

Comparison of two different methods of prosthesis placement in otosclerosis

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Abstract

Objective: Objective: Choice and positioning of the prosthesis is a fundamental element in successful operations for otosclerosis. The present study compares two different techniques for placing a prosthesis when undertaking surgery for otosclerosis.

Materials and Methods: A retrospective review was undertaken of records from 50 cases of individuals (33 women, 17 men) undergoing stapedotomy between the years 2009 and 2016. Two alternative procedures were used: in the "reverse" technique, placement of the prosthesis preceded stapes removal; in the "conventional" technique, placement of the prosthesis followed stapes removal. These groups were labelled groups 1 and 2, respectively. There were 25 cases in each. The two groups were compared for hearing outcome and incidence of complications.

Results: An air-bone gap below 20 dB was obtained in 80% of cases following the reverse technique, and 76% of cases after conventional surgery. The difference between the two techniques lacked statistical significance ($p>0.05$). A single case in group 1 required a revision procedure since the prosthesis was taken out 4 months post-surgery. In group 2, a single case sustained injury to the chorda tympani. Vertigo symptoms occurred in 7 individuals in group 1, and 8 in group 2.

Conclusion: There is no significant difference between treatments in terms of improved auditory function or fewer complications. The authors suggest clinicians' experience is the key factor in deciding which technique to favour.

Keywords: Otosclerosis, hearing disorders, vertigo.

Introduction:

Otosclerosis, in which the stapes becomes immobilised, leads to worsening conductive and mixed type hearing loss. The principal therapeutic modality employed for conductive deafness is surgical [1]. However, surgeons disagree as to the optimal method to be used. A number of operati-

ons are mentioned in reports: stapedectomy, stapedotomy, small fenestrated stapedotomy, Causse's stapes tendon reconstructed stapedotomy and laser stapedoplasty [2]. There are also variations in the kind of prosthesis used and the way it is put into position [3]. The literature contains reports of research undertaken with a "conventional" place-

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ment of prosthesis following detachment of the stapes, as well as a “reverse” placement, where the prosthesis is attached whilst the stapes is still present. However, there is a paucity of evidence on how the two techniques compare. The present study therefore aims to evaluate these two techniques from the point of view of improvement in auditory function and minimisation of undesired sequelae.

Materials and Methods

Following the granting of ethical approval by the local Ethics Committee, data were obtained from a retrospective evaluation of patients’ records from individuals who had undergone stapedotomy in the period January 2009 to August 2016. All cases were divided into group 1 (reverse technique used) or group 2 (conventional technique). Each group consisted of 25 cases. The characteristics of group 1 were as follows: mean age 41.92 years (range 26-52), of which 7 were men and 18 women; 9 cases involved the right ear, 16 the left. The characteristics of group 2 were as follows: mean age 39.12 years (range 27-55), of which 10 were men and 15 women; 6 cases involved the right ear, 19 the left.

In all cases, the transcanal operative approach was used and the patients received general anaesthesia. Two surgeons, both with extensive experience of performing surgery for otosclerosis, performed the procedures. A rosen incision was made and the tympanomeatal flap raised. Stapedotomy was achieved with a manual perforator. A teflon piston prosthesis was placed either in the conventional or reverse order sequence, being inserted into the hole in the oval window and secured to the incus with small Hartmann forceps.

The reverse technique used the following sequence: stapedotomy, prosthesis insertion, division of the incudostapedeal joint and withdrawal of the stapes superstructure.

The conventional technique, in contrast, used the following sequence: section of stapes muscle, division of the incudostapedeal joint and withdrawal of the stapes superstructure, stapedotomy and insertion of the prosthesis.

An audiogram was undertaken pre-operatively and 1 year post-operatively and the air-bone gap (ABG) was evaluated from the thresholds at frequencies of 500, 1000, 2000 and 4000 Hz. The assessment involved both air and bone conduction. Revision surgical cases were excluded from the study.

The SPSS 20 statistical package application for Win-

dows (SPSS Inc.; Chicago, IL, USA) was used to produce a database and to perform the statistical evaluations. A p value below 0.05 was taken to indicate statistical significance.

Results

The groups did not differ at the level of statistical significance in terms of age ($p=0.357$), sex ($p=0.469$) or ear operated ($p=0.546$). One case within group 1 had required a revision procedure 4 months post-operatively, during which detachment of the piston from the long arm of the incus was observed. In group 1, the ABG detected prior to surgery was 40.4 dB, 40.2 dB, 30.4 dB and 29.5 dB at 500 Hz, 1000 Hz, 2000 Hz and 4000 Hz, respectively. In group 2, the ABG detected prior to surgery was 45 dB, 41.6 dB, 37.2 dB and 38.2 dB at 500 Hz, 1000 Hz, 2000 Hz and 4000 Hz, respectively. In group 1, the ABG measured at 12 months post surgery was 18.5 dB, 17.5 dB, 14.5 dB and 15.2 dB at 500 Hz, 1000 Hz, 2000 Hz and 4000 Hz, respectively. In group 2, the ABG measured at 12 months post surgery was 21.8 dB, 21.6 dB, 16.8 dB and 19.4 dB at 500 Hz, 1000 Hz, 2000 Hz and 4000 Hz, respectively. No statistically significant differences existed for ABG in the two groups (Table 1). No statistically significant differences existed for ABG in the two groups for gain at 500Hz ($p=0.538$), 1000Hz ($p=0.798$), 2000Hz ($p=0.199$) or 4000Hz ($p=0.243$) (Figure 1). Post-operatively, vertigo was seen in 7 individuals from group 1, lasting on average 2.28 (range 1-4) days, and in 8 individuals from group 2, lasting on average 2.62 (range 1-4) days. The associated p value was 0.896. There was no instance of damage to the chorda tympani in group 1. In group 2, a sole individual was affected in this way. The associated p value was 0.784. In no individual was sensorineural auditory loss, facial paralysis or tympanic membrane perforation seen.

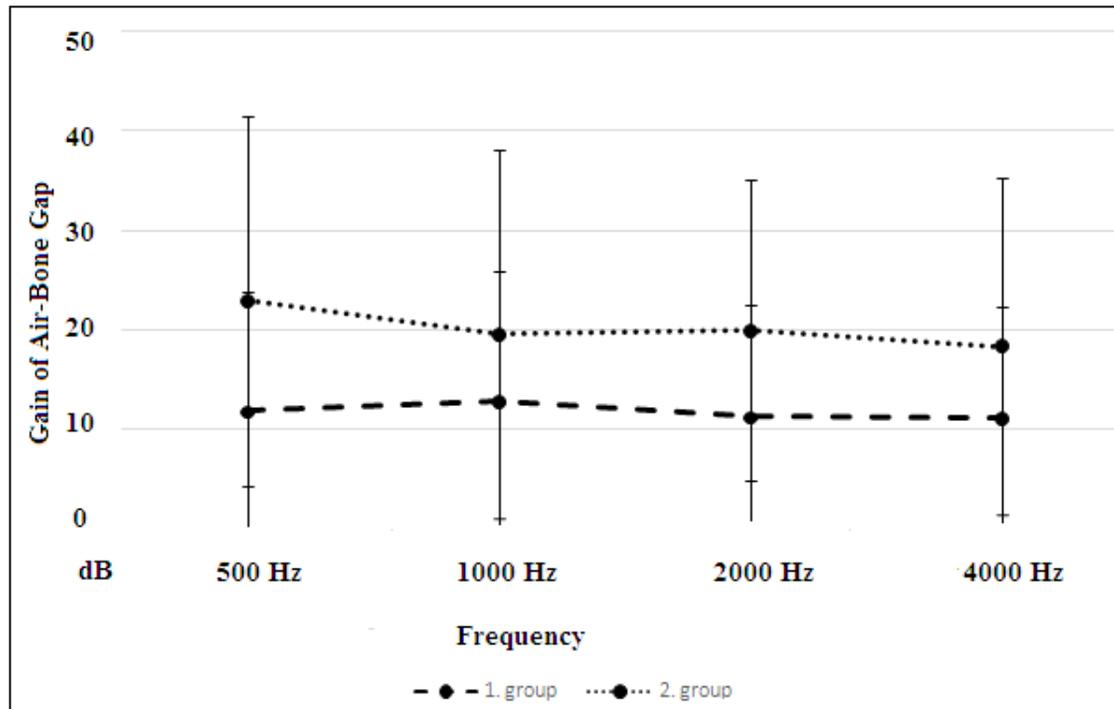
Table 1. ABG at 12th month after surgery.

	1. group	2. group	P value
< 10 dB	5 (20.8%)	8 (32%)	.479
11-20 dB	14 (59.2%)	11(44%)	.388
> 20 dB	5 (20.8%)	6 (24%)	.742

dB: Decibel. ABG: Air bone gap.

Discussion:

The literature reveals that stapedotomy has the greatest reliability amongst surgical interventions undertaken for otosclerosis. Nonetheless, the procedure is not without



Hz: Hertz. dB: decibel.

Figure 1. Mean gain of ABG hearing thresholds and respective standard deviations after prosthesis placed with reverse (group 1) and conventional (group 2) technique (12th month after surgery).

potential complications, such as absolute deafness, facial paralysis and symptoms of vertigo [4]. Thus, it is a matter of concern to establish which operative approaches lead to the lowest rate of complications and are most effective.

The reverse surgical method has the rationale that it may decrease the untoward occurrence of dislocation, resulting in hearing impairment. The rationale behind the conventional technique is that a wider angle of visualisation should make it easier to avoid complications [5].

Research by Adedeji *et al.* revealed that stapedotomy diminished the ABG to less than 20dB in 85.2% of those cases with a prosthesis placed according to the reverse method. Complications occurred with the following frequencies: perforated tympanic membrane (5.6%); facial paralysis (3.7%); vertigo (3.7%). Similarly, Akdag *et al.* [7] report that stapedotomy diminishes the ABG to less than 10dB in 83.2% of cases. Vertigo troubled 28% of the cases and lasted from 1 to 11 days, whilst just two cases were complicated by a perforated tympanic membrane. Husban *et al.*, using the conventional method of prosthesis place-

ment achieved a reduction in ABG of less than 10dB for 88% of their cases, noting no occurrence of complications with the technique. The corresponding rates reported by Mahafza *et al.* [9], with the conventional method, were: ABG <20dB in 85.57% of cases; vertigo in 5.76%, sensorineural auditory loss in 2.88%, facial paralysis in 1.92%, chorda tympani injury in 2.88% and a perforated tympanic membrane in 1.92%. Hancı *et al.* [10] reported on 327 stapedotomy cases approached conventionally. They found the following ABG results had been achieved: <10dB in 62%; <15dB in 88%; and <20dB in 94%. As for complications, the incus luxated in 1.5% of cases with the same rate for damage to the chorda tympani, the tympanic membrane became perforated in 4%, 0.6% complained of vertigo and 0.9% sustained an injury to cranial nerve VII.

In the research undertaken by Freni *et al.* [11], the same two methods were contrasted as in the present study. The authors conclude the two methods confer similar hearing benefits and have similar rates for complications. Both Szymanski *et al.* [4] and Gołabek *et al.* [12], nonetheless, as-

sert that complications decreased if the footplate were to be fenestrated prior to taking away the arch of the stapes. We report that 80% of those in group 1 and 76% of those in group 2 benefited from the reduction of ABG to less than 20dB when assessed a year after stapedotomy, but we also excluded one case from group 1 in which the prosthesis had subluxed, necessitating revision surgery. Vertigo occurred for 1 to 4 days after surgery for 7 individuals in group 1, and 8 in group 2. The present authors hypothesize that this apparently increased rate of complications is

due to a difference in how vertigo was measured between studies: in most published studies only vertigo lasting more than 7 days was counted. Chorda tympani injury in our study happened once (in group 2), but no complications beyond this were noted.

Conclusion: Since neither method is proven to be superior for either improvement in hearing nor for avoidance of complications, the choice of approach should depend on individual surgeons' preferences.

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