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Myringostapediopexy: surgical expectation

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Abstract
Myringostapediopexy may occur as a result of incus erosion with medialization of the tympanic membrane and is recognized as often producing serviceable hearing. The technique may be used as part of tympanoplasty following either canal wall up or canal wall down surgery for chronic otitis media. The use of this type of reconstruction is influenced by the anatomy of the ear after disease excision. This review of the hearing levels associated with myringostapediopexy shows that there is a similar range of hearing level both for naturally formed as well as surgically fashioned myringostapediopexy. For both 'naturally formed' and following canal wall up surgery about 80 per cent of patients will have an air-bone gap of 20 dB or less compared to 60 per cent of those who undergo canal wall down surgery.

Key words: Otitis Media, Surgical Procedures, Operative; Treatment Outcome

Introduction

During the middle of the last century it was recognized that there was variation in the hearing results following surgery for chronic suppurative otitis media, even among cases presenting with similar clinical findings.[1,2]

At the time Wullstein[3] described a system of tympanoplasty and reported results[4] showing the excellent closure of the air-bone gap that could be achieved with careful reconstruction of sound pressure transformation by myringostapediopexy. Similar results for myringostapediopexy have been reported by Pennington[5] and Proctor.[6] Modern otology has developed tympanoplasty to incorporate partial and total ossicular replacement techniques that can be applied to both canal wall up and canal wall down surgery. Wullstein type III tympanoplasty (myringostapediopexy) has become less fashionable because of comparatively poor hearing results compared to incus transposition ossiculoplasty when an intact stapes is present;[7,8] optimal hearing results being achieved when there is an adequate middle-ear volume[8,9] and a malleus-stapes assembly is used.[10] The achievement of these conditions is influenced by the surgical anatomy, after canal wall down surgery with a lowering of the facial ridge the shallower middle ear may be better suited to reconstruction by myringostapediopexy than by an interposition that will act as no more than a columella between the drum and stapes.

The relative contribution of tympanic membrane surface area and the incudo malleolar fulcrum upon the movement of the stapes is such that myringostapediopexy is expected to be an efficient hearing mechanism and this is to some extent borne out by clinical experience. However, surgical outcome is uncertain and when counselling patients for surgery that may involve tympanoplasty estimation of the potential hearing outcome is important. This report of the hearing outcome following myringostapediopexy examines the results following both canal wall up and canal wall down surgery and compares this with the hearing achieved by a naturally formed myringostapediopexy.

Method

The author's personal database of surgery for chronic otitis media was searched for patients who either had a naturally-formed myringostapediopexy and a dry ear prior to surgery or who had a myringostapediopexy surgically fashioned. Three groups were examined; those with a naturally formed myringostapediopexy, those with myringostapediopexy formed after canal wall down surgery and a small group who, for one reason or another, formed a myringostapediopexy following canal wall up surgery.

Data was collected about age, sex, the procedure performed and the pre- and post-operative hearing thresholds and, whenever possible, the post-operative audiogram used was carried out one year or longer following surgery. The averaged threshold and standard deviation for frequencies 0.5, 1 and 2 kHz were calculated. The air-bone gap for the three frequency average was calculated.

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Student's *t*-test was used to compare the 0.5, 1 and 2 kHz mean bone and air conduction thresholds and air-bone gap. A Fisher's exact test was used to assess the different numbers achieving an ABG of 20 dB or less for those with a naturally formed myringostapediopexy compared with those undergoing canal wall down surgery with fashioning of a myringostapediopexy.

Results

These are summarized in Tables I-IV. The three groups have a similar composition. There were four patients who had canal wall down surgery whose post-operative audiogram was performed less than one year after surgery. The average air and bone conduction thresholds are similar for each group as is the air-bone gap average and range, *t*-tests showed there was no significant difference between the means. Myringostapediopexy following canal wall down surgery appears less efficient at closing the air-bone gap to within 20 dB compared with myringostapediopexy either naturally formed or fashioned following canal wall up procedures (Table IV), however, statistical analysis did not show a significant difference.

Discussion

Thorburn[2] when discussing the factors influencing hearing following surgery for chronic otitis media described a case of modified radical mastoidectomy with removal of the malleus head and incus. With healing the drum attached along the line of the facial nerve and 16 months after surgery the average (0.5, 1, 2 kHz) threshold was 18 dB. This is a clear description of a myringostapediopexy created at the time Wullstein[4] and Zollner[11] were devising their classifications of tympanoplasty. Thorburn[2] formulated his observation into the principle that 'the ideal

TABLE I
DEMOGRAPHIC DATA

	Naturally formed	CWU	CWD
n	15	6	35
Age ranged	14–66	10–65	3–66
Average age	36	43	36
M:F	7:8	2:4	18:17
Range time to audio	–	12–108 months	3–39 months
Average time to audio	–	28 months	15 months

CWU = Canal wall up surgery; CWD = Canal wall down surgery.

TABLE II
FREQUENCY SPECIFIC AND 3 FREQUENCY AVERAGE BC THRESHOLDS AND STANDARD DEVIATION() IN DB HEARING LEVEL

		Frequency kHz				
	n	0.5	1	2	4	0.5 1, 2
Naturally formed	15	18.0 (15.1)	13.3 (9.2)	27.0 (12.2)	25.7 (16.1)	19.7 (10.3)
CWU	6	24.2 (20.3)	15.0 (18.2)	25.0 (16.1)	30.8 (18.6)	21.7 (17.6)
CWD	35	19.6 (14.7)	15.3 (14.0)	27.4 (17.0)	30.1 (20.0)	20.8 (14.3)

CWU = Canal wall up surgery; CWD = Canal wall down surgery.

TABLE III
FREQUENCY SPECIFIC AND 3 FREQUENCY AVERAGE AC THRESHOLDS AND STANDARD DEVIATION() IN DB HEARING LEVEL

		Frequency kHz				
	n	0.5	1	2	4	0.5, 1, 2
Naturally formed	15	36.7 (9.7)	34.7 (9.0)	40.7 (12.3)	52.7 (17.5)	37.3 (7.2)
CWU	6	43.3 (26.6)	38.3 (22.3)	36.7 (19.7)	54.2 (13.6)	39.1 (22.6)
CWD	35	40.4 (18.4)	38.3 (19.1)	39.9 (19.3)	60.0 (23.1)	39.8 (17.8)

CWU = Canal wall up surgery; CWD = Canal wall down surgery.

TABLE IV
THREE FREQUENCY AVERAGE AIR-BONE GAP, RANGE AND CLOSURE IN 10 DB BINS

		0.5, 1, 2 kHz ABG range dBHL	0.5, 1, 2 kHz ABG average dBHL, SD ()	ABG closure (%)			
	n			0–10 dB	10–20 dB	20–30 dB	>30 dB
Naturally formed	15	5.0–41.7	17.7 (9.4)	13	67	7	13
CWU	6	10.0–26.7	18.3 (4.3)	17	66	17	0
CWD	35	6.7–38.4	19.0 (6.8)	14	46	37	3

CWU = Canal wall up surgery; CWD = Canal wall down surgery; ABG = Air bone gap; dBHL = Decibels hearing level.

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to be aimed at is the creation of a mobile actual, or false, tympanic membrane, in functional continuity with the eustachian tube and covering one or both labyrinthine windows. If there is no malleus or incus an intact stapes is an asset, especially if the mobile false membrane covers and is adherent to it.'

At the same time Juers[1] made similar observations and described the need for an air-containing space over the round window, a sealed middle ear and, in the absence of an intact chain, the creation of a myringostapediopexy.

Subsequent interest in tympanoplasty and the development of bioimplants led towards a preference for partial or total ossicular chain reconstruction, particularly with the recognition that obliteration of a shallow mesotympanum[4,8] produced a poor hearing outcome. Austin[10] described a malleus stapes assembly in which either an autograft or homograft incus was shaped to bridge the space between the malleus handle and stapes, with excellent reported results. Smyth[8] confirmed the superiority of this method above others. The realization that a cartilage interposition between an allogenic implant and the tympanic membrane prevented implant extrusion[12] further reinforced the popularity of interposition tympanoplasty. Consequently, after the early 1960s there are few reports of hearing results for myringostapediopexy until open cavity mastoidectomy with mastoid tip removal became popular as a technique for producing a small open cavity.

Mastoidectomy with mastoid tip removal involves substantial lowering of the facial ridge so that middle-ear reconstruction is limited by a shallow middle ear. In canal wall down surgery the middle-ear volume is dictated, to some extent, by the degree of bone removal of the posterior canal wall/facial ridge. In a 'before backwards' approach[13,14] bone removal commences at the attic and extends superiorly and posteriorly to the limit of the disease. The degree of lowering of the facial ridge is dependent upon the extent of the disease and when there is localized disease it is possible to preserve the annulus posteriorly. Conversely, when commencing with dissection of the mastoid moving forward to display disease in the attic there is a greater chance that the posterior canal wall will have to be lowered to ensure access to the exposed mastoid. This produces a shallower middle ear with a greater chance that closure of the middle ear will leave the graft sitting on the stapes head; in this situation an interposition will only act as a columella from the drum to the stapes providing no additional benefit over and above a myringostapediopexy.

The results presented suggest that although the average thresholds and air-bone gap are similar for all groups there may be a less efficient closure of the air-bone gap when myringostapediopexy is formed as part of canal wall down surgery, as shown by the percentage closure to 20 dB or less (Table IV), this does not reach statistical significance. For canal wall down myringostapediopexy there is a range of reported closure to within 20 dB, this is between 44 per cent and 69 per cent on Table V[7,15–17] a good result is obtained in an average of 60 per cent of cases. When counselling patients about expected hearing outcome following canal wall down surgery that may involve fashioning of a myringostapediopexy it would be reasonable to quote either the range of expected outcome of, or for simplicity, to estimate a 60 per cent chance of achieving a good hearing outcome.

When compared with the author's results for myringostapediopexy in canal wall down surgery (Table V) neither a naturally nor a surgically formed myringostapediopexy appears to produce as reliable an ABG closure; although the spread of hearing threshold indicates that a high proportion of myringostapediopexy achieve an air-bone gap of less than 20 dB. Marchant[9] has suggested that when the middle-ear volume is less than 0.5 ml there may be an up to 10 dB drop in the hearing threshold; this may account for the smaller proportion of canal wall down cases with a post-operative air–bone gap in the 0–20 dB range. Additional reasons for a poor outcome are, the shallower middle ear which increases the chance of adhesions forming between the tympanic membrane and the medial wall and the smaller effective surface area of the tympanic membrane after removal of the outer attic wall. Additionally, failure to form a sound pressure transformation mechanism can occur if there is lateralization of the tympanic membrane so that the connection to the stapes head is lost. Pennington[5] and Proctor[6] suggested a small pinhole of the fascial graft used to seal the middle ear so that the stapes head protruded through this, thus preventing lateralization. This technique was more important for

TABLE V

THREE FREQUENCY AVERAGE ABG FOR 'NATURAL' MYRINGOSTAPEDIOPEXY AND REPORTED SURGICAL RESULTS FOLLOWING CWD SURGERY. (THE AUTHOR'S RESULTS FOR CWD MSA ARE SHOWN FOR COMPARISON.)

Authors	n	Post-operative ABG (%) 0–10 dB	0–20 dB	0–30 dB	>30 dB
Naturally formed (Table IV)	15	13	80	87	13
Dawes 2002 (Table IV)	35	14	60	97	3
Tos[7]	17	24	59	88	12
Cook *et al.*[16]	?	30	69	75	25
Beevarovski and Atlas[15]	25	16	44	76	24
Dawes[17]	25	8	68	88	12
CWD-MSA Dawes[17]	25	40	80	100	0

CWU = Canal wall up surgery; CWD = Canal wall down surgery; ABG = Air bone gap; MSA = Malleus stapes assembly; ? = n cannot be extrapolated from the original paper.

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canal wall up myringostapediopexy where there was less confidence that the graft would remain resting against the stapes. Pennington[5] describing his technique for canal wall up myringostapediopexy noted the importance both of removing part of the scutum and of release incisions of the ear canal skin to ensure that the stapes head was more centrally placed against the tympanic membrane. He considered these steps maximized sound transformation to the oval window. He noted that the different relationship between the stapes and tympanic membrane when a canal wall down procedure is done has an adverse effect upon sound transmission compared to canal wall up.

A malleus stapes assembly is not always feasible and at times may not be indicated as a part of canal wall down surgery. If an extensive dissection has been done, either the middle-ear volume or the relationship between a prominent stapes and malleus will preclude ossicular replacement because of insufficient middle-ear depth, the prosthesis only acting as a columella to the drum. When a second look is planned, it is prudent to avoid ossiculoplasty until the ear is re-inspected and found free of residual disease, a myringostapediopexy may form in the intervening period. The operated ear may have poor cochlear reserve compared to the other ear, such that binaural hearing cannot be achieved even with excellent air-bone gap closure. In this case, ossiculoplasty offers no advantage over myringostapediopexy. Finally, excision of disease should take priority and should not be compromised to create a situation where myringostapediopexy might be employed.

Conclusion

Myringostapediopexy may be formed by tympanic membrane medialization either as a result of the natural course of chronic otitis media or because of surgical intervention. Both the extent of disease and the surgical approach used influence the need to fashion a myringostapediopexy. When canal wall down surgery is performed the hearing results achieved by myringostapediopexy are comparable for differing surgeons. It can be expected that between 44 per cent and 69 per cent, on average 60 per cent, of patients having this type of tympanoplasty will achieve an air-bone gap closure to 20 dB or less.

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