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(*Founded in* 1887 *by* MORELL MACKENZIE *and* NORRIS WOLFENDEN)

October 1950

ATTIC SUPPURATION

By A TUMARKIN (Liverpool)

BEFORE discussing attic suppuration proper, I want to set it in perspective as one of many manifestations of infection in the tubo-tympano-mastoid tract. The attic and post-superior perforations are bracketed together as marginal. Their cardinal features being :

1. Insidious onset.
2. Association with a poorly pneumatized mastoid.

I follow Wittmaack (1918) in believing that some mysterious process in earliest life arrests pneumatization and leaves the mucosa devitalized so that it is prone to break down under stress. The breakdown may be extremely slow so that sheets of pavement epithelium are successively exfoliated without the production of pus or other exudate. The tympanic membrane is not involved and may remain intact for years. This is the so-called primary cholesteatoma so often mistaken for an epidermoid tumour. In other cases, the process after lying dormant for many years, is activated rather more vigorously so that laminated sheets have no time to form. Instead a whitish detritus is thrown off and a low grade osteitis develops, usually in association with granulations. This insidious process also occurs primarily behind an intact drum but perforation finally occurs because osteitis invades the annulus tympanicus and erodes the attachment of the drum in the immediate vicinity. That is why the marginal perforation declares itself insidiously.

By contrast, the central perforation occurs in association with a well-pneumatized mastoid during the course of an acute suppuration. Perforation is caused by the hydraulic pressure of pent-up pus. Thus in both acute and chronic conditions there is a stage before the drum bursts and a later stage when otorrhœa becomes manifest. The adjectives "enclosed" and "perforating" serve to distinguish those stages as

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shown in Fig. 1. It would of course be quite wrong to think of the various entities in Fig. 1 as entirely distinct from each other. There is in fact, a continuous gradation from the acute suppurative mastoiditis of the perfectly pneumatized mastoid to the symptomless "primary cholesteatoma" of the non-pneumatized mastoid. Furthermore, exceptions are not infrequent although on closer examination they are usually found to be apparent and not real. For example, a marginal perforation may occasionally declare itself with acute symptoms. Almost invariably, however, this is found to be merely an acute flare-up of a pre-existing chronic disease. Conversely, cases are periodically reported of

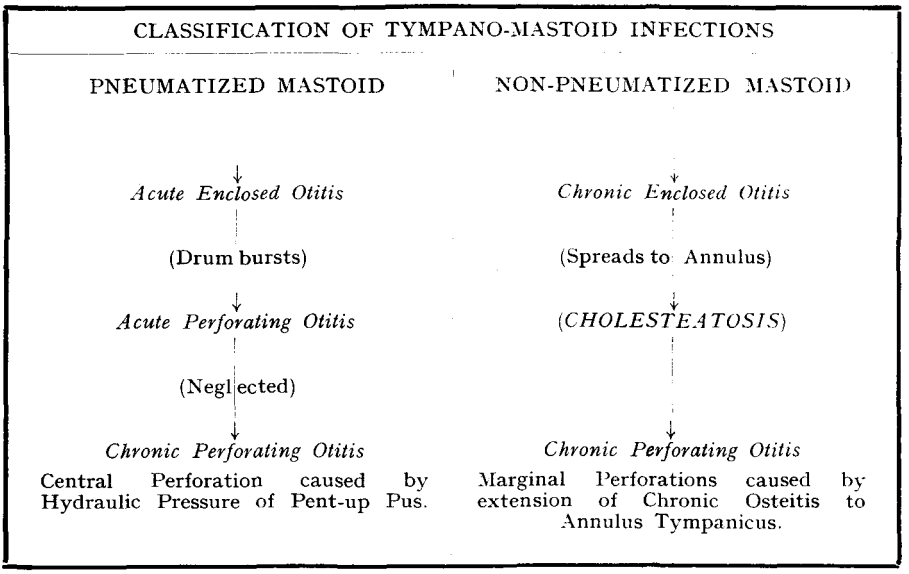


FIG. 1.

"cholesteatoma" occurring in a pneumatized mastoid. Usually the patients are quite young and it is not difficult to envisage a localized failure of pneumatization due to some patchy inflammation in infancy, giving rise later to an encysted pathology surrounded by healthy pneumatized bone. Such a combination, however, is excessively rare.

From this short review, I have excluded the muco-purulent otorrhœas arising from inflammation of the ciliated epithelium of the antero-inferior portion of the tubo-tympanic tract. These rarely, if ever, give rise to true marginal perforations. We are concerned here solely with manifestations of inflammation in the pavement epithelium which lines the ossicles, attic and air cells. All the protean manifestations of mastoiditis —whether chronic, acute or pseudo-acute, enclosed or perforating—can

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be explained as the natural reaction of this pavement epithelium more or less modified by the factor of pneumatization.

Thus, there is certainly no need for the word cholesteatoma with its implication of tumour formation, and the idea is slowly gaining ground that it should be abandoned. The expression " Cholesteatosis " recently proposed has much to commend it (Young, 1950).

Chronic Perforating Epitympanitis

It is natural to ponder on the factors which determine whether a given case of cholesteatosis shall perforate at the post-superior quadrant or in Shrapnell's membrane. In a non-pneumatized mastoid the main surface available for the development of cholesteatosis will be the antrum and to a lesser extent the epitympanum. We can easily envisage the process creeping along to the annulus and so eroding the annular ligament at the post-superior quadrant. In attic perforations a special factor must be noted—the incus. This ossicle hangs suspended in mid air and its anatomical connections are tenuous in the extreme. Its blood supply at best must be precarious, and in the presence of cholesteatosis is liable to become quite inadequate so that the ossicle falls into a state of anæmic necrosis.

CASE 1.

A doctor whose hearing had been normal until 1933, sustained a blow on the head during a Rugby game, followed by left otorrhœa for a few days. In 1940, following shell blast, he again had left otorrhœa for about six weeks and in 1943, a further week of otorrhœa following shell blast. In 1945, he was demobilized with a dry—but deaf ear. In January, 1949, after a severe cold, he developed chronic otorrhœa which resisted the most persistent conservative treatment. At operation, there was no sign of the incus whatsoever and the mastoid was non-pneumatized—in contrast with the right mastoid which was fully pneumatized.

The explanation of these findings is as follows :

The left ear had failed to pneumatize in infancy and the incus—already precariously nourished—was shaken loose from its moorings by repeated trauma and finally gave up the ghost. Thus the process which declared itself in 1949 as a perforating epitympanitis may have started as an enclosed epitympanitis at any time in the preceding fifteen years or it may have been precipitated by the acoustic trauma. Enclosed epitympanic cholesteatosis is probably far more common than we suspect but obviously the diagnosis presents great difficulties. Perhaps the first step in the diagnosis would be to acknowledge the existence of this clinical entity. It is possible that X-rays might help in the form of precision tomographs but if not the question arises as to whether we should not perform exploratory atticotomy more often.

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CASE 2.

Some years ago, a man consulted me on account of unilateral deafness which came on suddenly as a result of acoustic trauma and had become steadily worse. There was no history of otorrhœa at the time and the drum was intact. I would have diagnosed traumatic otitis interna but the bone-conducted hearing was excellent. I was puzzled and, at the man's urgent request, I opened his attic. I found it full of a laminated mass of white debris. There was no sign of the incus. The onset of deafness immediately after the acoustic trauma suggests strongly that the two were connected and the conception of anæmic necrosis of the incus fits in with the anatomical and pathological facts.

Similar cases are described in the literature from time to time and are sometimes labelled as epidermoid tumours. Dan McKenzie (1931) maintained that thesis before this Society some years ago, but I submit that the explanation I have outlined accounts for the clinical and pathological findings far more satisfactorily.

Chronic Enclosed Epitympanitis

Having crystallized the conception of epitympanic cholesteatosis, and correlated it with anæmic necrosis of the incus in association with a non-pneumatized mastoid, we proceed to consider what form chronic epitympanitis will take when it is associated with a pneumatized mastoid.

Text-books describe a tubo-tympanic catarrh or secretory otitis media which can be extremely resistant to treatment. The explanation I believe is that in such cases the whole tubo-tympano mastoid tract is involved. X-rays almost invariably reveal a diffuse clouding of the whole mastoid. The drum may be amber or olive in colour or simply lack-lustre—but it is intact, and that provides us with the generic nomenclature " chronic enclosed otitis ". Its manifestations vary enormously from the simple transient middle-ear exudate to an intractable fibrino-plastic degeneration of the whole tympano-mastoid mucosa. In other words, a latent mastoiditis. This condition may seem unconnected with attic suppuration but in fact, it is very germane, because the final result of treatment may well depend on how efficiently the epitympanum is dealt with. When conservative treatment fails—as indeed happens all too frequently—it is usual to perform a cortical mastoidectomy. That, in my opinion, is an error because it fails to deal adequately with the epitympanum. Within recent years, I have explored many of these cases by the Permeatal route* and invariably I have found considerable disease in the attic as well as in the mastoid. That after all, is only to be expected seeing that exudate formed in the mastoid can only escape *viâ*

* Following McGuckin (1949) I now use the adjective Permeatal to label the operation which I originally described as Transmeatal atticotomy. (Tumarkin, 1938.) My reason is that Popper (1946) has recently described a route which is more truly transmeatal and it is desirable to avoid confusion in nomenclature.

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the eustachian tube by seeping over the watershed of the external semicircular canal past the body of the incus.

The aims of an operation in such a case must be :

1. To explore and if necessary to exenterate the diseased mastoid cells.
2. To drain the infected epitympanum.
3. To segregate the epitympanum from the general mastoid cavity so that it does not have to act as a common drain.
4. And above all not to disturb the ossicular chain.

Simple mastoidectomy complies with (1) and (4) but not with (2) and (3) and the classical radical is obviously out of the question. It appears

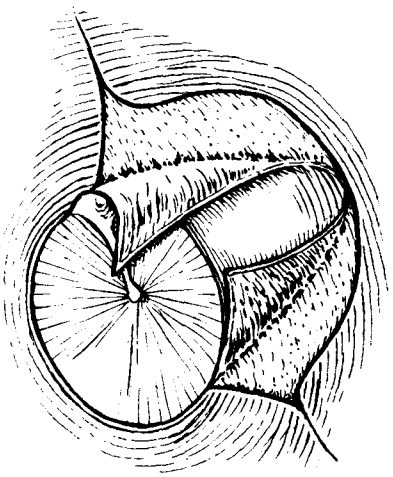


FIG. 2.

A " Fenestration flap " has been demarcated and partially elevated.

that some form of conservative radical procedure is indicated. When I attacked this problem originally, I used the standard permeatal technique but that may leave the ossicles uncomfortably exposed (Fig. 9).? Latterly, therefore, I have used a fenestration flap instead of an atticotomy flap. A fenestration flap is elevated (Fig. 2) and turned down across the drum exposing the posterior tympanic cavity with the round window, chorda tympani and incudo-stapedial joint. Fig. 3 shows the first semi-lune removed exposing the long process of the incus, the facial nerve and the oval window. Fig. 4 shows the attico-antrotomy completed. The flap is then gently folded back over the ossicles so as to segregate them from the mastoid cavity and also protect them from the external world. The results have been most gratifying. The ears heal almost by first intention and the hearing improves remarkably.

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The granulations removed from the attic in these cases are curiously indolent. Our Pathologist reports as follows (Fig. 5):

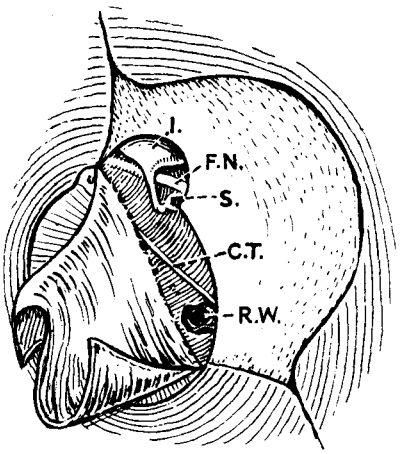


FIG. 3.
The flap has been elevated down to the annulus and turned forward across the drum bringing into view the posterior third of the tympanic cavity. The first semilune has been removed bringing into view the long process of the incus I and the facial nerve F.N. R.W.—Round Window. C.T.—Chorda Tympani. S.—Stapes.

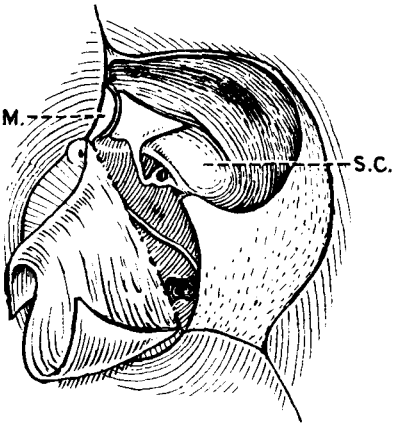


FIG. 4.
The attico-antrotomy has been completed. The incus is fully exposed lying on the semicircular canal S.C. The head of the malleus M. is visible. Diseased cells are removed wherever they ramify and finally the flap is turned into place over the ossicles so as to segregate them from the mastoid cavity.

"Specimen consists of rather vascular fragments showing a marked fibroblastic reaction with a deposition of a little collagen and a slight diffuse lymphocytic and plasma cell infiltration. One or two foreign body type of giant cells are present. Staining for tubercle bacilli is negative. Appears to be the result of a very low-grade infection."

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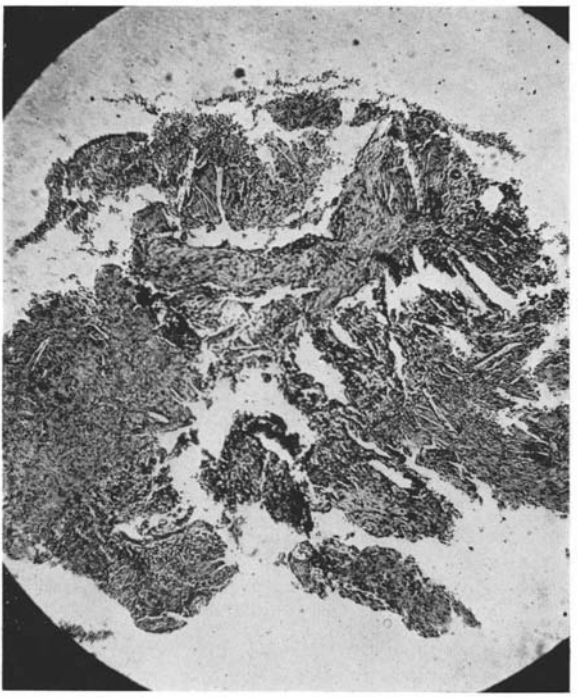


FIG. 5.

Micro-photograph of granulations removed from a case of chronic enclosed mastoiditis. The disease had been present for over a year and yet the drum was intact. Diagnosis was based on the lack-lustre gun metal appearance of the drum plus typical clouding of a pneumatised mastoid.

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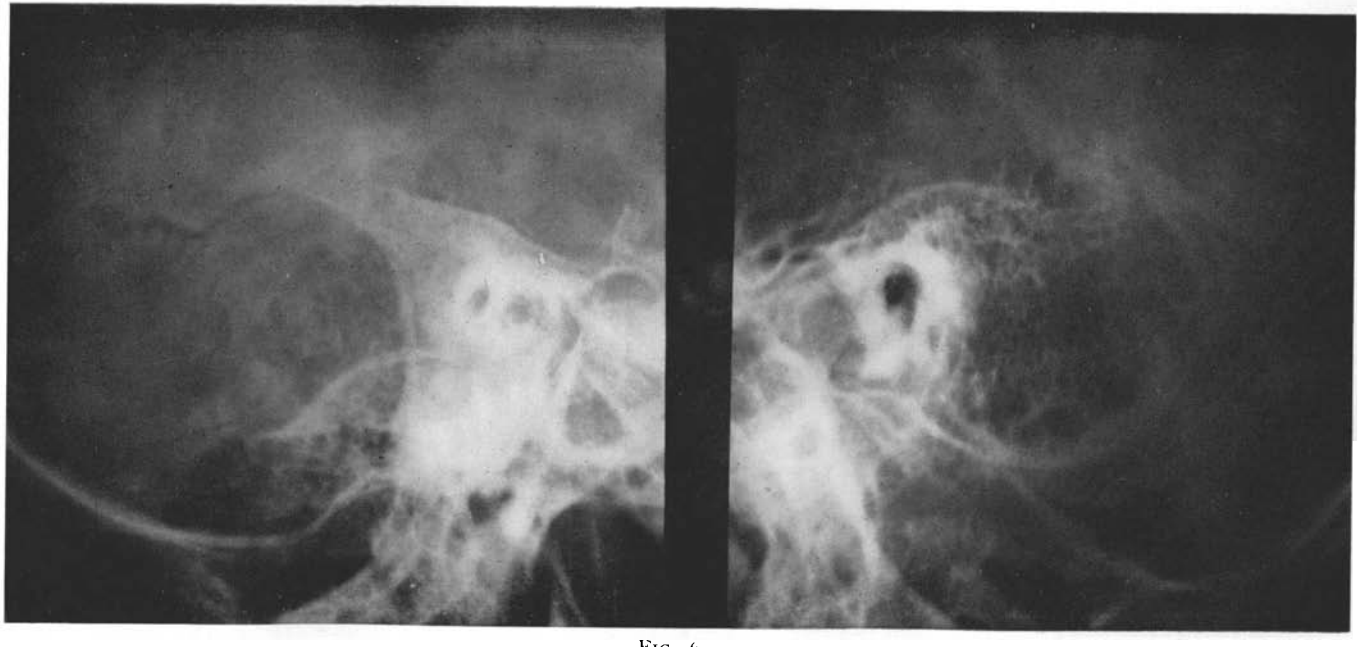


FIG. 6.

Sub-acute enclosed (L) mastoiditis. The normal (R) mastoid is shown for comparison. The (L) drum was intact but Shrapnell's membrane was bulging and the pars tensa was lack-lustre.



FIG. 7.

Keratosis obturans showing extreme widening and blurring of external auditory canal due to accumulated debris. The mastoid process is well pneumatized.

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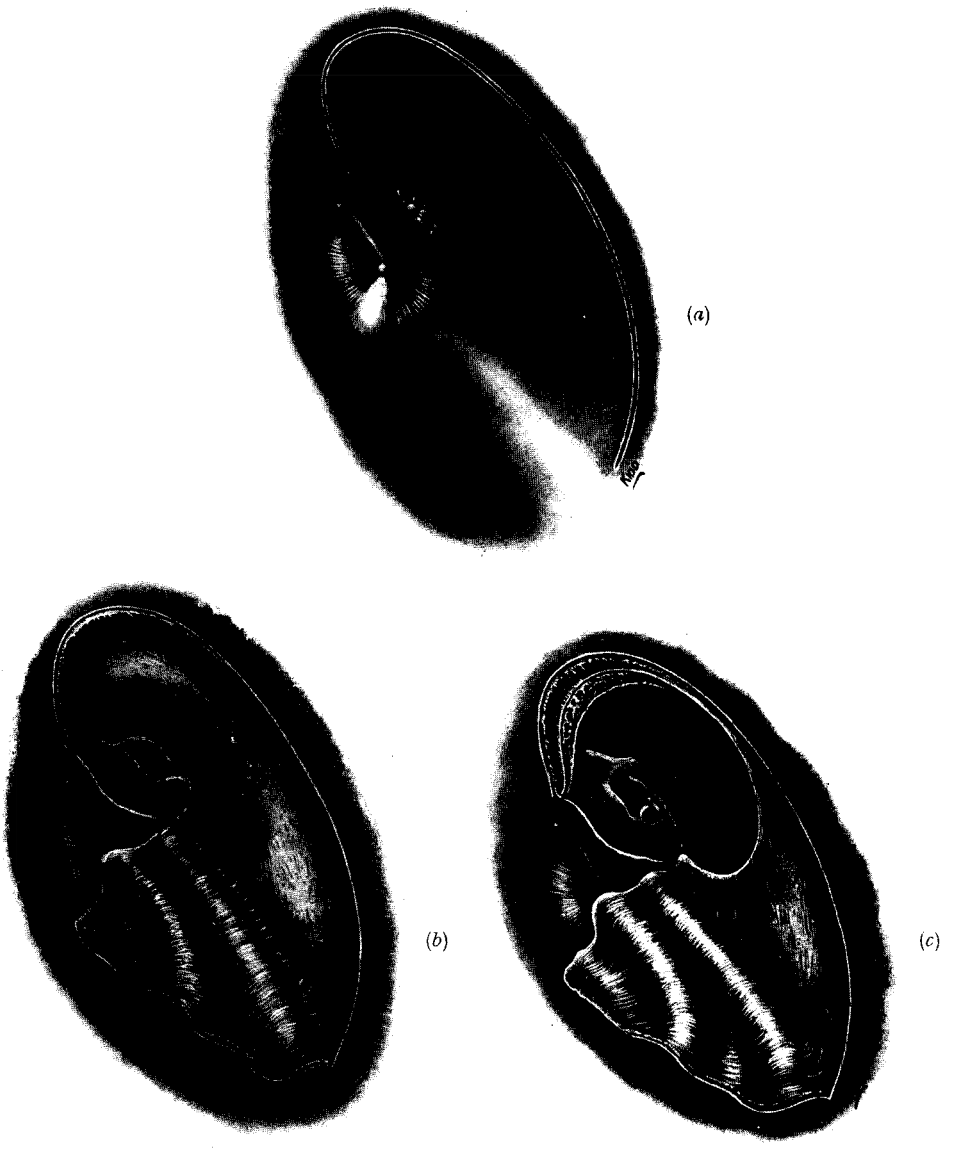


FIG. 8.

PERMEATAL ATTICO-ANTROTOMY.

(*a*)

The incision starts at Shrapnell's membrane, ascends the outer attic wall and then traverses the roof of the external auditory canal as far as the Endomeatal spine. There it turns backwards and downwards. This outlines an elliptical flap. Note the granulations in the post-superior quadrant of the tympanic ring.

(*b*)

The flap has been elevated and thrust forward on to the floor of the external auditory canal. Two semi-lunes of bone have been chipped away carrying the granulations with them. The long process of the incus comes into view with the crura of the stapes.

(*c*)

A later stage. More bone has been removed exposing the body of the incus, the horizontal canal and the facial nerve. In favourable cases no more need be done. Usually, however, it is necessary to remove the incus. The anterior attic pouch and the head of the malleus are easily exposed by removing the overlying outer attic wall. Diseased cells ramifying up to the sino-dural angle or down to the mastoid tip are easily followed and if necessary the whole mastoid process exenterated.

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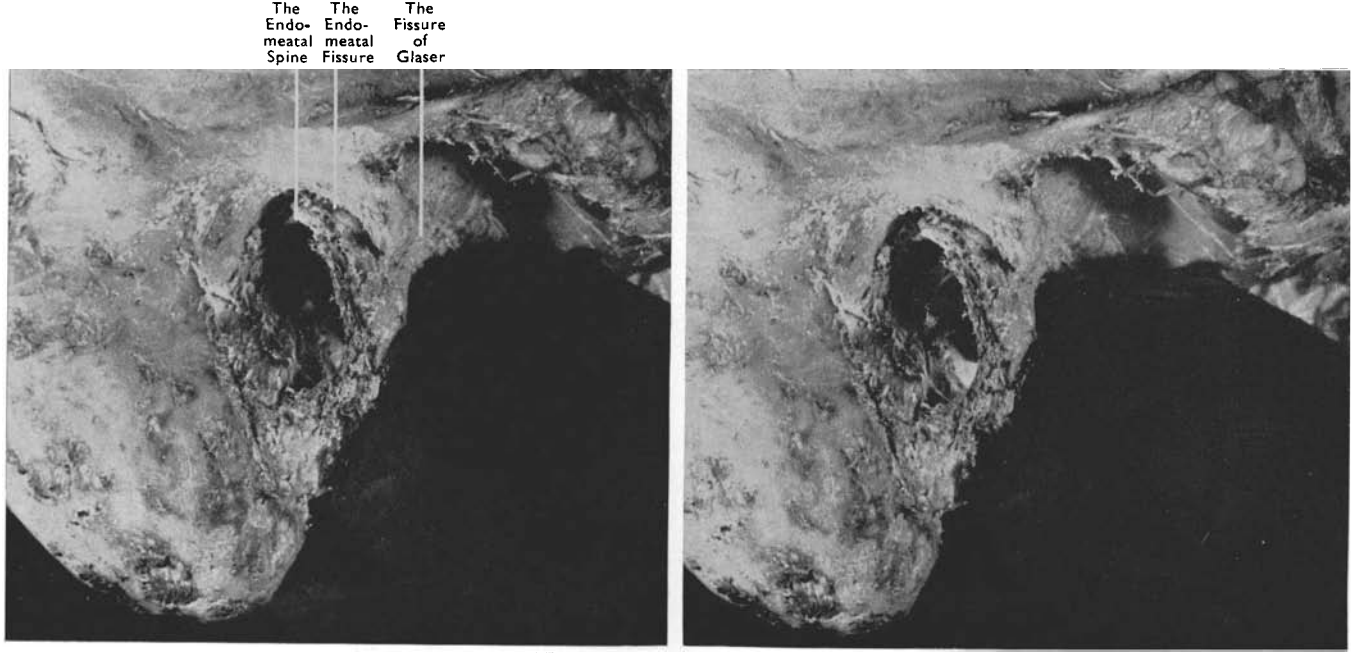


FIG. 9.

THE ENDOMEATAL SPINE AND FISSURE.

These photographs should be viewed through stereoscopic binoculars, otherwise the anatomical details do not stand out very clearly.

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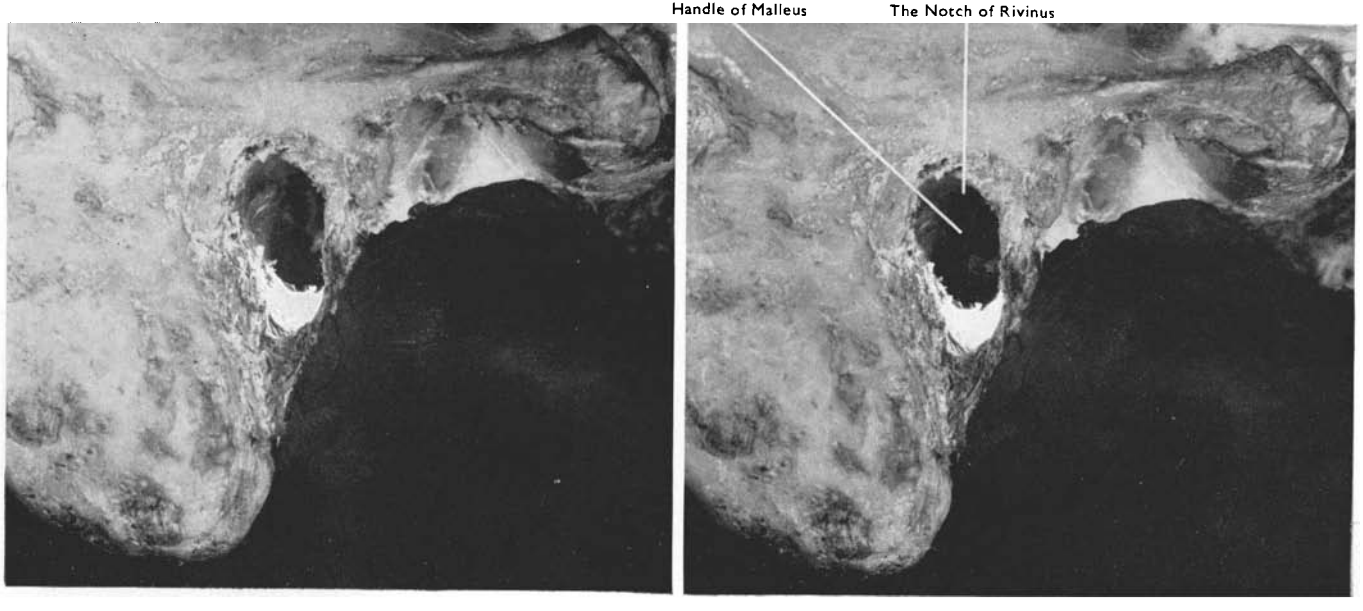


FIG. 10.
EXPOSURE OF OUTER ATTIC WALL FOLLOWING REMOVAL OF ENDOMEATAL SPINE.

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This picture, as I have said, is characteristic of the indolent granulations removed from a chronic enclosed epitympanitis arising in a pneumatized mastoid. It obviously differs markedly from cholesteatosis and it confronts us with an unsolved pathological problem. Are the two reactions fundamentally different—or are they merely variants of a single process. I believe the answer lies midway. Both are due to inflammation of the pavement epithelium but cholesteatosis does not occur unless that epithelium has already been devitalized by some preceding pathological reaction which characteristically also aborts pneumatization. Thus we may encounter all stages between the two extremes according to the extent to which pneumatization has been aborted.

Acute Epitympanitis

Here again, it is necessary to consider the effect of impaired pneumatization on the manifestations of acute attic inflammation. Cholesteatosis is by definition a chronic process, nevertheless occasionally a post-superior—or even an attic—perforation presents with acute symptoms and yet at operation the typical picture of cholesteatosis is revealed. In these cases, it cannot be doubted that the cholesteatosis must have been originally present as a chronic enclosed process and the final perforation has been precipitated by a super added acute inflammation. This may well be labelled Pseudo-acute Epitympanitis.

On the other hand, primary acute mastoiditis arising in a fully pneumatized mastoid rarely—if ever—perforates in Shrapnell's membrane. The reasons for this are not very clear. Possibly the pars flaccida is protected from the hydraulic pressure of the pus by the head of the malleus and the swollen mucosa which fills the epitympanic pouches so that the main impact of the pent-up pus is directed against the drum head proper which—because of its very tenseness is prone to burst more readily.

Thus in the past, acute epitympanitis rarely occurred as an isolated clinical entity although of course, it was usually present as part of a generalized acute pan-otitis. Today, however, the picture is changing somewhat as a result of the widespread and often inadequate use of the anti-biotics.

CASE 3.

A schoolboy developed acute left otitis media which was treated with inadequate doses of sulphathiazole. The acute symptoms subsided but two weeks later he again began to complain of deafness, tinnitus and discomfort in that ear. I saw him at that stage. The hearing in the left ear had receded by about 40 db. The pars tensa was somewhat lack-lustre but Shrapnell's membrane was obviously bulging and the outer attic wall was boggy. I

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diagnosed sub-acute, enclosed epitympanitis but the X-ray revealed a diffuse clouding of the whole mastoid. (Fig. 6.)

Why did he present a bulging Shrapnell's membrane ? Why not the usual bulging pars tensa ? I suspect that the general mastoid infection had been more or less suppressed by the initial treatment but the more vulnerable attic structures, especially the incus, had not recovered so well. Possibly a few granulations had formed and when his inadequate medications came to an end, those granulations were the first to start grumbling again. That boy was treated intensively with penicillin followed by a prolonged course of sulphathiazole and he recovered. But suppose he relapses, as well he may. I fear his trouble next time may present again in the attic because his incus may be devitalized. Even now, may he not be developing a chronic enclosed epitympanitis ?

Treatment of Attic Disease

I have already referred to the treatment of enclosed epitympanitis and it remains to discuss the treatment of the more common Perforating Epitympanic Cholesteatosis. Despite its insidious and apparently benign course, this condition can be most resistant to conservative treatment, partly because caries of the incus has taken place and also because cholesteatosis once started is extremely difficult to dislodge from the tortuous epitympanic cavities. I used to irrigate with carbon di-sulphide and other lotions and to ionize with mono-polar and bi-polar electrodes, but I have abandoned those methods. Simple local hygiene will cure some cases but relapse is all too common and in most cases, only surgery can provide a permanently dry ear.

It should be borne in mind that despite their apparent indolence, these epitympanic infections can produce fatal intracranial complications.

CASE 4.

Recently, at the request of my neuro-surgical colleagues, I examined a man who obviously had an intracranial lesion. His pars tensa was absolutely normal. The pars flaccida was perforated by a tiny indolent polyp and there was a little whitish debris in the perforation but no obvious discharge or pulsation. With some real reluctance, I opened his mastoid and to my amazement found a completely gangrenous lateral sinus and an extradural abscess extending to the torcula. At a later operation, a temporo-sphenoidal abscess containing nearly an ounce of pus was evacuated.

Radiology

In addition to pre-operative audiograms, X-rays should always be taken. These will usually reveal a poorly pneumatized mastoid—but even so, it is useful to know whether or not the bone is completely

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eburnated. The density of the bone can be a determining factor in the choice of operation, as also can be the presence of excavation.

CASE 5.

Recently a case of keratosis obturans was most resistant to treatment. The attic contained granulations and debris and my Assistant, suspecting that it was really a primary attic cholesteatosis simulating keratosis obturans put the patient down for an atticotomy. Preliminary X-rays revealed an essentially normal pneumatization, but the external auditory canal (Fig. 7) was markedly expanded and blurred. On the strength of that X-ray I decided not to operate. We continued with conservative treatment and in due course it turned out to be a true keratosis obturans with a secondary invasion of the middle ear and attic.

Naturally, when complications are suspected all other considerations are thrown to the wind in favour of adequate exposure which can only be achieved by the post-aural route. In the " cold " cases—which should constitute the vast bulk of all our work it is imperative to adopt a more conservative approach dominated by functional considerations. This principle has been widely accepted but unfortunately—in practice—it has been mis-applied repeatedly. The following desiderata should be borne in mind :

1. The ossicular chain must be preserved if it is functioning.
2. The disease must be adequately laid open. Not only must the whole area be drained but it must be readily accessible to inspection afterwards.
3. On the other hand, excessive mobilization of soft tissues and excision of compact bone must be avoided.

It follows that procedures such as ossiculectomy are fundamentally unsound. Similarly, blind curettage of the attic advocated by Babbitt (Jackson & Jackson, 1946) under the title " Modified attic drainage " has nothing to commend it. Both fail to comply with the first two desiderata, whilst orthodox radical surgery and its various modifications fail in the third.

The required operation must attack the disease at the primary focus in the attic and must be sufficiently elastic to enable the surgeon to follow the disease wherever it ramifies. The permeatal route complies with these requirements adequately and I have used it exclusively ever since I adopted it in 1935 (Fig. 8). It leads the surgeon directly on to the outer attic wall where he will usually find, after elevating the flap that the notch of Rivinus has been eroded much more than would be suspected from the pre-operative appearances. Occasionally the permeatal route presents difficulty because of narrowness of the external auditory meatus due to over development of the Endomeatal spine

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(Fig. 9) (Tumarkin, 1949). This spine is nothing more than the antero-superior corner of the tympanic plate curled into the lumen of the meatus. The writer is indebted to Popper for emphasizing the importance of the tympanic plate in both permeatal and transmeatal routes. As Fig. 10 shows, a limited excision of the endomeatal spine greatly increases the accessibility of the attic. Such a limited excision can easily be carried out immediately after elevating the flap.

I must admit that my attitude to attic disease has altered in the past five years. I originally performed atticotomy pure and simple, being fired by Dan McKenzie's suggestion that such a limited exposure might be successful. Subsequent experience, however, has taught me that it is almost always necessary to expose the antrum. Thus the title Attic-otomy as used in this context is misleading. The operation is almost always an Attic-Antrotomy.

It remains to consider whether Permeatal Attico-Antrotomy complies with the desiderata laid down above. These points have already been discussed " in extenso " elsewhere (Tumarkin, 1947) and may be briefly summarized as follows :

(*a*) The permeatal route leaves the whole pinna completely undisturbed. It is performed entirely within the bounds of a soft tissue flap elevated from the posterior and superior walls of the external auditory canal.

(*b*) It begins at the main focus of disease in the attic and proceeds thence to the antrum. From that point exposure can be extended at will to the outermost confines of the mastoid process. This claim, ambitious as it may seem, can be confirmed by all who have acquired the necessary technique.

(*c*) The post-operative cavity heals readily—being comparatively small. Nevertheless, it provides ample access to the attic and antrum.

(*d*) Above all, however, the functioning structures can be supervised throughout the operation with striking precision.

The whole question of how and when to preserve the ossicular chain needs careful consideration. Unfortunately, in attic cholesteatosis the incus is rarely present and frequently the head of the malleus is necrosed. The pars tensa usually looks so normal that the surgeon is at great pains to preserve it. This may be a grave error. Caries of the malleus head, and of the inner tympanic wall may produce granulations *behind* the drum and so maintain a troublesome otorrhœa. It is desirable therefore—when the incus is absent—to dissect out the malleus and allow the drum head to collapse against the inner tympanic wall.

When, however, the incus is viable the surgeon should proceed as follows. In cutting the first semi-lune, the gouge is gently tapped until

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the thin bone is just felt to crack through. Then with a fine hook the semi-lune of bone is lifted free. It should never be picked out with a forceps because that is liable to thrust it on to the incus which lies immediately beneath it. Once the first semi-lune is removed the long process of the incus comes into view and the surgeon proceeds with greater confidence because he is rapidly moving away from the vital structures which in any case are now clearly visible. An alternative method may be necessary sometimes when the first semi-lune, although apparently cracked through, remains locked in position. In that case, the second and

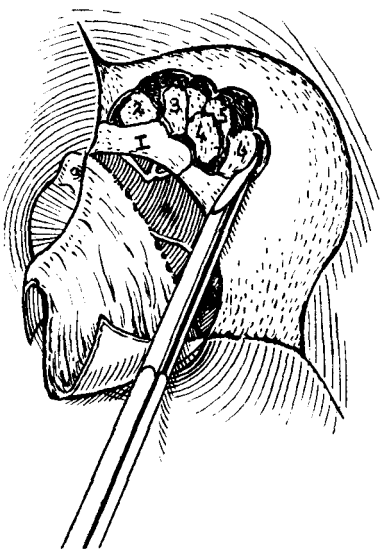


FIG. 11.

The Fenestration flap has been turned down exposing the posterior portion of the middle ear. The first semilune (1) being too bulky to remove immediately, is left *in situ* whilst adjacent semilunes 2, 3, 4, 5, and 6 are cut. At (6) the gouge has entered the antrum and the bone chips can then be safely removed in *reverse order*.

subsequent cuts should be made until the gouge sinks into the antrum. The bone chips can then be picked out easily starting at the antrum (Fig. 11). The first semi-lune in that way is finally exposed from both sides and can be lifted away precisely without damage to the incus (Fig. 12.)

Even when the incus *is* present the decision to preserve it may be fraught with difficulty. Owing to its precarious blood supply, it may sequestrate after an otherwise perfect operation and form a nidus for granulations. In such cases it must be picked out without delay. This is an extremely simple procedure, and, if combined with dissection of the malleus, will lead to prompt healing of the attic.

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It should be noted that the ossicular chain can function even though the incus is badly eroded. The chain is usually described as strung between two pivots, the posterior one being the fossa incudis (Fig. 13).

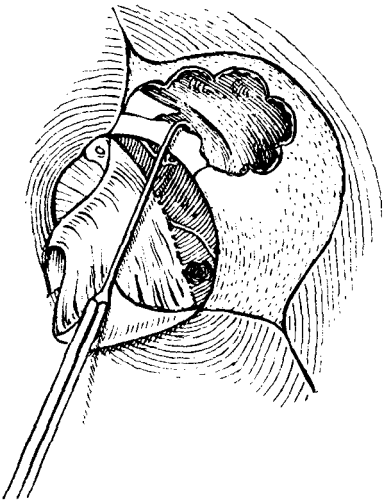


FIG. 12.

The antrum is well exposed and the first semilune can now be elevated from the body of the incus under direct vision without fear of disturbing the ossicle.

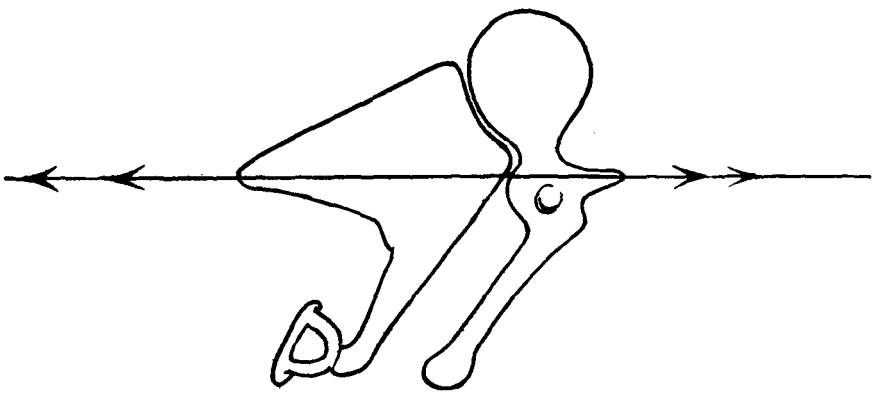


FIG. 13.

The ossicular chain is commonly regarded as strung tautly between two pivots. This is erroneous.

That is quite erroneous. Fenestration surgery has shown us that the fossa incudis is a myth—the incus is easily flicked away and the malleus remains absolutely undisturbed being held in equilibrium by its ligaments, its muscle and the elastic fibres of the drum. It appears, therefore, that

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the incus is a mere passive lever held in the grip of the malleus (Fig. 14) and it follows that it will function adequately so long as it provides some sort of physical continuity between the head of the malleus and the stapes. On functional grounds, therefore, we should not lightly sacrifice it.

I have in this article, outlined certain conservative techniques which have proved reasonably successful. No doubt other methods will be evolved. The exact technical details matter less than the underlying principle, i.e. the need to abandon the old attitude to Otological Surgery.

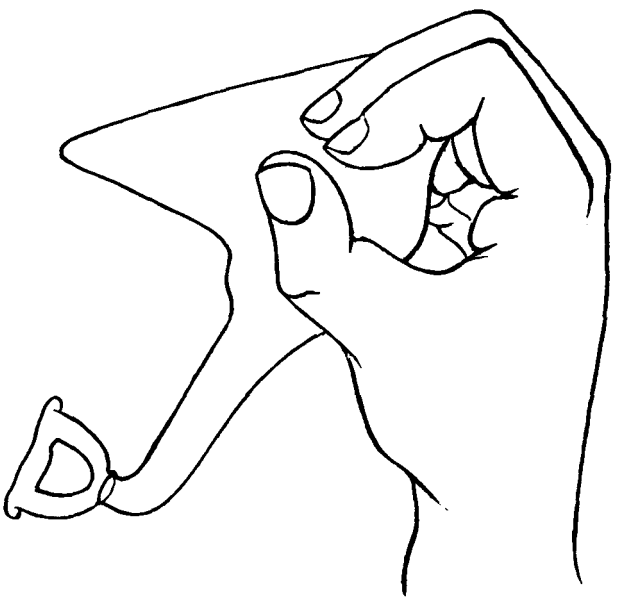


FIG. 14.
The incus lies passively in the master grip of the malleus.

The Schwartze operation stops short of the attic. The Stacke-Zaufal operation enters only to destroy. Yet the attic is the focal point of all our problems. Its physiology, pathology and above all its surgery, still present a most fascinating field for research.

Summary

Attic inflammation may be acute or chronic and in each case there is an important " enclosed " stage before overt discharge appears.

The significance of pneumatization is discussed and the thesis is supported that—as elsewhere in the mastoid—cholesteatosis is closely associated with faulty pneumatization.

The role of anæmic necrosis of the incus in attic cholesteatosis is discussed.

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The mechanical action of the incus is analysed.

Enclosed epitympanitis in the pneumatized mastoid is described. This condition—along with all other types of latent inflammation—has become more common since the advent of the anti-biotics, and accounts for many obscure cases of deafness.

Suitable surgical techniques for the various clinical entities are discussed with special reference to the problem of preserving the ossicular chain.

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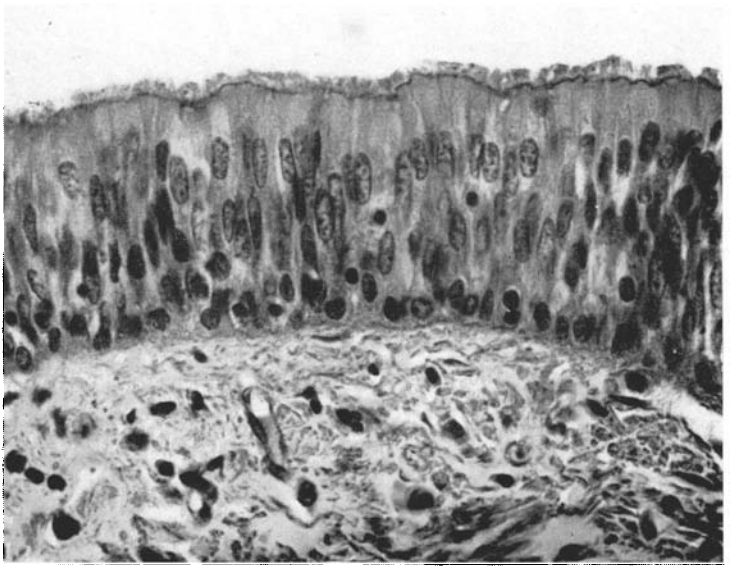


Fig. 1.

Transverse section of the wall of the external sac. 8μ thick. Stained with Hæmatoxylin and Eosin. × 500.

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