

Bone pate repair of the eroded incus – five years on

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Abstract

Seventy-four patients undergoing bone pate repair of the long process of the incus as part of a tympanoplasty are presented. Mean follow-up time was 66 months (range 12–143 months). Hearing results are averaged over the frequencies 500, 1000, 2000 and 4000 Hz. Thirty-two per cent of the patients had hearing thresholds better than 30 dB pre-operatively. A significant improvement in hearing was seen ($p < 0.001$). The data were also analysed to assess the effect of the pre-operative state of the tympanic membrane on the final result. The pre-operative condition of the tympanic membrane was either perforated (35 ears) or atrophic (33 ears). Six tympanic membranes were intact but these were excluded from the final results. No difference in hearing result was found between patients who had an ossicular repair in combination with either a perforated tympanic membrane repair or an atrophic membrane repair. Average hearing gain in the perforated group was 13 dB, in the atrophic group 9 dB and in the intact group 7 dB.

Key words: Tympanoplasty; Ossicular replacement prosthesis; Bone

Introduction

Bone pate repair of the eroded incus (in order to restore ossicular continuity), has been reported previously (Solomons and Robinson, 1989). The technique was used to repair a disrupted incudostapedial joint as part of a tympanoplasty procedure whose main aim was to repair tympanic membrane disease. The tympanic membranes were abnormal i.e. either perforated or grossly atrophic. Following the original report of the technique, the question was raised as to whether the pre-operative state of the tympanic membrane had any effect on the outcome.

This paper looked at a group of patients who underwent this technique. In particular it looked at the different effects of the pre-operative state of the tympanic membrane on the final hearing results.

Some of our patients had normal pre-operative hearing. Bone pate was used in these cases to reinforce a partially eroded incus or to repair a defect resulting from the surgical elevation of the tympanic membrane remnant. In these ears, erosion of the incus resulted in a natural myringostapediopexy or a tenuous fibrous joint between the eroded incus and the stapes.

Patients and methods

The patients in this study were selected for surgery on the basis of having either a perforated tympanic membrane with erosion of the long process of the incus or a grossly atrophic tympanic membrane with

incus erosion. Some patients have been reported in an earlier publication on this topic (Solomons and Robinson, 1989), but this study has been enlarged to 74 patients.

Pre-operative audiology was performed on the day prior to surgery and post-operative audiology levels were the most recent available results. Pure tone averages over the frequencies 500, 1000, 2000 and 4000 Hz were used as the basis of the results presented here. For the purposes of this paper only patients with the potential for normal hearing in the affected ear have been included. If the average pre-operative bone conduction threshold was worse than 30 dB, the ear was excluded from this data, despite the fact that in some circumstances the patient could still benefit from ossicular reconstruction.

A post-aural approach was used for all the ears, which coincidentally allowed good access to cortical bone dust. The bone dust was harvested with an otological drill. All patients had an intact, mobile stapes and a mobile incudo-malleolar complex. The degree of disruption of the incudo-stapedial joint varied greatly from a large erosion of the length of the long process causing total discontinuity, to a fibrous connection with only early erosion of the incus.

Fibrin glue (TISSEEL[®]) was used in many patients to help stabilize the repair. If it was used, the first part of the fibrin glue was incorporated into the bone dust mix. The second part of the fibrin glue was placed both on the head of the stapes and the

TABLE I
PURE TONE AVERAGE HEARING RESULTS

Pre-operative tympanic membrane condition	Pre-operative hearing (dB)	Post-operative hearing (dB)	Gain (dB)
Perforated (35)	38.0 (SD= 14.9)	25.0 (SD= 11.6)	13*
Atrophic (33)	35.5 (SD= 9.6)	26.5 (SD= 13.9)	9*
Intact (6)	44.0 (SD= 19.9)	37.0 (SD= 14.4)	7

*Using the paired *t*-test to assess the significance of the hearing gain:

perforated group $t = 6.04$, 95% CIs; are 35 to 71 dB ($p < 0.001$);

atrophic group $t = 5.96$, 95% CIs, are 24 to 48 dB ($p < 0.001$).

Using the unpaired (2-sample) *t*-test to compare the gains between the two groups:

$t = 1.59$, 95% CIs, are 4 to 39 dB ($p < 0.2$ i.e. not significant).

long process of the incus. The bone dust was then used to bridge the defect. Fibrin glue was not used in all cases. If the repair was closely related to either the attic wall or posterior canal wall, the adjacent bone was reduced with a curette to remove the risk of ankylosis by the bone dust.

Results

Ninety-nine patients underwent this procedure from 1979 to 1992. Of these, 15 patients had a pre-operative bone conduction average of worse than 30 dB, and records were incomplete in another 10 patients. The remaining 74 patients were included in this study.

There were 26 males and 48 females whose age ranged from nine to 67 years (mean 34 years). Thirty-five of the tympanic membranes were perforated pre-operatively, 33 were atrophic and six were intact. Follow-up ranged from 12–143 months with a mean follow-up of 66 months. Post-operatively all tympanic membranes were intact, although two were retracted and four had become persistently moist with a granular myringitis. Table I shows the hearing results according to the pre-operative condition of the tympanic membrane. The patients with intact tympanic membranes pre-operatively constituted a small number (too small for statistical analysis). However this group of patients did not do well: only three of the six improved, one remained unchanged and two had a deterioration in their hearing. As already mentioned, a number of patients had normal thresholds pre-operatively, due to a type 3 myringostapediopexy effect, or incomplete erosion of the tip of the long process. There was a statistically significant improvement as a result of surgery.

TABLE II
DETERIORATION IN HEARING

Reason	No. of patients
Mucosal tympanic membrane	4
Post-operative retraction	2
Sensorineural loss	4*
Adhesive otitis	1
Failure of bone dust to take	1
Total	12

*Two patients had a drop at one frequency only (4 kHz); 1 patient had an additional average sensorineural loss of 6 dB; 1 patient had an acute labyrinthine event 4 weeks post-operatively and developed an additional average bone conduction loss of 17 dB. This was not felt to be a secondary effect of the surgery.

Fibrin glue was used in 59 patients and the average improvement in air conduction thresholds in this group was 13.6 dB. Twelve patients did not have fibrin glue used and their thresholds improved by an average of 9.3 dB. Due to the small size of the group without fibrin glue, no precise statistical conclusion could be made.

Table II shows details of the patients who developed further hearing loss post-operatively. These losses have been included in the overall figures given in Table I.

Discussion

The results presented here build on those reported five years ago by Solomons and Robinson (1989). The results showed that 76 per cent of patients had a good post-operative hearing level. Other ossiculoplasty techniques have claimed normal hearing rates between 64 and 82 per cent post-operatively (Wehrs, 1982; Pennington, 1983; Smyth, 1983). It should be noted that in our series 32 per cent had good hearing before surgery. This was due to the fact that the prime reason for operating was tympanic membrane disease, rather than hearing loss. These patients underwent a primary tympanic membrane repair procedure, to close a perforation or reinforce an atrophic tympanic membrane. The ossicular repair was performed coincidentally if the long process was found to be eroded. If no benefit was achieved from this, then a standard interval ossiculoplasty could always be performed subsequently. If normal hearing was achieved then the patient was spared another operation.

This procedure is within the technical grasp of any otologist working on the ossicular chain, and adds only a little to the overall operating time. The technique involves relatively little manipulation of the stapes and so the risk of inner ear damage is minimized. The elevation of an atrophic tympanic membrane attached to the stapes itself is likely to stimulate the inner ear more than the actual ossicular repair. Only three patients developed any sensorineural loss attributable to surgery, and only one of these had a loss affecting any frequency apart from 4 kHz. None had a severe loss.

As most patients had surgery for a tympanic membrane repair, only six out of the 74 patients had a normal intact tympanic membrane pre-operatively. These six patients did not do well, and this would suggest that it is not a useful procedure to perform in

ears with normal tympanic membranes. Other workers have had similar poor results when using this technique in a simple tympanotomy situation (Mofat, 1994: personal communication). The reasons for this are not clear, but this group of patients obviously had a more stable middle ear and perhaps there is less stimulus for the bone pate to heal onto the ossicles. When an atrophic tympanic membrane is dissected from an incudostapedial joint a certain amount of inflammation must occur on the exposed ossicular bone. This is possibly the mechanism to promote adhesion of the bone pate.

The differences between the groups with perforated or atrophic drums were not large. The main reason for the hearing deficit was the ossicular damage, rather than the tympanic membrane damage, and as the ossicular repair was identical in each group, the end hearing result was similar.

The effect of fibrin glue tends to suggest that it is a useful part of the technique. Unfortunately the group of patients who did not have the glue used is very small which makes statistical conclusions unrealistic.

Many of the ears had no significant change in hearing thresholds. This was due to a direct failure of the bone pate repair, or the bone dust having been used to reinforce a partially eroded incus, or due to a successful repair in an ear with a type 3 myringotapedioplasty. These latter ears had an atrophic tympanic membrane but reasonable hearing pre-operatively. If the type 3 mechanism was dismantled in order to repair the tympanic membrane adequately and reconstruction of the incudostapedial defect successful technically, the measured hearing loss will be little altered.

Of the ears that deteriorated post-operatively, no one major factor emerged as the cause. No major conductive loss had been created in any of these failed ears which implied that bony ankylosis of the ossicular chain to surrounding structures, had not occurred.

The mean follow-up time was 66 months. It is recognized that in ossicular reconstruction early results can be misleading and a follow-up of several years minimum is required (Lierle and Sheehy, 1965). There was no evidence in our series that any

late deterioration of hearing had occurred. It was assumed therefore that the bone repair was fully stable over the long-term.

Conclusions

(1) Bone pate repair of the eroded incudostapedial joint proved to be a simple procedure which could significantly improve hearing.

(2) There was no significant difference, in post-operative hearing thresholds, comparing patients with a pre-operative perforated tympanic membrane with those with an atrophic tympanic membrane, when both have undergone bone pate repair of the incudostapedial joint.

(3) A fascia graft myringoplasty appeared to be a necessary part of the procedure to ensure good survival of the bone pate repair. A tympanotomy alone may not be sufficiently stimulating.

(4) The use of fibrin glue may be a necessary part of the procedure to ensure stability of the bone pate during the healing phase.

(5) If the procedure fails to improve hearing, an interval ossiculoplasty using a standard technique is always possible.

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