STAPEDECTOMY – AN END OF TERM REPORT

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Charles Bulman has a lifetime's experience of stapedectomy, an operation which he believes has stood the test of time alongside improvements in microscopic and implant technology. He was an author of an important audit of the procedure published in 2000⁽¹⁾ and describes here his own experiences and personal case series. His colleague Dr Ali Mahrous is currently staff grade ENT surgeon in the Medway group of hospitals.

Otosclerosis is a condition in which conduction of sound from the middle ear to the inner ear is impaired due to abnormal fixity of the stapes in the oval window. Patients usually present in early middle life with decreased hearing or tinnitus. In many cases there is a family history suggesting a role for genetic factors, and recent gene mapping has confirmed the locus of a number of different genes associated with the condition. There is a small sex difference in favour of females but this is probably a reflection of the fact that females tend to report their infirmities more readily than men. Most cases are bilateral but unilateral cases are not infrequent. The otosclerotic lesion in the oval window is staged from I to IV, according to the degree of the obliteration; patients with more advanced stages present with a greater degree of deafness and at a later age – but this is not a linear relationship. Many quite severely handicapped patients have low stage disease and *vice versa*. It is thought that Beethoven suffered from otosclerosis but it is impossible to be entirely confident about this.

HISTORY

Initial surgical efforts to treat such patients were made at the end of the 19th century and were abandoned after it became clear that the risk of 'dead ear' (ie total deafness) was too

high. This was before the era of the operating microscope and antibiotics. However, efforts were resumed in the 1930s by Lempert⁽²⁾ in New York who used a mastoidectomy approach to perform a fenestration procedure in the lateral semicircular canal thereby bypassing the diseased oval window altogether. In the 1950s, aided by the operating microscope and antibiotics, there was a rediscovery of the old operation which aimed at dealing with the primary site of the disease – the stapes and the oval window. Rosen⁽³⁾ described mobilisation of the oval window, which was modified by Portmann⁽⁴⁾ to include attention to the often involved round window. Portmann, operating in Bordeaux, was the first surgeon to use a microdrill in the oval window.

From the time it was described by Dr Shea⁽⁵⁾ in Memphis in 1958, stapedectomy has been the definitive treatment in suitable cases. The alternative possibility of aiding (hearing aid) may also be appropriate in the very elderly or the very cautious. Successful surgery usually begins with a period of observation lasting a year or so during which the use of a hearing aid maybe an advantage. The operation involves exposure of the middle ear via a flap of canal skin and ear drum. The stapes is seen in the posterior tympanum and is dissected free from the incus. The superstructure of the stapes is then removed leaving the footplate in situ. The crux of the procedure is the fenestration of the oval window through the diseased bone and this can be done in a variety of ways including the use of a pick, a drill or a laser or some combination of these. A prosthesis (Figure 3) is then placed on the long process of the incus so that the distal end passes into the newly created fistula. Some surgeons then graft the oval window while others let the opening heal naturally. Revision operations are very rarely required but occasionally the prosthesis may become detached either proximally or distally causing a secondary hearing loss and in such cases a second operation can successfully restore the situation.

METHOD

One hundred and forty stapedectomies have been performed by one surgeon (CB) over a period of 27 years, and these were reviewed for this article. Though few when compared to series such as those of Shea⁽⁶⁾ (N=14459) and Marquet⁽⁷⁾ (N=2521), this series compares favourably with others in the UK, where an average of five operations are done per year per surgeon⁽⁸⁾. In this era of evidence-based practice, stapedectomy is well placed to satisfy the critic. This is because the result is measured in changes in the threshold of hearing, which is readily determined by audiograms (Figures 1 and 2). However, even the threshold determination leaves room for 'interpretation', and the earlier authors relied on the three lower frequencies (250 Hz, 500 Hz and 1.0 KHz) to the neglect of the higher frequencies. As otosclerosis affects primarily the lower frequencies, and as the lower frequencies are more valuable in terms of hearing, this was a valid approximation. However, it is now customary to include 2.0 KHz and 3.0 KHz as well. The first audiogram (Figure 1)

Beethoven – was he suffering from otosclerosis?

shows an inversion of the normal and is described as a 'conductive' deafness. The difference between bone and air thresholds is called the 'air-bone gap' and closure of this gap is the objective of surgery. In this example, all the frequencies are affected more or less equally but this is not inevitably the case and in otosclerosis as in other forms of conductive hearing loss (especially glue ear) the lower frequencies are more affected.

Figure 1 Audiogram showing that the bone conduction (marked by the $\triangle$ symbol) is near-normal and the air conduction (symbols $\circ$ = right ear and X = left ear) is well down

The second audiogram (Figure 2) is taken of the same patient after stapedectomy in both ears. This shows a significant gain in hearing in both ears. The bone conduction is a measure of the status of the inner ear (cochlear) and it is not possible to improve inner ear function surgically except by a cochlear implant. Thus in this case a successful operation could not be expected to raise the hearing threshold above 10-20 decibels. The 'gain' is the difference between the preoperative and the postoperative thresholds – in this case the difference could be up to 30 decibels, but not more.

Figure 2 Audiogram following bilateral stapedectomy. There is a significant gain in hearing in both ears

The method used here is to take an average of the audiometric thresholds measured over the five frequencies as follows; 250 Hz, 500 Hz, 1.0 KHz, 2.0 KHz, 4.0 KHz. This average is taken before surgery and again at some time postoperatively when the ear has settled down. This is usually between two and six months; in any event the best postoperative result is selected. It is very rare for secondary deafness to occur after this period; complications usually occur within the first two weeks if they are going to happen.

Figure 3 Prosthesis photographed alongside a matchstick for comparison of size

RESULTS

One hundred and forty operations have been performed over a period of 27 years. The incidence per year has varied quite markedly from a maximum of 13 to a minimum of two. The age range of the patients is as shown in Figure 4. There was a preponderance of females in the ratio of 3:2. Thirty percent of operations were for second ears.

Figure 4 Case mix stratified by age and gender

The results are shown below. The first bar chart (Figure 5) demonstrates the average deafness of the individual ears before operation, measured in decibels. The second chart (Figure 6) shows the average gain in hearing measured over five frequencies. After some initial failures there has been a steady flow of satisfactory results showing gains of between 30 and 50 decibels. No patients have been significantly worse in the last 15 years. In ten cases the hearing in the operated ear was reduced (<10%) but it must be remembered that the operated ear is often an ear which has very little value from the hearing point of view and that this result may not make life any more difficult. Eighty-seven per cent were better and often very markedly so. In 2% the result is not recorded either because the patient failed to attend for follow up or because an insufficient period has elapsed between surgery and going to press.

COMPLICATIONS

The main complication is failure to achieve a closure of the air-bone gap, ie a failure to improve the hearing threshold. As seen above, this is not common but is nevertheless very disappointing when it occurs. Most patients experience transient vertigo for a few hours. This may be extended for two or three days but is very rarely severe. One case in this series developed postoperative Meniere's disease and one author (CB) knows of another similar case which was operated elsewhere. Tinnitus postoperatively is very rare, indeed tinnitus may be an indication for surgery and the operation may be quite successful in this respect. Thus otosclerosis constitutes one of the very few treatable causes of tinnitus. Disturbances of taste (due to division of the chorda tympani in the middle ear) are quite common but usually mild and transient. Two cases in this series suffered significant problems with taste disturbance. This risk is greater when operating on second ears. Perforation of the tympanic membrane does occur but is usually recognised at the time and steps taken to repair the defect with a graft. No long term perforation occurred in this series. Secondary conductive deafness due to dislocation of the piston can occur. Sometimes the situation can be rectified by a second operation; sometimes not. Revision surgery can constitute quite a significant proportion of cases in some operative series but this is not so in the present series. High frequency sensorineural deafness at 8.0 KHz, and to a lesser extent at 4.0 KHz, is very common but has no adverse effect on speech discrimination or any other measurable function. Facial palsy or weakness is reported but has not occurred in this series.

CONCLUSION

Stapedectomy is an operation which has stood the test of time and which can be recommended as warmly today as it could when it was first introduced in 1958. Indeed it has more than satisfied the test of time in the sense that whereas in an unoperated ear the threshold will inevitably sink with the progression of the disease, the operated ear will only deteriorate in line with expected changes due to age. Complications are few when set against the manifest advantages. This is not to discount the adverse effects, which can be devastating for a very few individuals. Strong words of caution are always necessary and a full explanation of the possible complications is mandatory. Timing is the essence of good practice; it is best to postpone surgery until the lesion has matured. However, it can be difficult to persuade patients to wait.

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