



## POST OPERATIVE HEARING RESULTS IN STAPEDOTOMY VERSUS STAPEDECTOMY

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Article Received on 31/12/2024

Article Revised on 20/01/2025

Article Accepted on 10/02/2025

### ABSTRACT

Stapedial otosclerosis is the most common type of otosclerosis causing stapes fixation with progressive low frequency conductive or mixed hearing loss and air-bone gap seen in pure tone audiometry. Many patients show Carhart's notch which is a depression in bone threshold at 2000 Hz. It is mainly treated surgically; by stapedotomy which is the most efficient surgical procedure or by stapedectomy in some other cases. The aim of our study is to compare hearing results in patients underwent stapedotomy or stapedectomy for the treatment of conductive hearing loss due to otosclerosis. A retrospective analysis of hearing results of 45 patients underwent stapedotomy or stapedectomy at Otolaryngology Department, King Hussain Medical Centre between March 2020 and March 2022 were compared. In our study, we evaluated 13 patients who underwent stapedectomy and 32 patients underwent stapedotomy. The average age was 36.7 years for the stapedectomy cohort and 35.1 years for the stapedotomy group. There was 39% male in the stapedectomy group and 40% in the stapedotomy group. The median duration of illness prior to surgery was 27 months for both sets of patients. Regarding the ear affected by otosclerosis, 15% of the stapedectomy group had the right ear affected, compared to 16% in the stapedotomy group. Bilateral involvement was high, with 77% in the stapedectomy group and 78% in the stapedotomy group. We concluded in the last of our study that there were no significant differences in postoperative pure-tone average (PTA) or air-bone gap between the two groups of patients underwent either stapedotomy or stapedectomy. By these results, either procedure shows approximately same hearing results.

**KEYWORD:** Otosclerosis, Stapedotomy, Stapedectomy, Pure tone audiometry, air-bone gap.

### INTRODUCTION

Otosclerosis is a genetic condition that primarily targets the otic capsule's endochondral bone, leading to the development of new, dense sclerotic bone. This typically affects individuals between the ages of 15 and 50 who have an intact tympanic membrane. There are two variations of the disease: histologic otosclerosis, which does not present symptoms and does not involve the stapes bone or adjacent structures, and clinical otosclerosis, which does cause symptoms and involves the stapes bone, stapediovestibular joint, and cochlear endosteum. The latter frequently manifests as stapedial otosclerosis, particularly around the fissula ante fenestrum, causing progressive conductive or mixed hearing loss at low frequencies and a noticeable air-bone gap during pure tone audiometry. Carhart's notch, a dip at the 2000 Hz bone threshold, is often noted in these individuals.<sup>[1]</sup> Surgical intervention is generally considered when the air-bone gap reaches a minimum of 25 dB, although some institutions opt for surgery with gaps as small as 10 dB.<sup>[2-4]</sup> If a Rinne test with a 512 Hz

tuning fork indicates air conduction is better than bone conduction, surgery is usually not suggested. Conversely, a negative result, where bone conduction exceeds air conduction by at least 20 dB, would typically lead to a recommendation for surgery.<sup>[5]</sup> Our research aims to evaluate the hearing outcomes for patients who have undergone stapedotomy as opposed to stapedectomy for managing conductive hearing loss attributed to stapedial otosclerosis.

The underlying causes of otosclerosis are still being explored, but it is believed to be linked to a variety of factors, including genetic, viral (measles), hormonal, and autoimmune influences.<sup>[6-9]</sup> The disease is most often inherited as an autosomal dominant trait with varying degrees of expression, though alternative inheritance patterns are also recognized.<sup>[10]</sup>

Epidemiological data show otosclerosis is more common among Caucasians than other ethnicities, with clinical otosclerosis occurring in less than 1% of white

populations. It affects women twice as often as men and is bilateral in about 80% of the cases. The majority of patients experience a slow progression of conductive hearing loss accompanied by tinnitus.<sup>[11-20]</sup>

In managing otosclerosis, the choice of treatment can be between surgical options and hearing aids, with the latter being preferred if surgery is not an option or if there is concurrent sensorineural hearing loss. Surgical options include stapedotomy and stapedectomy, which involve creating an opening in or removing parts of the stapes footplate, respectively. Stapedotomy is often favoured due to fewer postoperative complications. In our study, all surgeries were conducted under general anaesthesia, with a focus on either small fenestra stapedotomy or large fenestra stapedectomy, depending on the case. Some procedures also involved sealing the fenestra with a graft and inserting a Teflon piston prosthesis. Following the surgery, patients underwent pre- and post-operative auditory evaluations through Puretone Audiometry, with a follow-up PTA conducted a month later. The statistical significance of the results was assessed using SPSS, with values less than 0.05 deemed significant.<sup>[21-22]</sup>

## METHODS

We conducted a retrospective analysis to compare the hearing outcomes of patients who underwent stapedotomy or stapedectomy at the Department of Otolaryngology, King Hussain Medical centre, over a period spanning from March 2020 to March 2022. Our study was designed to assess the effectiveness of these surgical interventions in treating conductive hearing loss while considering the pre-operative and post-operative air-bone gap (ABG) measurements.

A total of 45 patients were selected based on stringent inclusion and exclusion criteria. To qualify for the study, patients were required to be between the ages of 15 and 60 and exhibit conductive hearing loss, verified by an intact tympanic membrane and an ABG exceeding 30 dB. We meticulously excluded any individuals younger than 15 or older than 60, as well as those with an ABG of less than 30 dB. Additionally, patients with a history of Chronic Otitis Media (COM) or those who had undergone revision stapes surgery were not

considered for this analysis.

This methodological approach allowed us to compile a focused cohort from which we could derive significant insights into the comparative outcomes of the stapedotomy versus stapedectomy procedures in a demographically diverse group within the specified age range. The study's aim was to elucidate the efficacy of the two surgical techniques and contribute to the body of knowledge that informs clinical decisions in the management of otosclerosis-related hearing impairment.

## RESULT

The following table 1 provides a comparison between patients who underwent stapedectomy (N=13) and those who had stapedotomy (N=32) with various pre-surgery and surgery-related variables. The mean age of patients was 36.7 years (with a standard deviation of  $\pm 10.6$ ) for the stapedectomy group, and 35.1 years (with a standard deviation of  $\pm 10.3$ ) for the stapedotomy group. In the stapedectomy group, 39% were male (5 patients), compared to 40% male (13 patients) in the stapedotomy group. The median duration of illness for both groups was 27 months. For affected ears before surgery: Right ear 15% (2 patients) in the stapedectomy group and 16% (5 patients) in the stapedotomy group. Left ear: 8% (1 patient) in the stapedectomy group and 6% (2 patients) in the stapedotomy group. Both ears: 77% (10 patients) in the stapedectomy group and 78% (25 patients) in the stapedotomy group.

Regarding tinnitus and vertigo before surgery: Tinnitus was reported by 23% (3 patients) in the stapedectomy group and 28% (9 patients) in the stapedotomy group. Vertigo was reported by 15% (2 patients) in the stapedectomy group and 9% (3 patients) in the stapedotomy group. Both tinnitus and vertigo were reported by 8% (1 patient) in the stapedectomy group, and none in the stapedotomy group. No tinnitus or vertigo was reported by 54% (7 patients) in the stapedectomy group and 63% (20 patients) in the stapedotomy group. Side of surgery performed: Right side 60% (8 patients) in the stapedectomy group and 40% (13 patients) in the stapedotomy group, left side 40% (5 patients) in the stapedectomy group and 60% (19 patients) in the stapedotomy group.

**Table 1: Patient Characteristics.**

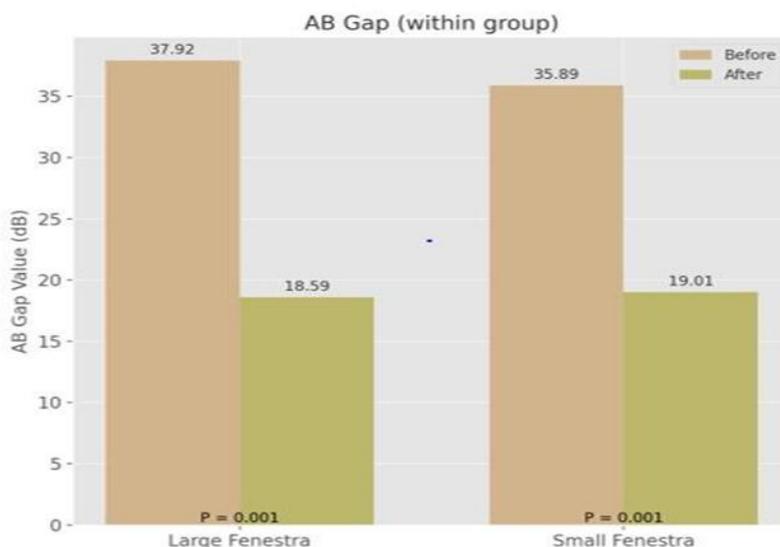
Description	Stapedectomy Group (N = 13)	Stapedotomy Group (N = 32)
Average Age (Years)	36.7 (Standard Deviation: 10.6)	35.1 (Standard Deviation: 10.3)
Gender Distribution (Male)	5 individuals (39%)	13 individuals (40%)
Illness Duration (Months)	Median duration: 27 months	Median duration: 27 months
Ear Impacted	Right: 2 (15%), Left: 1 (8%), Both: 10 (77%)	Right: 5 (16%), Left: 2 (6%), Both: 25 (78%)
Symptoms Prior to Surgery	Tinnitus: 3 (23%), Vertigo: 2 (15%), Both: 1 (8%), None: 7 (54%)	Tinnitus: 9 (28%), Vertigo: 3 (9%), Both: 0, None: 20 (63%)
Operated Side	Right: 8 (60%), Left: 5 (40%)	Right: 13 (40%), Left: 19 (60%)

Before surgical intervention, the Air-Bone Gap (ABG) for patients receiving large fenestra stapedectomy was

recorded at 37.92 with a variability of 7.4, which reduced to 18.59 with a variability of 12.88 after surgery,

indicating a significant change with a p-value of 0.001. Similarly, for those undergoing small fenestra stapedotomy, the initial ABG was 35.89 with a variability of 5.95, which diminished to 19.01 with a variability of 10.42 post-surgery, also significant with a

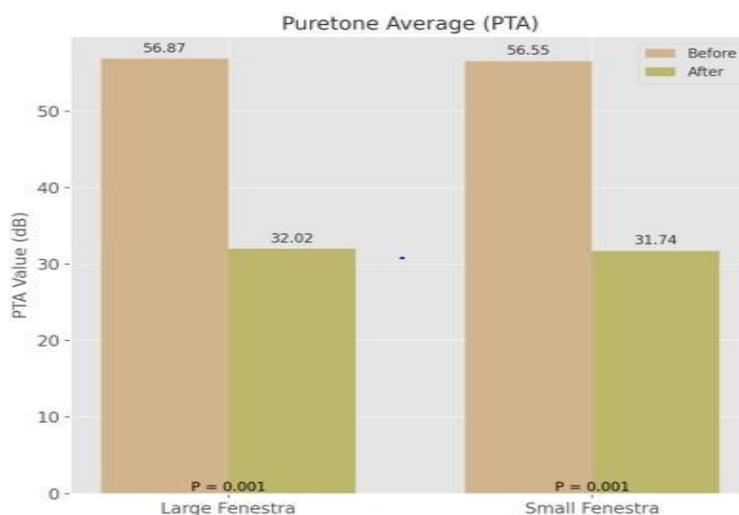
p-value of 0.001. While the reduction in ABG within each surgical category was notable, the comparative analysis of ABG reduction between the two surgical techniques did not yield a significant difference, as evidenced by a p-value of 0.749.



**Figure 1 Air Bone Gap (within group).**

In terms of the Puretone Average (PTA), there was a notable decrease from 56.87 with a variability of 11.07 to 32.02 with a variability of 15.75 for the large fenestra group after surgery, and a decrease from 56.55 with a variability of 11.98 to 31.74 with a variability of 13.01

for the small fenestra group, with both changes being statistically significant (p-value of 0.001). However, the comparison of PTA improvements between the large and small fenestra surgical groups did not demonstrate a significant difference, as indicated by a p-value of 0.929.



**Figure 2 Pure Tone Average (within group).**

Among the patients chosen for the study, complications arose in only two individuals who underwent stapedectomy, both experiencing sensorineural hearing loss as a postoperative issue. It was observed that there were no notable differences in the postoperative pure-tone average (PTA) or air-bone gap outcomes when comparing the two groups of patients, regardless of whether they had received a stapedectomy or stapedotomy.

## DISCUSSION

In our investigation, we aimed to assess the outcomes on hearing in patients with otosclerosis, comparing those who underwent small fenestra stapedotomy to those who received large fenestra stapedectomy. Postoperative assessment showed notable enhancement in both pure-tone average (PTA) and air-bone gap (ABG) across both surgical groups. Specifically, the small fenestra group demonstrated a significant improvement in ABG at the

4000 Hz frequency, although this level of improvement was not observed at other frequencies, with no discernible statistical differences between the two groups overall. Such results suggest that each surgical method comparably improved the ability to hear without external amplification.

Our findings challenge the presumption that more extensive removal of the footplate would lead to better bone conduction threshold improvement, as no difference was seen in ABG outcomes between the groups. The aim of reducing the air-bone gap to under 10 dB, in line with what most patients achieved, corresponds with the high success rates reported in broader studies—approximately 95% and differs from the lower average success rates of about 80% noted in smaller studies.<sup>[23-29]</sup> Echoing Morrison<sup>[30]</sup>, our analysis determined that both stapedotomy and partial stapedectomy led to similar gains in post-operative air conduction at all tested frequencies, utilizing a 0.6 mm Teflon piston prosthesis and, in stapedectomy cases, covering the oval windows with fascia or perichondrium. Furthermore, in agreement with Mc Kenna *et al.*<sup>[31]</sup>, we noted an improvement in post-operative bone conduction thresholds and the resolution of pre-operative Carhart's notch in many instances. Our study also reflects the gender incidence ratio of otosclerosis, with females being more affected than males at a ratio of about 2:1, as indicated by Altman *et al.*<sup>[11]</sup> The unpredictable effect of surgery on tinnitus, a symptom commonly linked to otosclerosis, was also noted.

Our research supports the original observations made by Carhart regarding the phenomenon now named after him, Carhart's notch, which was first identified after lateral semicircular canal fenestration and stapes footplate fixation. Among potential postoperative complications, sensorineural hearing loss (SNHL) is the most significant concern, occurring in less than 0.5% of cases managed by skilled surgeons, a finding consistent with the report by Vincent *et al.*<sup>[24]</sup> Importantly, our study had no instances of total hearing loss or enduring vertigo, emphasizing the infrequency and gravity of such adverse effects post stapes surgery.

## CONCLUSION

Both stapedotomy and stapedectomy have been deemed safe and effective methods for treating conductive hearing loss (CHL) in patients with otosclerosis, without any harmful effects on hearing function observed. Outcomes from both procedures are comparably positive, especially when performed by experienced surgeons, affirming their efficacy. The lack of serious complications associated with these surgeries supports the viability of operating on both ears for individuals with bilateral hearing loss. Moreover, stapes surgery successfully addresses the conductive component of hearing loss, thereby reducing, or even eliminating the immediate necessity for hearing amplification for the majority of patients.

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