RELIEF OF DEAFNESS BY STAPES MOBILIZATION

BY

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[WITH SPECIAL PLATE]

One of the greatest advances in the whole realm of otology of this century has been the perfection of the fenestration operation for the relief of otosclerotic deafness, and an interesting twist in the history of medicine is the fact that this elaborate surgical ritual should have been largely replaced by a manipulation so obvious and so seemingly simple as to be deemed in some quarters an "office procedure." It is also of interest to note that our forebears of the last century, in their attempts to alleviate deafness, turned their attention first to the stapes, and it was probably Kessel who carried out the first mobilization in 1875. Kessel gives a fascinating description of how in one case he freed the stapes, with a gratifying improvement in hearing, but with no relief from the tinnitus which was the patient's main complaint. On the following day he divided the stapedius tendon, and ultimately it was found that not only had the hearing improvement been maintained but the tinnitus cured (Kessel, 1876). During the ensuing 25 years further attempts either to mobilize or to remove the stapes were made, and these pioneering operations were associated with the names of Miot (1890), Boucheron (1888), and Faraci (1899) in Europe and Blake (1891, 1892, 1893), Jack (1891, 1892, 1893a b, 1894), and Burnett (1893) in America.

The usual method was to approach the middle-ear cavity by incising the tympanic membrane rather than by reflecting it. Illumination was poor, and to the best of our knowledge no use was made of magnification—an adjunct which is to-day considered essential to the proper execution of the later stages of the operation. Notwithstanding such severe handicaps, large numbers of these operations were performed—more, in fact, than is generally realized—and Miot alone in 1890 published no fewer than 200 cases. It is therefore rather a mystery that at the turn of the century the sun should have gone down on stapes surgery, not to rise again for 50 years. It might be assumed that post-operative infection was responsible for bringing the technique into disrepute, for there were no guardian angels in the form of antibiotics to protect the patient's life and the surgeon's reputation; but it would seem that even in the absence of antibiotic "cover" serious post-operative complications did not occur. It is possible that the fear rather than the actual fact of intracranial complications was partly to blame, for such complications, which occurred frequently in the course of chronic middle-ear suppuration, often defied all attempts at treatment and terminated fatally. The relentless progress of these grim complications from stage to stage was well known to the general public, and they acquired a sinister reputation which persists to-day in spite of their rarity. Moreover, at the end of the last century the attitude of several distinguished otologists was unfavourable to the natural development of temporal-bone surgery in non-infected cases, and it was indicted for numerous reasons, many of which were invalid.

Samuel Rosen in 1952 rediscovered the operation when testing the stapes for immobility under local

analgesia (Rosen, 1953). It is said that the discovery was accidental, and great credit is due to him for his observation and perseverance, and for launching a method of relieving deafness which was destined to have such an impact on otology.

Indications for Stapes Mobilization

(1) The operation is most commonly indicated in cases of otosclerosis in which fenestration would have been advised formerly, and the various criteria on which the decision for that operation was based have been repeated on numerous occasions during the last 20 years. To recapitulate briefly, the diagnosis of otosclerosis should be firm and the hearing loss reasonably symmetrical. Pure-tone audiometry should ideally show a 35-55 decibel loss of air-conduction for the critical speech frequencies, with a satisfactory air-bone gap (preferably at least 20 decibels). Amplification should be well tolerated, paracusis present, and Schwartz's sign absent.

(2) Early cases of otosclerosis which hitherto would not have been subjected to the fenestration operation on account of its magnitude are suitable for stapes mobilization. In the past it was the usual practice to examine these cases at intervals of six or twelve months with the intention of advising operation when the hearing reached a level low enough to render a major surgical procedure worth while. This management, however, was not entirely free from objections. Patients would move and become lost from the follow-up, or would be inveigled into purchasing a hearing-aid (usually unsuitable, unwelcome, and very expensive), or, worst of all, would arrive for audiometry at the appointed time only to show a serious and inexplicable hearing loss placing them in the category of late and unsuitable cases.

(3) Late cases of otosclerosis have in many circumstances been regarded as unsuitable for fenestration. The perceptive element of the deafness may reduce the possible theoretical gain in hearing to such a level as to necessitate the wearing of a hearing-aid post-operatively. Obviously, it is of dubious value to subject the patient to a major operation giving but little hope of dispensing with an appliance but at the same time producing an operation cavity in which it may be impossible to wear that appliance. Stapes mobilization, however, in the same patient is a different proposition. There is a chance that it may permit the instrument to be discarded, but in the event of failure an aid may continue to be worn, even in the operated ear.

Finally, there is the very late case in which a powerful aid gives insufficient amplification, and here also the stapes operation is feasible, for it may improve the hearing sufficiently to enable the patient to obtain benefit from an aid.

(4) Unilateral cases of otosclerosis with good hearing in the contralateral ear have seldom, in my opinion, justified fenestration. The over-all subjective improvement is disappointing when the hearing level of a deafened ear is raised, provided the other ear is normal, and, though a dramatic difference may be shown audiometrically, the patient is seldom enthusiastic. Nevertheless, it is certainly most desirable that the hearing in both ears should be symmetrical, and stapes mobilization is without doubt justified in an endeavour to achieve this state.

(5) Patients suffering from conduction deafness caused by adhesions following serous otitis media are suitable for exploration of the tympanic cavity by the techniques of Lempert and Rosen. For many years the management of this type of deafness consisted of repeated politzerization or eustachian catheterization, involving the patient in great loss of time and not a little suffering, the net result being in most cases a minor and transient improvement in hearing. In recent years these methods of treatment have been used less and less, partly because their limitations are appreciated, and also for the reason that conduction deafness due to causes other than otosclerosis is seen less frequently than

hitherto owing, no doubt, to the increased care of the upper respiratory tract in childhood and to the introduction of antibiotics. Nevertheless these cases are seen in moderate numbers, and the technique of stapes surgery opens a new vista in their investigation and treatment.

(6) Lastly, the techniques referred to provide a direct and safe method for inspecting the tympanic cavity and for carrying out curative procedures in obscure cases of deafness the precise diagnosis of which may be in doubt prior to operation. These include such conditions as round-window otosclerosis (McLay, 1957) and traumatic ossicular dislocation (Gisselsson, 1958).

Technique

Anaesthesia

The operation is most commonly performed under local analgesia, which carries distinct advantages. The hearing may be tested at all stages, and the achievement of a mobile stapes is immediately verified by the hearing improvement obtained, thus obviating any manipulation which might be unnecessary and traumatic. Many persons in Great Britain, however, have a deep antipathy towards local analgesia whilst being perfectly happy to undergo general anaesthesia, thanks no doubt to the high degree of perfection to which the latter has been raised by anaesthetists. It is my belief that such patients should not be denied the operation, but should be given a general anaesthetic, under which extremely good results may be obtained. Some surgeons, in fact, prefer general anaesthesia as a routine, as it gives them freedom of movement and freedom of speech (!) (Venters, 1958).

Premedication consists of pethidine, 100 mg. intramuscularly, and atropine, 1/100 gr. (0.65 mg.) subcutaneously, and is given 45 minutes beforehand. No shaving of hair or other local pre-operative preparation is necessary, but the meatus is carefully inspected on the day before operation in order to ensure the absence of cerumen or any inflammatory condition. After swabbing of the meatus and pinna with flavine 1:1,000 in 50% spirit, "xylotox" 2% with adrenaline 1:80,000 is injected at several points under the skin of the meatus at the junction of the osseous and cartilaginous parts of the latter. Only 1-2 ml. is used, and the extreme degree and widespread analgesic effect of this small quantity is surprising. It has not yet been my experience for the patient to complain of pain at any stage of the operation, apart from the initial needle prick. (Special Plate, Figs. 1 and 2.)

Operative Details

The incision is derived from that of Lempert for tympano-sympathectomy (Lempert, 1946), but differs slightly in position, being made from 12 o'clock to 6 o'clock in the skin of the posterior meatal wall. Its upper and lower extremities are 2 mm. from the edge of the tympanic membrane, but its centre portion is at least twice this distance. (Special Plate, Fig. 3; Text Fig. 1.) The most useful instrument for making the incision has proved to be one of Rosen's bone spoons which is sharpened before each operation until a knife-edge is obtained. This was suggested to me by McKenzie (McKenzie and Rainer, 1957) and has also been mentioned by Simson Hall (1958).

The collar of skin medial to the incision is now gently raised from the underlying bone until the edge of the tympanic membrane can be lifted from its sulcus, exposing underlying mucous membrane. The latter is pierced with a sharp seeker, which serves to divide it in the line of

the annulus tympanicus, and at this stage a large air-bubble invariably appears from the middle-ear cavity (Special Plate, Fig. 4; Text Fig. 2.) The posterior part of the tympanic membrane may now be folded forwards across the manubrium of the malleus, exposing the middle-ear cavity (Plate, Fig. 5; Text Fig. 3.) This first stage is very laborious, and must be executed with extreme caution in order to avoid tearing the tympano-meatal flap at the junction of the tympanic membrane with the delicate skin of the posterior

TEXT FIG. 2.—Entry into tympanic cavity.

TEXT FIG. 3.—Incudo-stapedial joint and stapedius tendon.

TEXT FIG. 4.—Incudo-stapedial joint, stapedius tendon, chorda tympani, and round-window niche.

TEXT FIG. 5.—Removal of part of tympanic ring.

meatal wall. In many cases the incudo-stapedial joint is now clearly seen, with the stapedius tendon and chorda tympani (Plate, Figs. 5 and 6; Text Fig. 4), but in some cases these structures are partly hidden by overhanging annulus tympanicus, which must be removed with Rosen's curette or Lempert's fenestration curettes (Text, Fig. 5).

At this juncture it is desirable to employ increased magnification if, as is often the case, the first stage has been carried out with the aid of a binocular loupe magnifying two diameters. The Zeiss operating microscope gives a large choice of magnifications, but for the preliminary steps in mobilization 10 or 16 diameters are adequate.

The stapes may now be tested for mobility, after which mobilization should be attempted, starting with manœuvres as atraumatic as possible, and in the event of failure passing on to manipulations involving greater forces. The reason for this orderly sequence is that the degree of fixity of the stapes varies from case to case, and it is obviously better to achieve mobilization with the minimum risk of trauma to the middle and internal ear structures. The first and least traumatic manipulation, which is perhaps most closely parallel to normal physiological movement, is the transincudial method advocated by Goodhill (1955), House (1957), and Scheer (1958). The point of the seeker is firmly planted in the tip of the long process of the incus and pulsating pressure is exerted towards the oval window, compressing the stapes from head to footplate (Text Fig. 6). In a

TEXT FIG. 1.—Incision in meatal wall.

TEXT FIG. 6.—Compression of stapes via incus.

small proportion of early cases mobility is effected, but only minimal pressure may be permitted or the stapedia crura might be fractured or driven through the footplate, and it is usually necessary to pass on to the second manœuvre. (Text Fig. 7). This consists in attempting to rock the stapes from side to side in the axis of the long diameter of its footplate and is advocated by McKenzie and Rainer (1957); but the forces acting here are at right-angles to those when Rosen's original method of pressure on the anterior aspect of the stapedia neck is employed. My third manœuvre is to attempt mobilization by downward pressure on the small lip of footplate which sometimes projects well in front of the anterior crus (Text Fig. 8); and, fourthly, to endeavour to prise the footplate loose in the manner described by Rosen (1955).

If all these methods fail, it is probable that further attempts at mobilization would fracture the stapedia crura, and it is advisable to proceed to Rosen's method of footplate fenestration (Rosen, 1956). The point of the instru-

TEXT FIG. 7.—Stapes rocking about axis in long diameter of footplate.

TEXT FIG. 8.—Downward pressure on footplate of stapes anteriorly.

ment used, which resembles a crochet hook, is inserted with extreme care through the footplate to a depth of not more than 1 mm., and on withdrawal brings away a small portion of bone, permitting the escape of a little perilymph. It is needless to stress that the footplate technique requires movements of precision which can be safely controlled only under high magnification.

In the conscious patient the hearing is tested from time to time, and there is usually little doubt when mobilization has been achieved, for the hearing improvement is sometimes dramatic and is enhanced by replacement of the tympanic membrane. "Gelfoam" provides a suitable dressing, and may be retained in position by a strip of $\frac{1}{4}$ inch (6.4 mm.)

ribbon gauze. Simson Hall (1958) places a small piece of oil-silk in contact with the tympanic membrane in order to lessen the risk of perforation—a method which would seem to be most advantageous, as the oil-silk may be left for a considerable time should a healing perforation be suspected, and will act as a perfect splint.

Post-operative Care

As a rule no particular sedation is required; the ribbon-gauze strip is removed after two to four days, and the patient is usually discharged on the fourth or fifth post-operative day. Penicillin is given regularly during this time. It is often found that the immediate improvement in hearing is temporarily lost, and it is wise to warn the patient that this is merely due to an accumulation of debris in the meatal canal and that the initial hearing improvement will almost certainly return when this clears. The debris usually separates and is extruded without assistance, and manipulations should be avoided so far as possible at the post-operative attendances.

If at the time of operation a successful outcome is expected but post-operative testing reveals no improvement in the hearing, a further exploration with attempted mobilization may be made at a later date. There is no contraindication to a repetition of the same technique; in fact, the exposure is often achieved more readily the second time. In the event of repeated failure, fenestration is advised if the case is considered suitable for this operation, and the fact that the patient has been the subject of one or more attempts at stapes mobilization in no way impedes the fenestration technique or reduces the chances of a successful outcome.

It may be of interest at this stage to collate certain aspects of the two operations—fenestration and stapes mobilization.

	Fenestration	Stapes Mobilization
Usual sojourn in hospital	2-3 weeks	3-5 days
Length of operation ..	1½-3 hours	1/3-1 hour
Anaesthetic ..	General (in U.K.)	Local or general
Post-operative vomiting	Occasional	Nil
.. vertigo ..	Variable	Rare
.. pain ..	Occasional	Slight
.. otorrhoea	Not uncommon. May be intractable	Rare
Indications ..	Limited	Wide
Possibility of repeating operation in the event of failure	Revision difficult and hazardous, and seldom meets with lasting success	Operation can be repeated on same ear two or three times. Ultimately possible to fenestrate ear
Post-operative attendances	May be frequent if operation cavity becomes infected	Occasional

Complications

A search of the literature reveals that very few complications are reported, the most common complication occurring during operation and consisting of a fracture of the anterior crus or of both crura of the stapes. This is met by abandoning any further attempts at mobilization and proceeding straight to footplate fenestration. Occasionally tears occur in the tympanic membrane, but these seldom result in permanent perforations. In the first 50 cases operated on at Westminster Hospital one small perforation persisted, but the tympanic membrane was subsequently repaired by myringoplasty. There were also in this small series four cases of acute otitis media which occurred after the patients had been discharged from hospital, but the infection responded rapidly to antibiotic treatment in each case. In some series transient facial pareses, which have cleared up completely as soon as the effect of the local analgesic agent has passed off, have been reported.

It might be thought that complications would be likely to follow invasion of the sanctum of the inner ear by the footplate manœuvres described, but Rosen (1958) reports that in over 200 footplate fenestrations there was not a single instance of labyrinthitis or involvement of the facial nerve.

Results

It is notoriously difficult to depict the results of a procedure designed to improve the hearing. Pre-operatively the patients fall into different categories as regards their suitability for operation and the amount of improvement which might be expected to accrue therefrom, so it is obviously invidious to compare the results obtained in one group with those in another unless the original pre-operative category of the patient is borne continually in mind. Pure-tone and even speech audiometry sometimes give a misleading picture which does not in every case correspond with the subjective sensations of the patient. Finally, the terms used by surgeons in describing improvement or deterioration, success or failure, though having an exact significance to their authors, do not always convey the same meaning to their readers.

Scheer (1957) found that the operation had resulted in the restoration of practical and functional hearing in 36% of cases, but later (Scheer, 1958), by including the footplate techniques, was able to obtain an acceptable hearing improvement in 75-80% of cases. Rosen (1958) in an analysis of 254 cases states that a significant improvement in hearing was obtained in 77%. Venters's (1958) initial successes (including "very successful" and "moderate") reached 70%, and the number maintained for six months or more 53%. It would seem that many surgeons find that of all their cases subjected to operation approximately one-third obtain a great, and in some cases dramatic, improvement in hearing; approximately one-third are improved, but to a lesser degree; whilst the remainder are scarcely affected. Of the first 50 cases operated upon at Westminster Hospital (admittedly a small number), 29 have shown a useful, and in some cases very great, improvement in the hearing, 11 have been moderately improved, and in 10 cases the hearing has remained unchanged. It is likely that in the course of time a few of the 29 "very successful" cases of the first 50 will deteriorate and enter other categories, so the eventual ratio of great improvement: slight improvement: no change may not be very far from 1:1:1.

Of extreme importance is the problem of the duration of improvement in terms of years. Rosen (1958) states that over 95% of the improved cases have maintained their hearing improvement, without regression, for periods of up to five years, and it is worthy of note that his first case, operated on in April, 1952, had at the time of reporting maintained his hearing improvement for 4 years 10 months.

Summary

The history of stapes mobilization is traced from the 1870's. After a dormant period of half a century the operation was resurrected by Rosen in 1952.

The indications for the operation are given, and it is noteworthy that stapes mobilization is more general in its application than fenestration of the labyrinth.

The technique is described. Local analgesia is preferred, but is not obligatory. After the incudo-stapedial joint and surrounding anatomical structures have been displayed, manœuvres aimed at freeing the stapes are carried out. If mobilization is found to be impossible, fenestration of the stapes footplate is undertaken. The progress of the operation is controlled by hearing tests at intervals.

The post-operative care is mentioned, and a comparison between features of stapes mobilization and fenestration shows that when such matters as length of stay in hospital and post-operative discomfort, etc., are considered the magnitude of the former operation is much less than that of the latter.

Results to date suggest that, of the patients undergoing the operation, approximately one-third may be expected to obtain a useful, lasting, and in some cases

great hearing improvement, one-third a slight improvement, and one-third no improvement. In cases in which the result is disappointing, the fact that the operation may have been performed several times does not preclude a patient from undergoing fenestration of the labyrinth at a later date.

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FAMILIAL HAEMOPHAGOCYTIC RETICULOSIS

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[WITH SPECIAL PLATE]

The title "familial haemophagocytic reticulosis" was given by Farquhar and Claireaux (1952) to an unusual disorder which affected the first two children of a family. Both infants had developed anorexia, vomiting, irritability, and pallor at the age of 9 weeks. Both had enlargement of the liver and spleen, and both had progressive anaemia, leucopenia with profound granulopenia, and thrombocytopenia. Smears of the peripheral blood always contained a high percentage of unrecognizable damaged cells and a small proportion of atypical mononuclear cells bearing some resemblance to those occurring in glandular fever. The first baby, a male, died at the age of 10 weeks. Clinical investigation of the second infant, a female, failed to reveal the cause of the pancytopenia. In particular, there was no evidence either of erythroblastosis foetalis or of exposure to drugs or poisons. The resistance of the red blood cells to hypotonic dilutions of saline was normal,

E. H. M. FOXEN: STAPES MOBILIZATION TO RELIEVE DEAFNESS

FIG. 1.—Right tympanic membrane.

FIG. 2.—Right tympanic membrane after injection of local analgesic.

FIG. 3.—Central part of the incision.

FIG. 4.—Entry into tympanic cavity.

FIG. 5.—Incudo-stapedial joint and stapedius tendon.

FIG. 6.—Chorda tympani, stapedius tendon, stapes, round-window niche.

FIG. 7.—Mobilization completed. Tympanic membrane has been replaced.

FIG. 8.—Gel-foam dressing applied.

FIG. 9.—A left ear. Seeker is at foot of anterior crus.

FIG. 10.—Showing pool of blood in round-window niche.

FIG. 11.—Blood aspirated.

FIG. 12.—A right ear. Otosclerotic bone involving both crura of stapes.