Tympanosclerosis

By G. D. L. SMYTH (Belfast)

I HAVE chosen tympanosclerosis as the subject of this short paper because it stands out as the least amenable of the diseases of the middle ear which we attempt to treat surgically. Not only are the techniques of functional restoration exacting in the extreme but in addition the hazards to the cochlea have proved considerably greater than in other forms of middle ear surgery. The purpose of this paper is to discuss the problems which have arisen, and to describe the technique which at present appears most appropriate for tympanosclerosis.

The surgical treatment of tympanosclerosis is essentially a tympanoplastic procedure and therefore should be subject to the basic principles of tympanoplasty. These principles are:

1. The removal of irreversible disease.
2. The maintenance of the posterior bony canal wall and the avoidance of an open mastoidectomy cavity.
3. The reconstruction of the sound transformer mechanism.

Although at first glance the first two of these principles might appear to have little relevance to the problems of tympanosclerosis, analysis of my cases has shown that cholesteatoma was frequently co-existent with tympanosclerosis, as was granular disease of the mucosa and therefore the first principle must not be ignored. Again, although it is frequently possible to carry out an operation on a tympanosclerotic ear entirely with a transcanal route there are occasions when tympanosclerotic plaques are present in the attic causing immobilization of the malleus and incus. In accord with the second principle of tympanoplasty the integrity of the bony sulcus and the osseous canal wall must be respected and access to the attic achieved by means of the combined approach technique. Little else need be said about the first two principles. The main purpose of this paper is to consider the third principle, that is, the restoration of the sound transformer mechanism.

Tympanosclerosis can occur in any part of the middle ear and is seen in the drumhead, or found lying anterior to the neck of the malleus associated with the tensor tympani, immobilizing the malleus head or incus body in the attic, or, most importantly, in relation to the stapes and the oval window niche. When there is conductive hearing loss in

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tympanosclerosis, almost without exception there is immobility of the stapes and, in my opinion, the key to success or failure lies almost entirely in the treatment of the stapes.

The degree of involvement of the stapes by tympanosclerosis can be categorized broadly as (Fig. 1).

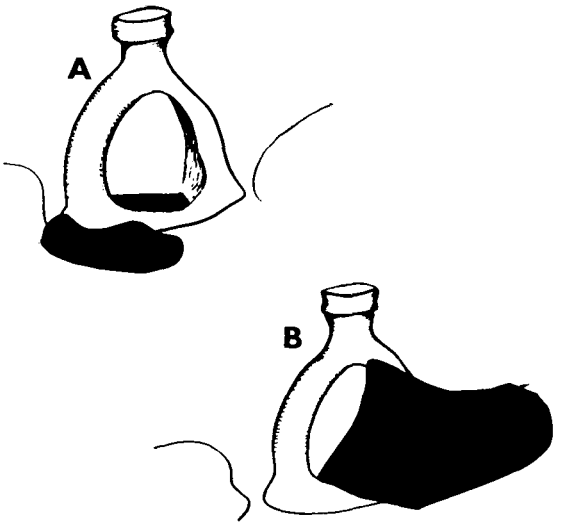


FIG. 1.

Categories of tympanosclerosis.

A. Minimal footplate involvement.

B. Moderate to gross involvement of stapes superstructure and footplate.

A. Deposits of tympanosclerosis related to the footplate causing moderate degrees of conductive loss.

B. Concretions of tympanosclerosis mounding up around the crura which may advance to engulf the stapes superstructure in a sea of tympanosclerosis, causing severe conductive loss.

For several years I have tried to treat these categories individually on their own merits. In category *A*, I have usually tried to achieve mobilization of the whole stapes by careful removal of the individual deposits of tympanosclerosis from around the edges of the oval window and from off the surface of the footplate. In category *B*, my attempts to preserve an intact stapes rarely succeeded and after painstaking and laborious removal of the tympanosclerotic plaques I have usually either inadvertently fractured the crura or intentionally removed them, until at last I was left with a mobile footplate. My aim at the time was to preserve, at best, a mobile stapes or, at worst, a mobile footplate so that the reconstruction of a sound transformer mechanism might be carried out using the methods which I routinely employ for these situations in tympanoplasty

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(Fig. 2). For example, when the stapedial arch was still present, a piece of bone was interposed between the stapes head and the malleus neck. (Introduced by Austin and now known as malleus-stapes assembly.) When only the stapes footplate remains then the cartilage strut made of preserved nasal cartilage and strengthened with stainless steel wire is placed between the mobile footplate and the undersurface of the drum.

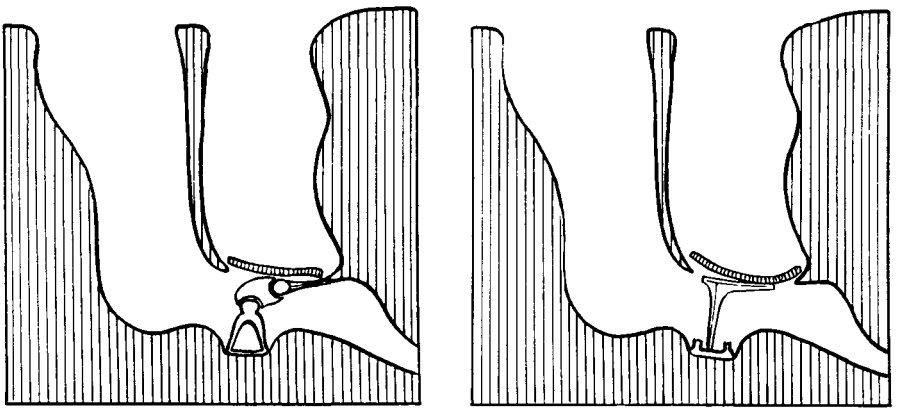


FIG. 2.

Ossicular reconstruction methods.
On left, malleus stapes assembly.
On right, boomerang strut.

This slide (Table I) indicates the results that have been achieved in regard to improvement in hearing loss and it is clear that they are far from satisfactory and constitute the worst sub-group of results in my series of tympanoplasties in which the overall equivalent rate is 75 per cent.

But, in addition, the effect of these operations on cochlear function are further cogent evidence that the results of this kind of operation are extremely unsatisfactory. So much so that two years ago I decided that I must either give up operations on the tympanosclerotic ear and provide these patients with hearing-aids whenever possible, or find an alternative operative procedure which would improve hearing more often and be less dangerous to the cochlea.

TABLE I.

TYMPANOSCLEROSIS.

Stapes mobilization		N. 46
AB GAP 10 dB	25	54%
	13	30%
Crurectomy		N. 11
AB GAP 10 bB	6	54%
	1	9%

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In analyzing the unsuccessful cases, some of which had had revision operations, it became clear that the cause of failure (Table II) to close the airbone gap was incomplete mobilization of the footplate at the time of operation or its subsequent refixation; and that the causes of cochlear loss were:

1. A hydraulic effect on the membranous labyrinth.
2. Postoperative perilymph fistula.

TABLE II.

CAUSES OF FAILURE.

1.	Conductive
	Refixation footplate.
2.	Perceptive
	(*a*) Hydraulic trauma
	(*b*) Perilymph fistula.

Those who have performed operations of the mobilization or crurectomy type I have already described, or watched movies of these, will agree that during the laborious, finicky and time-consuming 'picking off a bit there and levering off a bit here' type of surgery inevitably causes a very considerable amount of grossly unphysiological movement of the footplate. These damaging hydraulic effects are likely to extend around the cochlear duct.

At the same time, a fistula may readily follow the removal of plaques from the margins of the oval window. Alternatively, division of the crura, whether intended or accidental, may cause either footplate fracture or footplate dislocation, with subsequent perilymph fistula.

This assessment of the causes of failure led me to the conclusion that the solution might be found in a concise and expeditious stapedectomy followed by a closure of the oval window by connective tissue and the establishment of a connection between the oval window and the undersurface of the drum by a cartilage strut. It must be emphasized that stapedectomy should be performed in these ears only when the membrana tensa has been healed by natural or surgical means for at least six months and that at the time of stapedectomy the middle ear must be found to be healthy. The advantages of this method would be:

1. The possibility of subsequent footplate fixation would be eliminated.

2. The removal of tympanosclerosis carried out quickly and systematically, without any attempt to preserve the crura, followed footplate removal in a planned fashion, would lessen the risks of hydraulic cochlear damage.

3. An oval window seal with connective tissue would exclude the possibility of a postoperative fistula.

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Operative details

An essential prerequisite is that the middle ear is free from infection and the membrana tensa intact. Staging is frequently necessary to ensure this state of affairs.

Plaques of tympanosclerosis are removed using gentle leverage with a 3 mm. right-angled hook until at least the outer two-thirds of the crura are visible. These are then divided with Tabb forceps. It is important not to leave this step until the stapes footplate is nearly exposed, because then, the necessary leverage exerted might very well result in dislocation or fracture of the now unsupported footplate. The splinting effect of some residual tympanosclerosis makes this procedure safer. The footplate is then uncovered without delay by carefully removing the remaining layers of tympanosclerosis. The footplate, after vertical division, is removed in two pieces. What follows depends on the status of the incus. If the incus is missing then, immediately, a piece of fascia or vein which has been previously placed in the promontory is slid across the oval window and a boomerang-shaped strut of preserved nasal cartilage is positioned on the centre of the graft so as to fill the gap between the oval window and the drum (Fig. 3). If the malleus and incus are present and mobile, then a gelfoam-wire prosthesis is placed between the incus and oval window.

This technique has now been used in eighteen ears with very much better results than those obtained with the methods which I have previously employed. Not only has closure of the airbone gap been significantly more consistent, but the incidence of demonstrable irreversible cochlear trauma has been entirely avoided so far, as is indicated in Table III.

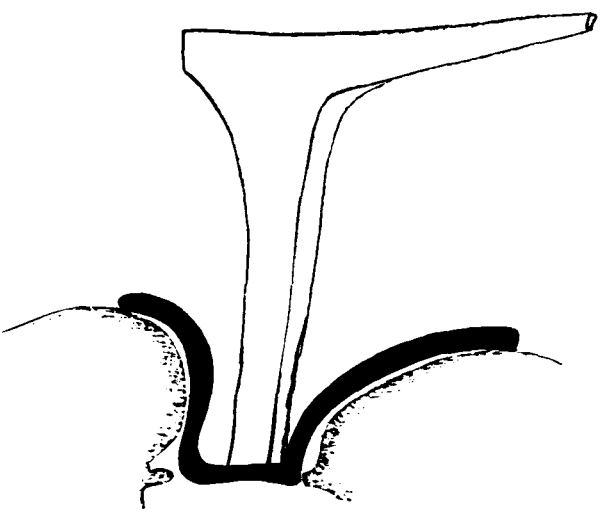


FIG. 3.
Reconstruction following stapedectomy.

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This striking improvement in results is probably due to:

1. Reduced manipulation of the stapes during the procedure.
2. Elimination of the fistula problem.

TABLE III.

HEARING RESULTS IN TYMPANOSCLEROSIS.

	No.	AB GAP 10 dB or less %	Cochlear loss %
Mobilization ..	46	54	17
Crurectomy ..	11	54	36
Stapedectomy ..	18	85	0

In conclusion, I would like to emphasize the very considerable risks inherent in the 'conservative' kind of stapes mobilization and crurectomy techniques when used in the tympanosclerotic ear, and to recommend a planned, concisely executed, stapedectomy with connective tissue-cartilage strut replacement as a much superior alternative.

23 University Square,
Belfast.

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