The Malleus to Oval Window Revision Stapedotomy: Efficacy and Longitudinal Study Outcome

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Abstract

Objective: To determine the longitudinal effectiveness of the malleus to oval window stapedotomy technique among patients undergoing revision surgery when the incus is unavailable.

Methods: Charts of 15 patients who underwent 17 malleus attachment stapedotomies performed by a single surgeon from 2000-2015 were reviewed. Surgery was ambulatory, transcanal, with laser technique, under local anesthesia.

Results: Of 17 stapedotomies performed, there were 9 first revisions, 6 second revisions, 1 third revision, and 1 fourth revision. There were no surgical complications. Mean preoperative pure tone average air-bone gap (ABG) was 32.3 dB. Mean postoperative ABG at 6 months was 10.7 dB, and at last follow up was 16.3 dB. Average length of follow up was 36.5 months. At last follow up, 100% of first revisions achieved ABG ≤ 20 dB (77.8% ≤ 10 dB), compared to 50% of second revisions with ABG ≤ 20 dB (none ≤ 10 dB), and 0% of third or fourth revisions with ABG ≤ 20 dB. Trend lines for second and third/fourth revisions showed a deterioration (widening) in postoperative ABG by 0.18 and 0.72 dB per month, respectively. The first revision trend line, conversely, showed negligible change with time, demonstrating the superior durability of first revisions compared to subsequent surgeries.

Conclusion: The malleus to oval window stapedotomy technique is more effective and longer lasting in first revision surgery compared to subsequent procedures. Implantable or external amplification devices may be preferable for patients with multiple prior procedures.

Introduction

Despite the effectiveness of modern stapes surgery, a small percentage of stapedotomy patients return with complaints of increasing hearing loss, tinnitus, or vertigo and require revision of their primary surgery.

When planning a revision, the surgeon may choose to reconstruct using a prosthesis attached to the incus in a similar manner to the primary surgery, or may opt to connect the prosthesis to the previously untouched malleus. A growing body of literature has established that malleus to oval window prostheses are safe and effective.[1,2,3,4]

The malleus stapedotomy (MS) technique is of particular use when significant erosion of the long process of the incus has occurred, as this situation precludes the simple replacement or resizing of the incus to oval window piston, and makes optimal surgical results difficult to achieve.

This study analyzes a single surgeon's 16 year experience using the malleus to oval window stapedotomy technique for revision stapes surgery and explores the effect of revision number on the initial and long term outcomes of these procedures.

Methods and Materials

Subjects: A retrospective chart review for the years 2000-2015 identified 15 patients who underwent 17 surgeries performed by the senior author using the malleus stapedotomy technique.

Surgical Technique: All procedures were performed under local anesthesia using a standard transcanal approach and a potassium titanyl phosphate (KTP) laser.

Audiometric Analysis: Auditory results conform to the guidelines provided by the American Academy of Otolaryngology and Head and Neck Surgery's Committee on Hearing and Equilibrium.[5] Air-bone Gaps (ABG) were reported as the difference between air and bone pure-tone averages at frequencies of 500, 1,000, 2,000, and 3,000 Hz (4,000 Hz was used if 3,000 Hz was unavailable).

Table 1: Mean Pre vs. Postoperative Auditory Results

	All Revisions (N=17)	1st Revisions (N=9)	2nd Revisions (N=6)	3rd, 4th Revisions (N=2)
Mean PreOp ABG (dB)	32.3	32.3	29.4	41.3
Mean 6 Month PostOp ABG (dB)	10.7	6.5	15.2	15.6
Mean Last PostOp ABG (dB)	16.3	8.1	20.2	41.3

Table 2: Last Follow Up Auditory Results

ABG Category	All Revisions (N=17)	1st Revisions (N=9)	2nd Revisions (N=6)	3rd, 4th Revisions (N=2)
0-10 (dB)	7 (41.2%)	7 (77.8%)	0	0
11-20 (dB)	5 (29.4%)	2 (22.2%)	3 (50%)	0
21-30 (dB)	2 (11.8%)	0	2 (33.3%)	0
>30 (dB)	3 (17.6%)	0	1 (16.6%)	2 (100%)

Results

Of the 17 stapedotomies performed, there were 9 first revisions, 6 second revisions, 1 third revision, and 1 fourth revision. The average length of follow up was 36.5 months.

At 6 months postoperatively, first revision patients had a significantly lower mean ABG than second revision patients ($p = 0.03$) (Table 1). At last follow up, first revision patients had a significantly lower mean ABG than both second revision and third/fourth revision patients ($p = 0.01$ and $p = 0.03$ respectively) (Table 1).

When postoperative ABG data was organized into 10 dB bins, first revision patients again had significantly lower ABG's than second revision patients at 6 months postoperatively ($p = 0.02$), and significantly lower ABG's than second and third/fourth revision at last follow up ($p = 0.02$, 0.004) (Table 2).

Figure 1 displays each patient's ABG plotted against time for all postoperative appointments. A line of best fit is generated for each revision category. The slopes of the best fit lines represent dB of ABG gained (deterioration) per month and provide an estimate of the durability of each revision type. Line slopes are as follows: first revisions -0.03 dB/mo, second revisions 0.18 dB/mo, and third/fourth revisions 0.72 dB/mo.

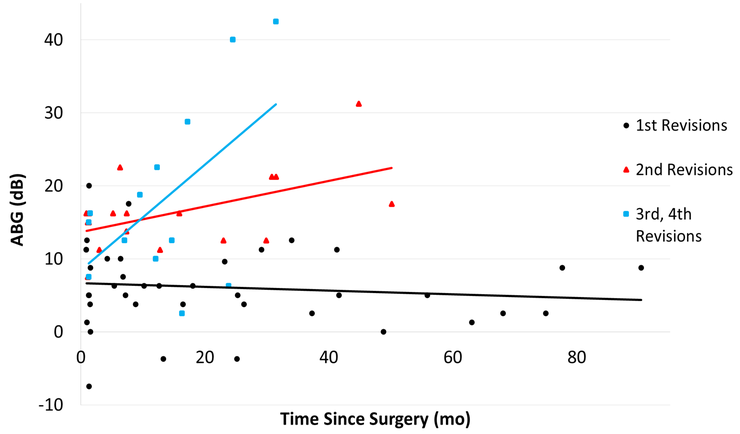

Figure 1. Air-bone gap vs. time, stratified by revision number. Data is included for all postoperative appointments. The slopes of the best fit lines represent dB of ABG gained (deterioration) per month. Line slopes: first revisions -0.03 dB/mo, second revisions 0.18 dB/mo, and third/fourth revisions 0.72 dB/mo.

Discussion

A review of the recent malleus stapedotomy (MS) literature demonstrates that surgeons using this technique are able to close 18-60% of patients to an ABG ≤ 10 dB, and 34-100% of patients to ≤ 20 dB.[1,2,3,4,6,7] Our results are consistent with these reports, with 41.2% of patients closed to ≤ 10 dB and 70.6% closed to ≤ 20 dB at last follow up.

The existing MS literature frequently ignores two potential influences on the postoperative air-bone gap: revision number and time elapsed since surgery. This study addresses these weaknesses by analyzing our cohort longitudinally over a lengthy follow up period (mean 36.5 months), while stratifying for revision number.

First revision patients experienced superior outcomes to second revision patients at 6 months postoperatively, and by patients' last follow up appointment first revisions were found to have narrower ABG's than both second and third/fourth revisions.

The effects of revision number and time since surgery are perhaps best represented by Figure 1. First revision patients generally benefit from durable surgeries that degrade little with time, however, this is not true for subsequent revisions. While regression analysis shows that the trend line for first revision patients is not significantly different from a slope of 0 dB per month ($p = 0.47$), second revision patients' ABG widened on average 0.18 dB each month after surgery ($p = 0.02$), and third/fourth revision patients' ABG increased by 0.72 dB monthly ($p = 0.051$ due to small sample size). This demonstrates a pattern of decreasing surgical durability as revision number increases.

Conclusions

The malleus to oval window stapedotomy technique is safe and effective. Through longitudinal analysis, we demonstrate that first revision surgeries have superior outcome and are longer lasting than second or third/fourth revisions. Implantable or external amplification devices may be preferable for patients with multiple prior procedures.

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