

# Long Term Hearing Outcome of Stapedotomy

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## ABSTRACT

**Background:** Otosclerosis is a bone disorder affecting the temporal bone, resulting in stapes fixation. leading to gradual and progressive conductive and mixed hearing loss. Stapedotomy is a reliable and safe procedure with positive hearing outcomes.

**Objective:** This study aims to evaluate the long-term hearing results following stapedotomy.

**Patients and Methods:** A retrospective study on long term outcomes following stapedotomy in Erbil/Iraq. The study focused on patients who underwent surgery between June 2010 and June 2014, with a minimum follow-up period of 10 years. During this time, 65 patients (40 females and 25 males), received treatment. The outcomes of pure-tone audiometry were evaluated preoperatively, one month postoperatively, and at later stages to assess the long-term impact of time on stapedotomy surgery.

**Results:** The mean air conduction preoperatively was 51.1dB, mean bone conduction was 21.3dB, and mean air bone gap was 29.2. The mean bone conduction readings were 21.33 preoperative, 16.23 early postoperative and 22.33 late postoperative. While the mean air bone gap results were 29.23 preoperative, 8.46 in early postoperative and 14.88 in late postoperative.

Comparison between means of preoperative, early postoperative, and late postoperative shows statistically significant differences. Specially comparisons of early and late postoperative results are statistically significant.

**Conclusions:** Although patients generally report satisfactory hearing but long term follow up for stapedotomy shows that the time has a negative impact on the results in form of air conduction and bone conduction..

**Keywords:** Otosclerosis, Stapedotomy, Hearing loss, Puretone Audiometry.

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## INTRODUCTION

Otosclerosis is a hereditary disorder affecting the otic capsule, transmitted through an autosomal dominant inheritance pattern with approximately 40% penetrance. It leads to demineralization and otospongiotic changes, with multiple bone remodeling sites at various stages of activity<sup>1</sup>. Recent studies have highlighted the significance of genetics in otosclerosis, while the roles of hormonal substances, viral agents, and autoimmunity remain uncertain<sup>2</sup>.

The condition commonly presents as conductive or mixed hearing loss, influenced by the location and severity of the lesions. Around 90% of cases show involvement in the fissula ante fenestram (area in front of the oval window), leading to stapedial fixation and conductive hearing loss<sup>3</sup>.

The typical manifestation of otosclerosis is a progressive conductive hearing loss that begins in adulthood. Approximately 10% will also experience sensorineural hearing loss, patients typically notice hearing loss when the hearing threshold exceeds 25-30 dB, making speech comprehension challenging<sup>4</sup>.

Patients might report better hearing clarity in noisy settings, a phenomenon known as Paracusis of Willis, where the conductive hearing loss reduces background noise, thereby enhancing the signal-to-noise ratio. Symptoms like tinnitus and vertigo may also be present<sup>5,6</sup>. The prevalence of otosclerosis varies geographically and differs significantly among various populations and it is more common in women, typically manifesting between the second and third decades of life<sup>7</sup>.

Treatment depends on factors like symptom severity, age, and whether the condition affects one or both ears. Treatment options range from monitoring, hearing aids, medical therapy to surgery<sup>8,9</sup>. Surgical treatment for otosclerosis was pioneered by Shea in 1956. Since then, a variety of surgical methods, techniques, and prostheses have been developed to treat the condition and improve hearing. Among these, the most widely accepted technique is the small fenestrated stapedotomy, as described by Fish. Today, stapedotomy is a routine procedure in many centers worldwide<sup>10</sup>.

While stapedotomy is generally safe, complications can arise, and hearing improvement may not be long-lasting in all cases. Long-term outcomes remain uncertain, with more data needed to identify which patients benefit most from the surgery. Therefore, both subjective patient assessments and audiological evaluations should be included in the standard of care postoperatively to ensure comprehensive success<sup>11</sup>.

## MATERIALS & METHODS

A study on long term functional hearing outcomes after surgical treatment of otosclerosis using stapedotomy was conducted at a specialized center in Erbil city, Kurdistan region. All surgeries were performed by the same surgeon. The study included patients who underwent surgery from June 2010 to June 2014. With minimum

follow up of 10 years. During this period, 65 patients (40 females and 25 males) aged 23 to 48 years were treated. Preoperative, 1 month post operative and late results of pure tone audiometry were compared studying the effect of time on stapedotomy surgery outcome.

### Surgical technique

The operation was conducted using an endaural approach under general anesthesia. The tympanomeatal flap was elevated, and the bone from the posterior scutum was removed with a curette or drill to expose the oval window and the stapes. The stapes' mobility was tested by moving the malleus handle with a needle. After detaching the incudostapedial joint with a joint knife and cutting the stapedial tendon with scissors, the posterior and anterior crus of the stapes were divided using fix and push technique by two microhooks which is a technique described and used by the author. A 0.6 mm fenestra was created at the junction of the posterior one-third and anterior two-thirds of the footplate using a micro-perforator. A fluoroplastic stapes piston prosthesis was used in all cases. The prosthesis was sized by measuring the distance from the footplate to the long process of the incus. The prosthesis was positioned after adjusting its length.

### Audiometric assessment

The diagnostic process included multiple analytical steps: reviewing the patient's medical history, conducting a clinical examination, performing pure tone audiometry (PTA), tympanometry, and stapedial reflex testing. All diagnostic procedures were conducted at a dedicated audiology center utilizing the Interacoustics equipment. Hearing assessments were conducted in a soundproof booth, with patients wearing calibrated TDH39 headphones for standard-frequency audiometry. Pure tones at 0.25, 0.5, 1, 2, 3, 4, 6, and 8 kHz were delivered to each ear individually, while bone-conduction thresholds were measured using a calibrated vibrator placed on the mastoid process at 0.5, 1, 2, and 4 kHz. Hearing thresholds were determined using the modified Hughson-Westlake method, following International Standards Organization guidelines. Measurements were performed preoperative; 4 weeks post-surgery and minimum 10 years post-surgery. Mean results of bone conduction (BC), air conduction (AC), and the air-bone gap (AB gap) for 500 Hz, 1000 Hz, 2000 Hz, and 4000 Hz. were compared. The mean results were calculated by summing the dB values at 0.5, 1, 2, and 4 kHz frequencies dividing by four.

### Statistical Analysis

The study involves performing statistical analyses using SPSS version 27 to examine the differences between multiple groups using ANOVA (Analysis of Variance) that combines for overall group comparisons and post hoc tests (LSD (Least Significant Difference) test is performed) to pinpoint specific differences, offering a thorough analysis of the impact of the groups on the dependent variables.

## RESULTS

A total of 65 patients 25 (38.46%) males and 40(61.54% females) aged between 23 and 48 years, with an average age of 37 years, underwent surgery. Bilateral diseases with different hearing loss levels, the worse ear was operated (37 Rt side and 28 left side). Patients were followed up post operatively minimum 10 years and maximum 14 years with a mean of 11.3 years. Mean of PTA data is shown in the (Figure 1).

Table 1 shows Pre versus early postoperative (mean of PTA data), The mean difference was 20.76154, with a p-value < .001. This shows a statistically significant difference, with Pre having a much higher mean than

early postoperative. The 95% confidence interval for this difference is between 16.9565 and 24.5665, which does not cross zero, further confirming significance (Table 1).

Table 2 shows early post operative versus late postoperative (mean of PTA data), the early postoperative group has a lower mean than the Late group, with a mean difference of -6.41615. This difference is also significant (p = .001), with a confidence interval of -10.2212 to -2.6112. Indicating the effect of time on the results of stapedotomy surgery outcomes (Table 2).

Table 3 shows preoperative versus late postoperative (mean of PTA data); the mean difference was 14.34538, again statistically significant (p < .001), showing that the

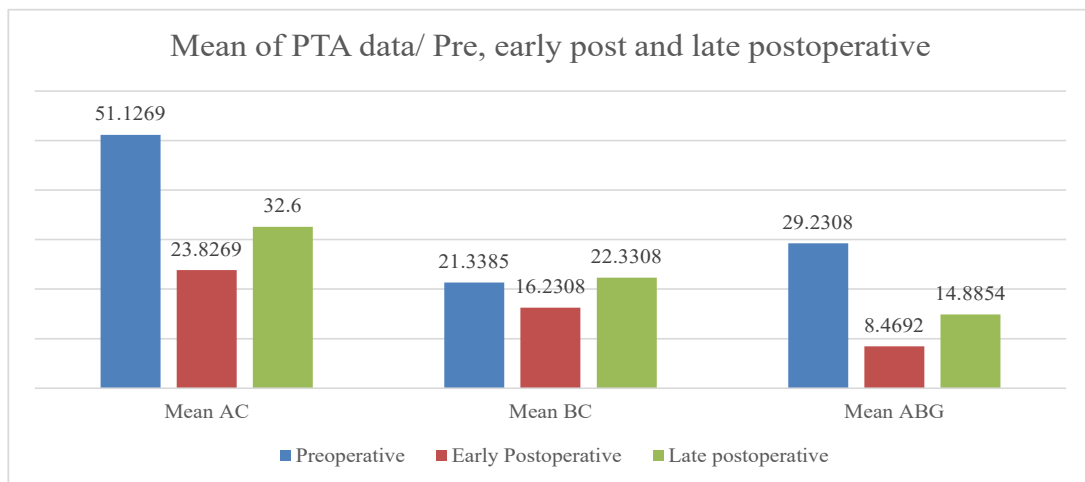


Figure 1: Shows the flow of our study.

Table 1: Mean of PTA data/ Comparison of Pre and Early post PTA results.

Groups		Mean	P-value
A	Preoperative	51.1269	0
	Early Postoperative	23.8269	
B	Preoperative	21.3385	0
	Early Postoperative	16.2308	
AB	Preoperative	29.2308	0
	Early Postoperative	8.4692	

Table 2: Mean of PTA data/ Comparison of Early and Late postoperative PTA results.

Groups		Mean	P-value
A	Early Postoperative	23.8269	0
	Late Postoperative	32.6	
B	Early Postoperative	16.2308	0
	Late Postoperative	22.3308	
AB	Early Postoperative	8.4692	0.005
	Late Postoperative	14.8854	

Table 3: Comparison of Preoperative and Late postoperative mean PTA results.

Groups		Mean	P-value
A	Preoperative	51.1269	0
	Late Postoperative	32.6	
B	Preoperative	21.3385	0.327
	Late Postoperative	22.3308	
AB	Preoperative	29.2308	0
	Late Postoperative	14.8854	

pre group has a significantly higher mean than the Late group. The confidence interval ranges from 10.5404 to 18.1504 (**Table 3**).

## DISCUSSION

A total of 65 patients 25 (38.46%) males and 40(61.54% females) aged between 23 and 48 years, with an average age of 37 years, underwent surgery which is close to other studies that showed a higher prevalence of women (65%) than men (35%)<sup>12</sup>and 36 female and 16 male in study done in Iraq<sup>13</sup>.

In our study mean AC preoperative was 51.1269, mean BC 21.3385, and mean AB gap was 29.2308 which is in accordance with a study by Dhogee et al in which the Preoperative mean AC was 53.13dB, the mean BC was 26.7dB and mean AB preoperative was 26.4 dB. This result means that our indication and timing for the surgery is similar to the international centers and follows the rules of indications guideline.

In our study comparisons (between all groups) showed a significant p value. This suggests that there are meaningful differences between the means of the Pre, Post, and Late groups. The Pre group consistently has higher means than both the Post and Late groups, while the Post group has a lower mean compared to the Late group which is close to a study by Dhogee et al which showed a significant difference between preoperative AC-PTA and both early and late postoperative follow-up<sup>14</sup>. These results show the effectiveness of the surgery on the results of pure tone audiometry when we compare the preoperative data with the early and the late postoperative results. But also show significant impact of time on the results of pure tone audiometry when we look to the early and late postoperative results.

In another study, the AC thresholds measured 6 months and 5 years post-surgery showed a significant improvement compared to pre-surgery levels ( $p < 0.01$ ). In contrast, the BC thresholds at the same time points did not exhibit any significant change from their pre-surgery values ( $p > 0.05$ ). These results suggest that long-term hearing loss after stapes surgery might be attributed to factors such as piston displacement or the closure of the fenestration hole due to bone regrowth<sup>15</sup>. We think also the longer the time of follow up the more the change on the results can be seen because of aging effect on hearing pathways and the otosclerosis by itself is a continuous process which may affect the inner ear by time.

In a study by Lucid et al with a follow up of 22 years following stapes surgery, a slight decline in both AC and BC thresholds is anticipated, with more noticeable sensorineural deterioration at higher frequencies. Despite this, patients generally report satisfactory hearing and overall sound perception<sup>16</sup>.

Currently, there is limited research on the long-term outcomes of stapes surgery. Over time, some patients experience a gradual progression of hearing loss, which

may be attributed to factors such as the degradation of the reconstructed sound conduction system, the advancement of otosclerosis pathology, or the development of sensorineural hearing loss caused by intraoperative trauma to the inner ear<sup>14,16</sup>.

The limitations of this study is that it's retrospective design, which carries a higher risk of loss to follow-up and less detailed data.

It's worth noting that most studies on stapedotomy have primarily focused on audiometric outcomes, with less emphasis on patient satisfaction and quality of life. Future prospective research should incorporate these critical outcome measures.

## CONCLUSION

Patients in early and late post stapedotomy generally report satisfactory hearing and overall good sound perception but the time has a negative impact on the audiometric results.

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