

## Stapes Management in Tympanosclerosis

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### Abstract

**Background:** Stapes management in tympanosclerosis has always been controversial. There are evidences supporting stapes mobilization, but there are concerns regarding refixation and recurrence of conductive hearing loss; therefore, supporting stapedectomy.

**Methods:** In this retrospective study, clinical records, operative notes, and audiologic data of patients with stapes fixation (1994–2011) were analyzed. Audiometric findings are reported according to the recommendations of the Committee on Hearing and Equilibrium 1995 Guidelines for the Evaluation of Results of Treatment of Conductive Hearing Loss.

**Results:** In the present study, 66 patients were enrolled (23 male, 43 female). Stapedectomy and stapes mobilization both had good hearing results (12.1 dB vs. 10.6 dB reduction in ABG) and there was no significant difference. Overall, 63.6% of patients had achieved good results (mobilization: 57.9%, stapedectomy: 71.4%). The difference in success rate between the two groups was not statistically significant.

**Conclusions:** Stapedectomy and mobilization of stapes both seem to be efficacious and safe in the treatment of stapes involvement in tympanosclerosis. The hearing improvement is long lasting in both procedures.

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### Introduction

Tympanosclerosis is one of the most common middle ear diseases in patients with chronic otitis media. It seems to be a nonspecific result of inflammatory process of the middle ear with hyaline degeneration, and calcification of fibrous and elastic layer of middle ear mucosa connective tissue (1). The exact pathophysiology of this chronic process is not thoroughly understood (2-5). However, the irreversible result of the inflammatory process seems to be common in all cases, because the sclerosis seems to be related with the duration of inflammatory process (6). The variable degree of calcification and deposition around ossicular chain, and oval and round windows leads to the variety of clinical presentation from minimal sclerosis with no hearing impairment to massive middle ear and mastoid disease causing

significant conductive hearing loss (5,7).

The uncertainty about the disease process has led to different strategies of treatment. Therefore, controversy in the management is rule, rather than exception. Risk of deterioration of hearing or recurrence of disease has always been considered. Surgery of these patients is even more challenging in the presentation of stapes fixation (7). Mobilization of fixed stapes and stapedectomy have both been described, and these approaches both have their potential advantages and disadvantages (8-13). Overall, surgeons achieve one of the following strategies for hearing loss in tympanosclerosis: (1) no manipulation of risky sites and use of amplification instead, (2) mobilization, or (3) stapedectomy.

The aim of present study was to compare clinical and operative findings, and hearing results of patients

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undergoing mobilization of stapes with those undergoing stapedectomy.

## Materials and Methods

### Patients

In this retrospective study (1994-2011), 66 patients with stapes fixation due to tympanosclerosis were enrolled. Of these patients, 57.6% have undergone mobilization of the stapes and 42.4% stapedectomy. Other pathologies such as cholesteatoma, chronic otitis media without any evidence of tympanosclerosis, previous failed ear surgery, and involvement of other ossicles with sclerosis were excluded from the study. All of the patients were selected from a tertiary referral otology private practice and all of the surgeries were performed in Day General Hospital, Tehran, Iran. All of the surgeries were performed by the senior author (MTK).

### Technique

Stapedectomy was only done in the second stage when the tympanic membrane had been repaired in the first stage and sterile middle ear had been prepared. Mobility of stapes was checked by round window reflex. Some cases had more than 2 operations; these patients' first stage (tympanoplasty) had failed and revision tympanoplasty had been performed. When mobilization was planned it was done only by removing plaques, because in our experience rocking the stapes in order to mobilize them will result in footplate avulsions, which will frequently re-fix or lead to inner ear fistula. In all of the stapedectomy cases a 0.6 × 6 mm Teflon piston prosthesis was used.

### Audiometric evaluation

All audiometric assessments were performed by one person. The patients were not isolated from other candidates for audiologic assessment. Audiometric findings are reported according to the recommendations of the Committee on Hearing and Equilibrium 1995 Guidelines for the Evaluation of

Results of Treatment of Conductive Hearing Loss (14). The latest preoperative audiometric assessment was used as the baseline hearing status and the most recent audiometric result was used as the postoperative hearing result. Pure tone averages of 500, 1000, 2000, and 4000 Hz was used to assess hearing. Operation was considered successful if one of the following criteria was achieved: postoperative air-bone gap (ABG; calculated as mean of gap in 4 frequencies) < 15 dB; hearing gain of 15 dB; postoperative air-conduction threshold < 30 dB (7).

Mean time of postoperative audiometry is 32.8 months. Detailed follow up audiometry time is mentioned in table 1.

### Data analysis

Parametric and non-parametric statistical tests were used as indicated, to investigate study results. Student's t-test was used to compare audiologic thresholds between groups, and chi-square was used to analyze success criteria among different groups. Audiometric result in different follow up groups was analyzed by linear regression. Statistical significance was set at P < 0.05 two tailed. Statistical Package for Social Sciences (version 16; SPSS Inc., Chicago, IL, USA) was used for data analysis.

## Results

A total of 66 patients were enrolled in this study (23 male, 43 female). The total number of operations were 115 operations; 23 had one stage surgery but 38 two stage, and 5 had more than 2 operations (Table 1).

Stapedectomy and stapes mobilization both had good hearing results (12.1 dB vs. 10.6 dB reduction in ABG) and there was no significant difference (P = 0.6; Table 2). Interestingly, stapes fixation treatment with either stapedectomy or stapes mobilization resulted in improved bone conduction and over closure of ABG in 2 KHz frequency band (Figure 1).

According to the successful results criteria, 63.6%

**Table 1.** Patients' data

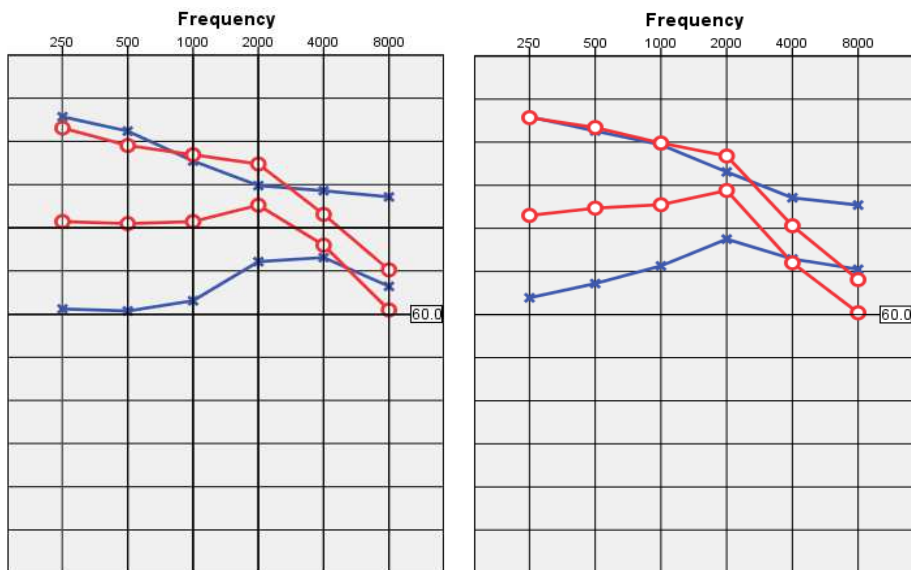
| Parameter                      | Total        | Mobilization | Stapedectomy |
|--------------------------------|--------------|--------------|--------------|
| Number of operations           |              |              |              |
| 1                              | 23 (34.8%)   | 21 (55.3%)   | 2 (7.1%)     |
| 2                              | 38 (57.6%)   | 13 (34.2%)   | 25 (89.3%)   |
| > 2                            | 5 (7.6%)     | 4 (10.5%)    | 1 (3.6%)     |
| Number of unplanned revisions  | 5 (7.6%)     | 3 (7.9%)     | 2 (7.1%)     |
| Symptoms                       |              |              |              |
| Hearing loss                   | 66 (100%)    | 38 (100%)    | 28 (100%)    |
| Vertigo                        | 2 (3%)       | 0            | 2 (7.1%)     |
| Tinnitus                       | 16 (24.2%)   | 8 (21.1%)    | 8 (28.6%)    |
| Otorrhea                       | 43 (65.2%)   | 27 (71.1%)   | 16 (57.1%)   |
| Side                           |              |              |              |
| Right                          | 36 (54.5%)   | 24 (63.2%)   | 12 (42.9%)   |
| Left                           | 30 (45.5%)   | 14 (36.8%)   | 16 (57.1%)   |
| Age (mean, range; year)        | 36.5 (14-67) | 37.9 (17-63) | 34.6 (14-67) |
| Follow up (mean, range; month) | 32.8 (5-170) | 29.4 (5-170) | 37.4 (6-152) |

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**Table 2.** Audiologic thresholds before and after surgery

|     |             | Total |      |       | Mobilization |      |       | Stapedectomy |      |       |
|-----|-------------|-------|------|-------|--------------|------|-------|--------------|------|-------|
|     |             | Mean  | SD   | P     | Mean         | SD   | P     | Mean         | SD   | P     |
| PTA | Before      | 55.3  | 13.3 |       | 57.2         | 15.3 |       | 52.6         | 9.5  | 0.001 |
|     | After       | 46.2  | 17.7 |       | 49.0         | 18.9 |       | 42.4         | 15.3 |       |
|     | Improvement | 9.1   | 14.4 | 0.001 | 8.2          | 14.2 | 0.001 | 10.2         | 14.8 |       |
| ABG | Before      | 28.6  | 10.5 |       | 30.0         | 12.1 |       | 26.8         | 7.9  | 0.001 |
|     | After       | 17.4  | 12.8 |       | 19.4         | 13.7 |       | 14.7         | 11.1 |       |
|     | Improvement | 9.1   | 14.4 | 0.001 | 8.2          | 14.2 | 0.001 | 10.2         | 14.8 |       |

SD: standard deviation; PTA: pure tone average; ABG: air-bone gap



**Figure 1.** Pre- (blue) and post- (red) operative bone and air conduction thresholds of patients undergoing stapedectomy (left panel) and mobilization (right panel)

of patients had achieved good results (mobilization: 57.9%, stapedectomy: 71.4%; Table 3). The difference in success rate between the two groups was not statistically significant ( $P = 0.26$ ). Table 4 shows speech audiometry results of groups.

Unfortunately, we did not have multiple serial audiologic evaluations of patients. However, we have categorized patients regarding their follow up period (Figure 2); ABG gain and ABG after surgery were not significantly different among these groups ( $P = 0.4$  and  $P = 0.7$ , respectively). This may indicate stable long term hearing results. However, as figure 2 shows, stapedectomy patients do better in the mid-term follow up period.

### Complications

A significant group of patients (31.8%) had improved bone conduction threshold after surgery.

Overall mean bone conduction had no significant change after surgery (mean BC change: mobilization: 2.3 dB, stapedectomy: 1.8 dB,  $P = 0.8$ ). Prevalence of bone conduction deterioration of more than 10 dB was 10.6% (mobilization: 7.9%, stapedectomy: 14.3%;  $P = 0.3$ ). Bone conduction threshold shift ranged from 17.5 dB improvement to 31.3 dB deterioration. We had no dead ear or facial nerve paresis after surgery.

### Discussion

Tympanosclerosis has always been controversial regarding hearing loss management. Most arguments are regarding durability of results and inability of surgery to stop the ongoing process of the pathology which leads to recurrence of hearing loss. Some even believe tympanosclerosis to be a contraindication for

**Table 3.** Success criteria for different patient groups

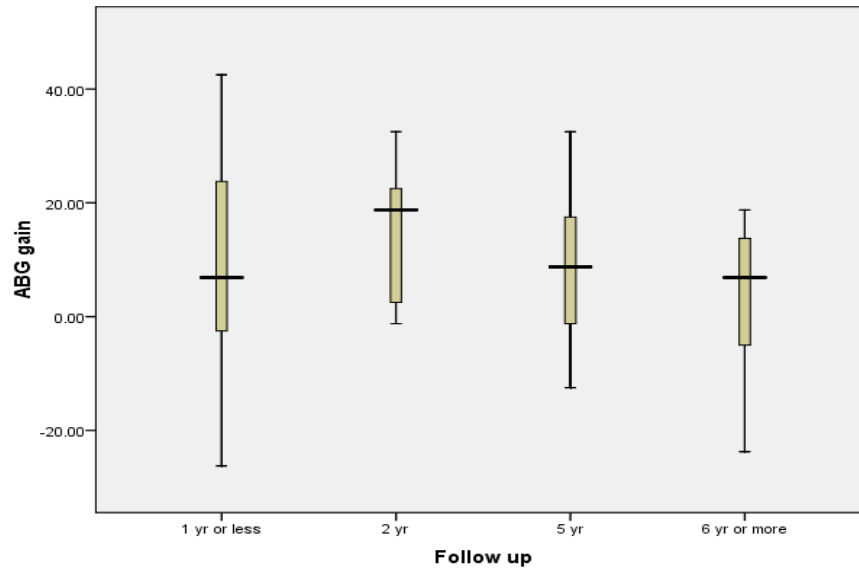
| Patient group | Good AC | Good ABG | Good AC gain | Overall |
|---------------|---------|----------|--------------|---------|
| Total         | 21.2%   | 57.6%    | 37.9%        | 63.6%   |
| Mobilization  | 21.1%   | 52.6%    | 31.6%        | 50.9%   |
| Stapedectomy  | 21.4%   | 64.3%    | 46.4%        | 71.4%   |

AC: air conduction; ABG: air-bone gap

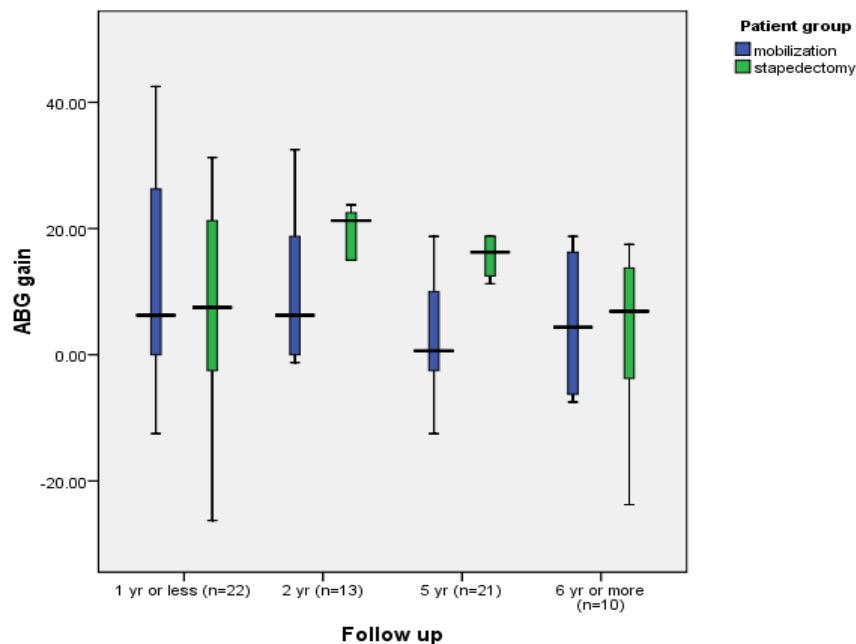
**Table 4.** Speech audiometry results of patients

| Parameter | Mobilization |             | Stapedectomy |             |
|-----------|--------------|-------------|--------------|-------------|
|           | Before       | After       | Before       | After       |
| SRT       | 55 (20-90)   | 44 (15-90)  | 55 (35-75)   | 41 (25-85)  |
| MCL       | 82 (50-100)  | 72 (45-100) | 83 (65-100)  | 71 (50-100) |
| SDS       | 96 (60-100)  | 97 (70-100) | 97 (85-100)  | 99 (90-100) |

SRT: speech reception threshold; MCL: mean comfortable level; SDS: Speech discrimination score



**Figure 2-a.** Air-bone-gap in different groups of patients with different follow up period



**Figure 2-b.** Air-bone-gap in different groups of patients with different follow up period (Gain is shown in both stapedectomy and mobilization groups)

hearing reconstruction procedures (15). Others believe surgery to be the best management option (9). Most of these controversies have been about stapes involvement and its management (12).

We do not know exactly whether stapes involvement

has a significant impact on the results of surgery or not. Teufert and De La Cruz showed that stapes status has no significant impact on results (1). However, Albu et al. found stapes fixation to be the only statistically significant prognostic factor of postoperative hearing

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result (10). As figure 2-a shows hearing results after stapes surgery seem to be long lasting, and stapes involvement seems not to have a negative impact on the long term hearing result in our patients.

Both groups had good hearing results whether stapes mobilization or stapedectomy were done. Although refixation affinity of stapes in tympanosclerosis has always been a concern, it does not seem to be the case in our patients. Moreover, proponents of stapedectomy believe there is a risk of cochlear damage during mobilization (11,15,16); but again, we had no dead ear and no significant bone conduction threshold shift. On the other hand, some believe that one stage surgery is the main advantage of choosing mobilization instead of stapedectomy (9,13). Although some surgeons prefer one of these methods, we think they are both safe and efficient. It should be noted that stapes mobilization in massive sclerotic lesion in the oval window area has a very high risk of inner ear damage and should be prevented. This finding is congruent with other recent evidences (17,18).

Over-closure of BC in many of patients is interesting and shows significant change in middle ear resonant frequency. However, we did not perform multiple frequency tympanometry to investigate this.

Regarding the durability of hearing status after surgery, as our results show, most of our patients have good long term hearing outcome. Although we did not have multiple hearing assessments during the follow up period, figure 2-b shows that there seems to be reasonable persistence of hearing improvement. This would be better studied if we had different audiograms of different patients.

Our overall success rate of hearing rehabilitation was 63.6%. However, lowering ABG improves hearing, makes better hearing aid usage possible, and improves asymmetric hearing to symmetric hearing. We believe in order to restore the ear with hearing aid, lowering the level of satisfaction should be discussed with the patient.

## Conclusion

Stapedectomy and mobilization of stapes both seem to be efficacious and safe in the treatment of stapes involvement in tympanosclerosis. The hearing improvement is long lasting in both procedures.

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## References

1. Teufert KB, De La Cruz A. Tympanosclerosis: long-term hearing results after ossicular reconstruction. *Otolaryngol Head Neck Surg* 2002; 126(3): 264-72.
2. Schilder AG, Zielhuis GA, Haggard MP, van den Broek P. Long-term effects of otitis media with effusion: otomicroscopic findings. *Am J Otol* 1995; 16(3): 365-72.
3. Schiff M, Poliquin JF, Catanzaro A, Ryan AF. Tympanosclerosis. A theory of pathogenesis. *Ann Otol Rhinol Laryngol Suppl* 1980; 89(4 Pt 2): 1-16.
4. Maw AR. Development of tympanosclerosis in children with otitis media with effusion and ventilation tubes. *J Laryngol Otol* 1991; 105(8): 614-7.
5. Ho KY, Tsai SM, Chai CY, Wang HM. Clinical analysis of intratympanic tympanosclerosis: etiology, ossicular chain findings, and hearing results of surgery. *Acta Otolaryngol* 2010; 130(3): 370-4.
6. Russell JD, Giles JJ. Tympanosclerosis in the rat tympanic membrane: an experimental study. *Laryngoscope* 2002; 112(9): 1663-6.
7. Tsuzuki K, Yanagihara N, Hinohira Y, Sakagami M. Tympanosclerosis involving the ossicular chain: mobility of the stapes in association with hearing results. *Acta Otolaryngol* 2006; 126(10): 1046-52.
8. Vincent R, Oates J, Sperling NM. Stapedotomy for tympanosclerotic stapes fixation: is it safe and efficient? A review of 68 cases. *Otol Neurotol* 2002; 23(6): 866-72.
9. Tos M, Lau T, Arndal H, Plate S. Tympanosclerosis of the middle ear: late results of surgical treatment. *J Laryngol Otol* 1990; 104(9): 685-9.
10. Albu S, Babighian G, Trabalzini F. Surgical treatment of tympanosclerosis. *Am J Otol* 2000; 21(5): 631-5.
11. Gormley PK. Stapedectomy in tympanosclerosis. A report of 67 cases. *Am J Otol* 1987; 8(2): 123-30.
12. WAN L, GUO M, XIE E, LIU S, CHEN S, CHEN N, et al. The effect of surgical treatment for tympanosclerotic stapes fixation. *Chinese Archives of Otolaryngology-Head and Neck Surgery* 2010; 4: 16.
13. Park HY, Jun HJ, Choung YH, Park K. Effectiveness of Stapes Mobilization in Tympanosclerotic Stapes Fixation. *Korean J Audiol* 2011; 15(1): 19-24.
14. Committee on Hearing and Equilibrium guidelines for the evaluation of results of treatment of conductive hearing loss. American Academy of Otolaryngology-Head and Neck Surgery Foundation, Inc. *Otolaryngol Head Neck Surg* 1995; 113(3): 186-7.
15. Smyth GD. Tympanosclerosis. *J Laryngol Otol* 1972; 86(1): 9-14.
16. Querat C, Richard C, Martin C. Labyrinthine fenestration for tympanosclerotic stapes fixation. *Eur Ann Otorhinolaryngol Head Neck Dis* 2012; 129(6): 297-301.
17. Giddings NA, House JW. Tympanosclerosis of the stapes: hearing results for various surgical treatments. *Otolaryngol Head Neck Surg* 1992; 107(5): 644-50.
18. Emmett JR, Shea JJ. Surgical treatment of tympanosclerosis. *The Laryngoscope* 1978; 88(10): 1642-8.