim should be to enter the antrum, in spite of the fact that the sinus through which the pus has escaped leads away from this. In attempting to enter this large pneumatic space the operator is liable to open either into the middle cranial fossa if the opening is made too high up, or to expose or open the lateral sinus if the cortex is removed too far behind the posterior wall of the meatus. The landmark to the antrum is the curved outline of the postero-superior margin of the bony meatus. If two lines be drawn, one horizontal tangent to the superior margin of the meatus and the second vertical tangent to the posterior margin, their point of intersection will be the apex of a triangle, the base of which is formed by the curvilinear outline of the entrance of the bony canal included between the points of tangency of these two lines. This triangle lies immediately over the antrum, and the deepest portion of the opening should always lie within this triangle.

At this late day nothing need be said of the advantages which the chisel possesses as an instrument for entering the antrum, as compared with the drill formerly used. By removing the cortex with the chisel or gouge, layer by layer, the entire field of operation can be seen, and even the deepest portions of the opening in the bone are sufficiently accessible to enable the surgeon to control severe hemorrhage if the sinus is accidentally opened and to then proceed with the operation. Formerly the opening of this large venous channel compelled the operator to abandon the operation, and the fatal termination was due usually to the fact that the patient had not been relieved of the condition from which he had been suffering, rather than because the sinus had been accidentally opened.

After the antrum has been entered the curette is freely used and all carious bone is removed. The entire pneumatic struc-

ture is obliterated by means of the curette and rongeur forceps, the tip of the mastoid being taken away. Particular care should be taken to thoroughly remove by means of the curette all softened bone from the channel leading from the antrum to the tympanic vault, as otherwise free drainage through the artificial opening will not be established, and although the mastoid symptoms may be relieved a purulent otitis often remains after recovery from the operation. After the softened bone has been thoroughly removed the larger vessels are secured by catgut ligatures and the cavity in the bone alone is packed with iodoform gauze. The edges of the wound are allowed to fall together, except at the lower angle of the incision where they are separated by the end of the strip of gauze used to pack the bone cavity. A narrow strip of iodoform gauze is also inserted into the external auditory canal, care being taken to carry it as far as the drum membrane; in this way any small accumulation of fluid draining through the perforation in the tympanic membrane is absorbed and infection of the meatus is avoided. Both the ear and the artificial wound are covered with a thick antiseptic dressing, which is left in position for four, five, or six days, unless pain or an elevation of temperature indicates the necessity for its removal.

The deformity which is so often spoken of as following an operation upon the mastoid process is not observed in these cases. The cicatrix lies close to the auricle in the line of auricular attachment. If the suggestions given above are followed in regard to the dressing of the wound, most of these patients are able to go about in from six to eight days after the operation, the later dressings being held in position by a firm pad simply. If the wound is kept open throughout its entire extent healing is much less rapid and the patient is obliged to wear a large, cumbersome dressing for a considerable period. In support of the statement, made earlier in the paper, that the mastoid operation is comparatively free from danger, I would say that of one hundred and seven cases upon which I have operated but five have terminated fatally, and in none of these was death at all traceable to the operation. In three instances meningitis had undoubtedly developed before surgical interference was instituted, while in two cases the fatal termination was undoubtedly due to cerebral abscess.

The unintentional opening of the cranial cavity, exposing

either the meninges of the middle fossa or the lateral sinus, or even the wounding of this large blood channel, are accidents which in no way increase the danger to the patient, provided, of course, proper aseptic precautions have been observed. In a number of my cases the lateral sinus was exposed, and on one or two occasions it was accidentally wounded; no untoward result followed and the cases went on to complete recovery. The same can be said of the accidental opening of the cranial cavity in other situations. If severe hemorrhage should follow a wound of the sinus it can easily be controlled by introducing a strip of iodoform gauze and applying firm pressure for a short time. If it is necessary to plug the entire wound in order to stop the hemorrhage the operation may be delayed for a few moments; the tampon is then removed cautiously, and if the hemorrhage persists a small pledget of gauze, held in position by the finger of an assistant, will then be sufficient to control it, and the operator may proceed to complete the operation.

When we consider the intracranial complications of middle-ear suppuration we should bear in mind that they may result from direct infection from the middle ear, the mastoid process remaining uninvolved throughout. Much more frequently, however, infection of the mastoid process precedes the intracranial involvement. The lateral sinus is the channel through which infection most usually takes place in cases complicating mastoid disease, and the formation of thrombus within its lumen is not an uncommon complication of severe middle-ear and mastoid inflammation. The signs of intracranial inflammation are unfortunately obscure in many cases, and the diagnosis is therefore uncertain in the early stages. The symptoms of a diffuse meningitis are so well known that they need not be dilated upon here. They are, as you remember, headache, photophobia, vomiting, and a persistent high temperature. When the meningitis is localized, forming an epidural abscess, the headache, instead of being general, is localized. The skull is frequently tender to pressure immediately over the purulent focus, and the temperature is not very much elevated. These cases ordinarily have a temperature ranging from 100° to 101.5° F. As the collection increases in size certain localizing symptoms may make their appearance, although these are often wanting. A collection of pus within the cerebral substance, or brain abscess, frequently gives rise to symptoms only after it

has existed for a long time; cases where the symptoms are acute are the exception rather than the rule. The temperature in the large majority of cases is not elevated above 99° F. and is often subnormal. The pain is not severe, but the patient is usually sleepless and complains of a dull feeling about the head rather than of acute pain. The general condition of the patient becomes steadily impaired, the mind becomes dull, and in the later stages localizing symptoms may make their appearance. In these chronic cases the failure of the patient to improve, in spite of the fact that no definite cause can be assigned for the general asthenia, should always excite suspicion, and, with the headache, sleeplessness, and low temperature, operative interference is justifiable in the absence of more definite indications.

When the process is acute a purulent collection within the brain substance is characterized by considerable temperature elevation, the symptoms being identical with those caused by an acute abscess in any other portion of the body. These cases, as already stated, are comparatively rare.

Where the lateral sinus is involved the evidence is much more certain. The temperature suddenly rises to from 104° to 106° F. There are rigors, followed by profuse sweating, and in a few hours the temperature falls spontaneously to normal. During the febrile movement delirium is often observed, but during the intermission the patient is perfectly rational and seldom complains of pain. If there is an extension of such a thrombus into the internal jugular vein, pressure along the anterior border of the sterno-mastoid muscle elicits tenderness. In some cases the occluded vessel can be felt as a hard, cord-like body running along the anterior border of the muscle. If unrelieved general systemic infection follows rapidly in these cases and ultimately causes the death of the patient.

It is to be remembered that these intracranial complications are almost invariably fatal unless relieved by surgical interference, and that a favorable termination in any case will depend largely upon how early the operation is performed. At the present day no one should hesitate to enter the cranial cavity for purposes of exploration in a doubtful case. Where the patient is in good general condition such an operation, if carefully conducted and completed within a moderate amount of time, does not augment the danger. On the other hand, if, after-

opening the cranial cavity, we are able to evacuate a collection of pus, to remove a focus of general infection, or to prevent the extension of a beginning meningitis, the patient's life will be saved. As mentioned above, the symptoms of involvement of the lateral sinus are usually so characteristic as to be recognized quite easily. Here the surgeon should never hesitate to expose the sinus at once, and, upon finding it occluded, to open it and to remove the clot by means of the curette until free hemorrhage takes place from each end of the wound in the sinus. The cavity is then to be packed with iodoform gauze and the wound dressed aseptically.

A brief history of a case of this character recently operated upon will demonstrate the truth of these statements. The patient was a young man of 18 who had suffered some five years previously from a suppurative otitis. From this time the ear gave no trouble until about five days before he came under observation. He then had severe pain in the ear, gradually extending backward to the mastoid region, dizziness, and nausea. There had been a slight discharge from the ear, but examination revealed that drainage through the canal was imperfect. As the mastoid process was not very tender and as the temperature was only 101° F., I contented myself with incising the drum membrane freely and applying cold to the mastoid, hoping to abort extension in this direction. About twelve hours later the patient had a pronounced chill, the temperature rose to 105.8° F., and there was intense headache and mild delirium. The temperature fell in the course of a few hours to 99° F. and then again began to rise, although the other constitutional symptoms were less severe. I operated immediately by making a free incision from the tip of the mastoid process upward to a point above the superior insertion of the auricle. This incision was about an inch behind the line of auricular attachment, for the reason that I expected to expose the sinus immediately after entering the mastoid antrum, and consequently it was necessary to make the incision further backward than in a simple mastoid operation. The lateral sinus, you will bear in mind, lies about half an inch behind the posterior margin of the bony meatus. By means of the chisel the cortex of the mastoid was removed and the antrum entered. The internal wall of the antrum was found to be completely destroyed, the meninges being exposed at the bottom of the wound. There was a col-

lection of pus covering the exposed meninges. The bone was rapidly removed by means of the rongeur forceps and the sinus brought into view; it contained absolutely no fluid. I then incised the sinus longitudinally, removing a firm clot by means of the curette, and then removed the bone covering the sinus, first downward to within about one-quarter of an inch of the jugular bulb. The sinus was then opened through the entire extent of the opening in the bone. By means of the curette a firm fibrinous clot was removed, and a probe passed downward into the jugular bulb caused a free hemorrhage, thus showing that the channel was free below. This portion of the wound was then plugged with gauze and the bone removed in the opposite direction toward the torcular Herophili; the sinus was laid open in this direction also and the curette used until free hemorrhage followed. The entire wound was then packed with gauze and an antiseptic dressing applied. The patient was discharged from the hospital two weeks after the operation, and at no time after the removal of the clot did the temperature rise above 99° F. The patient is now perfectly well. Here the indications for operation did not admit of any misinterpretation; in the following case, however, the operation was undertaken purely for purposes of exploration and yet the result was equally good.

The patient was a man, about 60 years of age, who had suffered from a double purulent otitis about twenty years before. The ears had practically given rise to but little trouble until about five weeks before I saw him, when he was suddenly seized with vertigo so intense that he was obliged to leave his work and go to bed. After the dizziness had somewhat passed away he began to have severe pain in his left ear. This pain soon began to radiate over the entire left side of the head, but was always most marked in the left temporal region. Although the dizziness had largely disappeared when I first saw him, the pain was intense and the left temporal region was exceedingly tender upon pressure. He consulted me upon the advice of Dr. J. A. Booth, of this city, who believed the pain was caused by some intracranial inflammation secondary to the purulent otitis and that the vertigo had also been of otitic origin. After eliminating all other causes for this pain it was decided by Dr. Booth that an exploratory operation was indicated. The man entered my service at the hospital and the operation was performed. During the two days previous to the operation the giddiness had

returned and was so severe when I operated that it was impossible for him to walk without assistance. During this period he had also developed a remittent temperature, fluctuating between 101° and 104° F. As we were entirely at a loss to locate the lesion, I at first explored the middle cranial fossa, making the incision from the tip of the mastoid upward, behind the ear, and then forward nearly to the external angular process of the frontal bone. This enabled me to turn down a large curved flap and to expose the squamous portion of the temporal, the margin of the bony meatus, and the region of the lateral sinus. In doing exploratory operations I much prefer this incision to any other, as it allows the operator to explore the cranial cavity in several places successively and to do this with great rapidity. The squama was easily perforated by means of the chisel and the opening enlarged by cutting forceps. The meninges were in a state of acute inflammation, the inflammation being more intense as the roof of the tympanum was approached. A probe passed along the roof of the tympanum, between the dura and the bone, revealed some roughness in this region and was attended by the escape of a large amount of serous fluid. A dural flap was then reflected and the cerebral substance punctured in various directions by means of an exploring needle, but no pus was found. As the temperature made me suspicious of sinus thrombosis, I rapidly removed the bony covering of this vessel, but upon exposure it was found to be normal. The mastoid antrum was not opened for the reason that there was perfect drainage through the external auditory meatus, and a probe could be passed through the canal upward into the tympanic vault and toward the antrum without any difficulty, showing that there was no retention of pus in this region. The dural flap was replaced and held in position by interrupted sutures. The epidural space over the tympanic roof was packed with iodoform gauze and the exposed dura covered by folds of the same material. The two extremities of the cutaneous incision were brought together by interrupted sutures, the central portion of the wound being allowed to remain open, thus affording free access to the middle cranial fossa and to the lateral sinus. The usual antiseptic dressing was then applied. The case made an uninterrupted recovery and was discharged about five weeks after operation. There was no rise of temperature and the history was one of uninterrupted improvement from the time operative

interference was instituted. Nothing, I think, shows more clearly than this case how little we have to fear from an exploratory operation. It also proves that we may prevent the generalization of a meningitis, provided the operation is performed sufficiently early. In other words, we limit the infection to the immediate vicinity of its source, as is done by Nature in the formation of an epidural abscess.

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