Hearing outcomes following primary malleostapedial rotation ossiculoplasty in patients undergoing modified radical mastoidectomy

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ABSTRACT

INTRODUCTION Treatment of cholesteatoma consists of either excision or exteriorisation of disease. Approaches have traditionally included a radical or modified radical mastoidectomy and combined approach tympanoplasty. Hearing thresholds following a modified radical mastoidectomy alone have been reported as poor. We assessed hearing outcomes in patients undergoing a primary malleostapedial reconstruction combined with their open cavity surgery.

METHODS All patients undergoing open cavity mastoidectomy with primary malleostapedial rotation ossiculoplasty between 2009 and 2013 were identified. Case notes were reviewed, and demographic data, recurrence rate and audiometry were recorded.

RESULTS Twenty-one patients were identified. The age range was 10–65 years. There was no evidence of recurrence of cholesteatoma. The mean postoperative air-bone gap was 20dBHL, 23dBHL, 10dBHL and 27dBHL at 0.5kHz, 1kHz, 2kHz and 4kHz respectively. Excluding cases consistent with a postoperative ossicular discontinuity ($n=3$), the mean postoperative air-bone gap was 15dBHL, 19dBHL, 8dBHL and 26dBHL at 0.5kHz, 1kHz, 2kHz and 4kHz respectively.

CONCLUSIONS The improvement in hearing thresholds demonstrated in this cohort of patients supports the use of this form of ossiculoplasty in those undergoing open cavity procedures. This would also suggest that the subsequent use of hearing aids in these patients would require less amplification and therefore provide superior hearing outcomes. As hearing loss remains a significant concern following modified radical mastoidectomy, we suggest an open cavity with primary malleostapedial rotation ossiculoplasty as a viable alternative to modified radical mastoidectomy alone, in selected cases.

KEYWORDS

Cholesteatoma – Hearing loss – Mastoid – Tympanoplasty – Ear ossicles

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A cholesteatoma is a locally destructive three-dimensional epidermal structure. Erosion of the ossicular chain may occur, resulting in a conductive hearing loss.^{1,2} Further extension and concomitant infection can lead to facial nerve paralysis, vestibular involvement with vertigo, intracranial abscess and death.^{3,4}

While some patients may be managed with regular aural toilet, treatment usually requires surgical exploration of the temporal bone and removal of disease. A modified radical mastoidectomy (MRM) with an open cavity provides a safe, dry ear but often at the expense of hearing in the affected ear. The subsequent ossicular discontinuity results in a widely recognised conductive hearing loss of up to 60dBHL.⁵

In recent years, some otologists have favoured a combined approach tympanoplasty (CAT), retaining the normal architecture of the external ear canal.^{6,7} Most surgeons consider a second look mandatory in canal wall up procedures to exclude recurrent disease and allow for a second

stage ossiculoplasty. However, this process relies on patient cooperation and compliance, and their understanding that a third or fourth look may be required. Consequently, an open cavity approach is more appropriate in some patients (either because of concerns regarding follow-up or in those unwilling or unable to undergo a series of procedures). In this group of patients, in order to achieve disease clearance and hearing preservation in a single procedure, a MRM was performed with a novel primary malleostapedial rotation (MSR) ossiculoplasty.

Methods

The case notes of all patients who had undergone mastoid surgery for cholesteatoma between February 2009 and June 2013 were reviewed. Those who had undergone an open cavity mastoidectomy and primary MSR ossiculoplasty were identified. The MSR ossiculoplasty was performed as

illustrated in Figure 1. Pre and postoperative pure tone audiograms were obtained, and the air-bone gap (ABG) was calculated for 0.5kHz, 1kHz, 2kHz and 4kHz.

Results

Of the 175 mastoid explorations performed during the relevant time period, 21 patients were identified for this study. The remaining patients underwent a CAT, had an intact ossicular chain or had an absent stapes superstructure. The male-to-female ratio was 10:11 and the age range was 10–65 years. The minimum follow-up duration was only four months

owing to poor patient attendance at follow-up appointments. No recurrence was observed although poor cavity ventilation resulted in intermittent discharge in one case.

The results demonstrate a mean postoperative ABG of 20dBHL, 23dBHL, 10dBHL and 27dBHL at 0.5kHz, 1kHz, 2kHz and 4kHz respectively (Table 1). In those with an ABG of 50dBHL or greater, a failure of binding between the malleus remnant and stapes head was assumed. Excluding these cases ($n=3$), the mean postoperative ABG was 15dBHL, 19dBHL, 8dBHL and 26dBHL at 0.5kHz, 1kHz, 2kHz and 4kHz respectively. The mean ABG was 20dBHL in 11/18 patients (61%). No patients sustained a 'dead ear'.

Figure 1 Technique of an open cavity mastoidectomy and primary malleostapedial ossiculoplasty: Following excision of disease, the tympanic membrane is reflected forward (A). The tympanic membrane is detached from the malleus using a curved needle, with the attachment at the umbo preserved (B). A malleus head nipper is used to sever the neck and the head is removed (C). The malleus is rotated gently forward to expose the tensor tympani tendon, which is divided with microscissors (D). The malleus handle may now be rotated posteriorly and placed over the head of the stapes (E). Spongostan® blocks (Ethicon, Somerville, NJ, US) are inserted into the middle ear to support and maintain the position of the ossicular remnants (F). An underlay temporalis fascia graft is inserted to close the mesotympanum (G).

Table 1 Postoperative air-bone gap following an open cavity mastoidectomy and primary malleostapedial rotation ossiculoplasty

	0.5kHz	1kHz	2kHz	4kHz
Mean	20dBHL	23dBHL	10dBHL	27dBHL
Median	15dBHL	20dBHL	5dBHL	25dBHL
Minimum	0dBHL	0dBHL	0dBHL	0dBHL
Maximum	65dBHL	55dBHL	35dBHL	60dBHL

Discussion

The primary surgical objective when dealing with cholesteatoma is that of converting an 'unsafe, wet' ear to a 'safe, dry' ear. This is achieved through either excision or exteriorisation of disease by means of a canal wall down procedure (eg radical mastoidectomy or MRM) or a canal wall up procedure (eg CAT).⁸

Advocates of both recognise advantages and limitations with each approach.^{3,4,9} A CAT maintains the normal architecture of the ear canal, enables 'waterproofing' of the ear and allows ossicular reconstruction at a subsequent exploration. However, this requires a second and, on occasion, a third 'look' procedure to exclude recurrence, and may not be an optimal solution in poorly compliant patients.

In contrast, a MRM (a single stage canal wall down procedure with an open cavity) allows early recognition of recurrence that may be managed by regular suction clearance alone. Nevertheless, owing to the resulting ossicular discontinuity, classically, with an ABG of up to 60dBHL,⁵ this approach could leave a patient devoid of functional hearing.^{1,2,4} While some patients may manage well with a conventional hearing aid, this could produce variable levels of distortion or result in chronic ear discharge. In others, an appropriate tight fitting mould may be difficult to achieve. Both situations result in poor hearing aid compliance. A bone anchored hearing aid may be considered in some patients unable to use conventional hearing aids although cosmetic and financial implications could limit this as an option.

A significant proportion of patients referred to our unit present with extensive disease and are unfortunately poorly compliant. In our experience, patients who seldom attend clinic follow-up appointments are equally unlikely to return for a second look procedure. (On occasion, patients have failed to attend to have their bismuth iodine paraffin paste packs removed.) This was clearly reflected in our study as the minimum follow-up duration was merely four months. An open cavity approach therefore provides a safer option than that of a CAT.

While a variety of ossiculoplasty techniques and prostheses have been developed to reconstruct the ossicular chain, prostheses may dislocate from their position and extrude through the tympanic membrane.¹⁰ The MSR ossiculoplasty described provides a significant improvement in hearing

thresholds compared with that seen with a MRM alone. In addition, this technique appears to provide a stable cavity without increased risk of recurrence. No patient has required revision surgery although poor ventilation due to an inadequate meatoplasty has resulted in intermittent aural discharge in a single case.

Methods of malleostapedial transposition have been reported previously, with good functional outcomes. Rubinstein *et al* describe two variations with either the malleus handle or the malleus head being swung on to the stapes head.^{11,12} In contrast to our study, the former was most often employed in these two papers. We found it mechanically preferable to maintain attachment at the umbo and remove the malleus head entirely, allowing the neck to be transposed on the stapes.

Incomplete closure of the ABG is likely to be a result of a number of factors including a change in the ear canal architecture and hence redistribution of sound in the ear canal and cavity, a reduction in the surface area of the tympanic membrane and loss of the malleoincus lever mechanism. However, the degree of loss has required little or no aiding in the majority of patients in our cohort. In 3 of the 21 patients, the ABG was similar to that anticipated with a MRM approach alone and suggests failure of binding of the malleus to the stapes.

Exclusion of this small cohort would improve the mean ABG of our sample (15dBHL at 0.5kHz, 19dBHL at 1kHz, 8dBHL at 2kHz and 26dBHL at 4kHz). Consequently, a method of bonding the malleus remnant to the stapes head may reduce the likelihood of discontinuity and we intend to undertake this additional step in a subsequent patient cohort.

While we would advocate the consideration of this procedure in selected patients, we acknowledge that a prerequisite (and therefore a limitation of the technique) is the integrity of the stapes superstructure, without which the malleus handle cannot be bound successfully to the stapes. In our cohort, six patients were found to have absent stapes superstructures, making a MSR impossible to perform.

A valid criticism of the results presented is the absence of recorded thresholds at 3kHz, meaning a direct comparison of audiological outcomes with other previously described ossiculoplasty techniques is difficult. Unfortunately, as some members of our patient cohort were non-compliant, we have been unable to recall and record values at this frequency. We intend to include this frequency when assessing future patients undergoing this technique and to report outcomes as presented in other studies. Furthermore, as mentioned previously, the minimum follow-up period was merely four months because of poor attendance. It is therefore not possible to comment on the longer-term outcomes on hearing and the stability of this method of ossicular reconstruction. However, no deterioration in hearing was noted in those patients who remained under follow-up for up to four years.

A possible future extension of this study would include assessment of patients according to the Glasgow benefit plot, in order to document their functional improvement following surgery as well as the changes noted on audiological testing.¹³

Conclusions

While the principal goal of cholesteatoma surgery is that of excision or exteriorisation of disease, an increasingly important secondary objective is provision of functional hearing. A primary MSR ossiculoplasty may be a valuable adjunct to open cavity surgery in selected cases.

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