



## RESEARCH ARTICLE

### HEARING RESULTS OF STAPEDOTOMY

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#### ABSTRACT

**Aim:** To evaluate hearing results after stapedotomy and comparison with preoperative hearing evaluation. **Materials and Methods:** Forty otosclerotic patients were enrolled for the study. Pure tone audiometry and impedance audiometry was done in patients. All the patients underwent stapedotomy under local anaesthesia. Postoperatively the patients were followed up monthly for three months and hearing evaluation was done and compared with preoperative evaluation. **Results:** Statistically highly significant difference was found between preoperative Air bone gap and Air bone gap at 3 months postoperatively ( $p < 0.05$ ). The Carhart notch disappeared in all the patients at 3 months postoperatively. Also the impedance audiometry showed a shift from 'As' to 'A' type of curve. Majority of the patients showed Air bone gap to within 10 db (80%). **Conclusions:** Stapedotomy is the method of choice for the surgical treatment of otosclerosis since the comparison of pre- and postoperative results revealed the significant and statistically verified reduction of Air bone gap.

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## INTRODUCTION

Otosclerosis is a disease that affects the bony labyrinth capsule, and is characterised by formation of centres of newly constructed bone, which are usually formed in the area of the oval window and annular ligament leading to stapes fixation. Otosclerosis occurs at certain sites of predilection within the temporal bone with the most common site being the area anterior to the oval window. It is usually bilateral, with involvement of both ears in 70-90 percent of cases. The definitive diagnosis of otosclerosis is always made by surgical exploration, which confirms the immobility of the stapes. Clinical symptoms of otosclerosis include progressive hearing loss and tinnitus. In rare cases, dizziness may occur as well.

The tympanic membranes in otosclerotic patients are sometimes described as being in 'mint condition'. The 'flamingo flush', or Schwartze sign, is uncommon (seen in 10% of the patients presenting with otosclerosis). It is said to be a result of vascular bone on the promontory, or blood vessels in the submucosal layer of mucus membrane of the promontory.

The audiological signature pattern in fenestral otosclerosis is conductive hearing loss with Carharts' notch at 2 kHz, excellent speech discrimination scores, low compliance on impedance audiometry (less than 0.3cc), normal middle ear pressure and absence or distortion of stapedia reflex. Carharts' notch is thought to be typical of otosclerosis. It is characterised by depression of bone conduction thresholds of approximately 5dB at 500 Hz, 10dB at 1k Hz, 15dB at 2kHz, and 5dB at 4kHz. Surgery improves bone conduction thresholds and Carharts' notch disappears following surgery. Impedance audiometry in otosclerosis shows 'As' type of curve. The conductive hearing loss due to otosclerosis is amenable to non-surgical and surgical remedies. However stapes surgery is currently the preferred treatment modality. The aim of stapes surgery is to obtain an Air bone gap within 10dB. Small fenestra stapedectomy has been the operation of choice in many centres, as this exposes the inner ear to minimum and there is minimal chance of operative inner ear hazards.

## MATERIALS AND METHODS

The present prospective study was conducted in the Department of Otorhinolaryngology and Head and Neck Surgery, SMGS Hospital, Jammu w.e.f November 2015 to October 2016. Forty otosclerotic patients were enrolled for the study.

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After thorough clinical examination including otoscopy and tuning fork tests, Pure Tone Audiometry and Impedance Audiometry was done in all the patients. After the diagnosis of clinical otosclerosis and excluding any contraindication for surgery all the patients underwent stapedotomy. Postoperatively the patients were followed up monthly at 1, 2 and 3 months and hearing evaluation was done and was compared with preoperative evaluation. Data obtained were recorded in an excel spreadsheet and were analysed using the Statistical Package for Social Sciences computer software program version 20. The patients included in the study were in the age group of 15-45 years, both males and females presenting with Progressive hearing loss (unilateral / bilateral), Vertigo, Tinnitus, On otoscopy- normal tympanic membrane and external auditory canal Tuning fork tests- Rinnie's test negative always, Weber's test-central or lateralized to deaffer ear. Pure tone audiometry- Air bone gap  $\geq 25$ dB with Carharts notch at 2kHz frequency. Impedance audiometry- showing 'As' type of curve. The patients with infected middle or external ears, perforation of the drum, only hearing ear, disease in the contralateral ear that may threaten hearing in future, Meniere's syndrome, bleeding diathesis, poor air-bone gap on Pure tone Audiometry were excluded from the study. All stapedotomies were performed under local anaesthetic blockage of ear with 2% xylocaine and 1:60,000 adrenaline. A transcanal approach with Rosen's incision was used in majority of the cases. Other approaches used were postaural and endaural. The tympanomeatal flap was elevated from the sulcus tympanicus through permealal incision and placed forwards. The chorda tympani nerve was freed from mucosal attachments and displaced anteroinferiorly to view the oval window complex. After proper exposure of the incudo-stapedial complex, the stapes superstructure was inspected and palpated to confirm the diagnosis of otosclerosis. The mobility of the ossicular chain was confirmed and the distance between the footplate of stapes and the inner surface of long process of the incus was determined. The incudostapedial joint was disarticulated, the stapedial tendon was cut and the crura of stapes fractured.

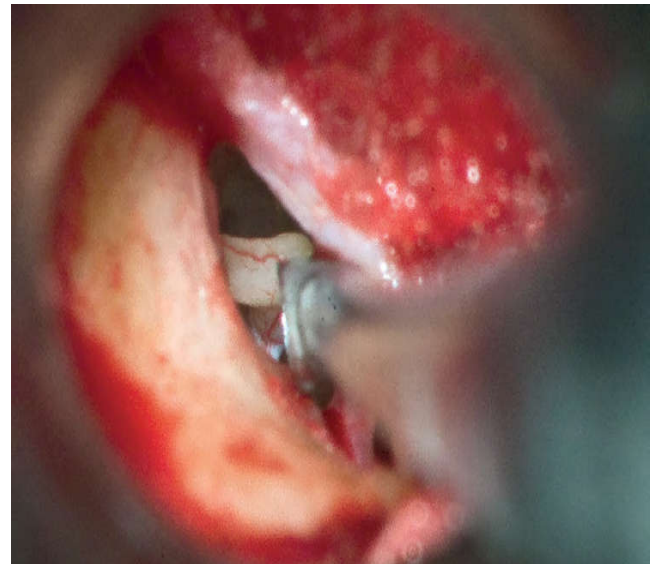
The footplate was perforated using a perforator. Titanium-teflon prosthesis with a diameter of 0.5 mm was used in all the cases and crimped to the long process of incus (Figure 1), the oval widow was left unplugged. Subsequently, after confirming the position of the prosthesis and subjective hearing improvement on the operating table, the tympanomeatal flap was replaced and secured with gelfoam and an antibiotic soaked pack. The patients were advised to attend the ENT OPD weekly for checkups and early detection of any complications. Postoperatively hearing evaluation was done in all the patients using Pure Tone Audiometry and Impedance Audiometry at 1 month, 2 months and 3 months and compared with the preoperative evaluation. Air bone gap closure was noted at 3 months. The outcome of stapedotomy was categorized at 3 months in terms of Air bone gap closure into success, partial success and failure. Success was defined as Air bone gap at 3 months postoperatively to  $\leq 10$  dB, partial success was defined as Air bone gap at 3 months postoperatively 11-20 dB and failure was defined as Air bone gap at 3 months postoperatively  $>20$  dB.

## RESULTS

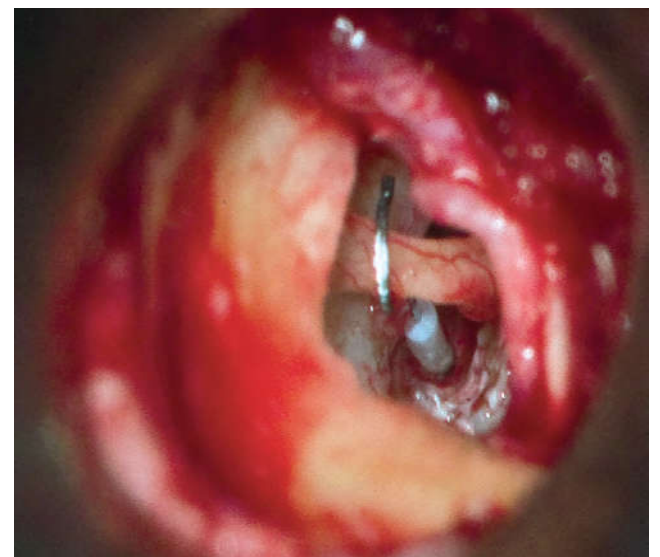
A total of forty patients were enrolled in the present study. The patients were in the age group of 16-44 years with the mean



**Figure 1. Measured right angled picks for the measurement of posterosuperior bony overhang**



**Figure 2. After measuring the posterosuperior bony overhang the bone is curetted with microcurette for proper visualisation of stapes area**



**Figure 3. Piston prosthesis placed between the lenticular process of incus and stapes footplate**

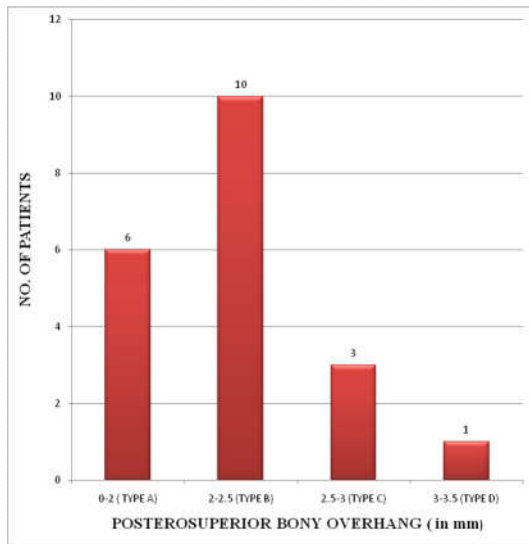


Figure 4. Posterosuperior bony overhang measurement

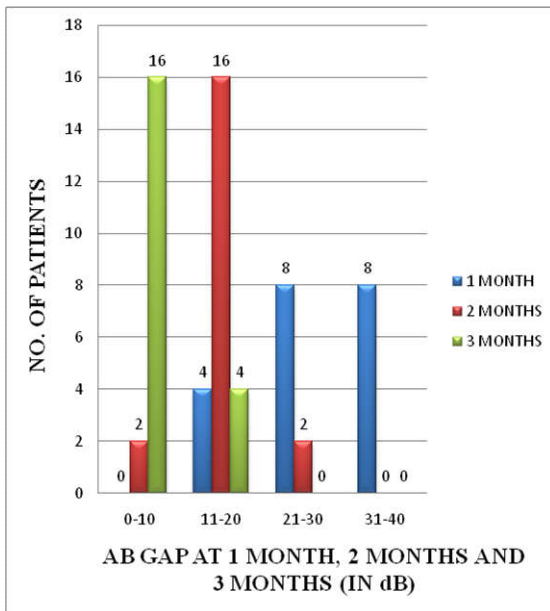


Figure 5. Comparison of Air Bone Gap at 1, 2 and 3 months postoperatively

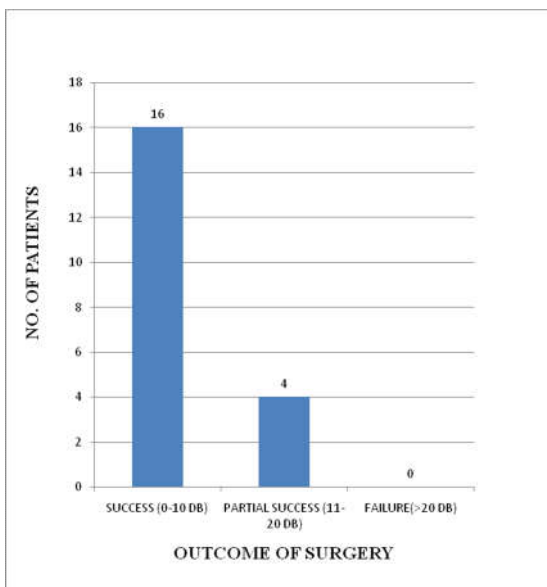


Figure 6. Outcome of Stapedotomy

age of  $28.5 \pm 8.5$  years. Maximum patients were in the age group of 20-40 years (70%). 55% patients were females and 45% were males and the F: M ratio was 1.2:1. Out of 22 females 10 (45%) were in the age group of 21-30 years whereas out of 18 males 8 (44%) were in the age group of 31-40 years. There was a history of progressive hearing loss in all the patients whereas hearing loss was associated with tinnitus in 10 (25%) patients. The mean age of onset of disease was  $25.05 \pm 7.73$  years. In females the mean age was  $22.90 \pm 7.48$  years whereas in males it was  $27.66 \pm 7.61$  years. The mean age of onset of disease was lower in females as compared to males. Based on symptoms and audiometric data, 8(20%) patients had unilateral disease whereas 32(80%) patients had bilateral disease at the time of presentation. The mean duration of symptoms was  $3.45 \pm 1.50$  years. Out of 40 patients, 32 (80%) had preoperative Air bone gap in the range of 30-50 dB. The mean preoperative Air bone gap was  $35.55 \pm 5.69$  dB. All the patients showed Carhart's notch at 2 KHz. All the patients had 'As' type of curve on Impedance Audiometry. (Figure 2 & Figure 3). All the patients were operated under local anaesthesia. The approach used was transcanal in 26 (65%) patients, postaural in 10 (25%) patients and endaural in 4 (10%) patients. The postaural approach was used when external auditory was narrow and the exposure was limited.

The mean Air bone gap at 1 month was  $28.00 \pm 6.56$  dB, 2 months was  $17.40 \pm 4.80$  dB and 3 months postoperatively was  $8.50 \pm 3.47$  dB. When mean Air bone gap preoperatively was compared to mean Air bone gap postoperatively at 1, 2 and 3 months, the difference in mean preoperative Air bone gap with postoperative Air bone gap at 1, 2 & 3 months respectively was highly statistically significant ( $p = 0.00, 0.00$  &  $0.00$ ) respectively i.e. there was significant improvement in hearing after the surgery. (Figure 4-7) At 1 month the mean postoperative Air bone gap was between 20-40 dB in 80% of patients, at 2 months the mean postoperative Air bone gap shifted to between 11-20 dB in 80% patients and at 3 months this shifted to 0-10 dB in 80% patient. When defining the success rates of surgery success was defined as Air bone gap at 3 months  $\leq 10$  dB, partial success was defined as Air bone gap 11-20 dB and failure was defined as Air bone gap  $> 20$  dB. 32(80%) out of 40 patients showed Air bone gap within 10 dB at 3 months postoperatively, 8(20%) patients showed AB gap between 11-20 dB (Figure 8). There was no case of failure i.e. all patients showed improvement in hearing at 3 months postoperatively. The Carhart's notch disappeared in all the patients at 3 months postoperatively. Impedance Audiometry done at 3 months showed conversion from 'As' to 'A' type of curve. Air bone gap closure was determined by subtracting the postoperative Air bone gap at 3 months from preoperative Air bone gap in all the patients. In 20(50%) patients Air bone gap closure i.e. the hearing gain was between 21-30 dB. The mean Air bone gap closure was  $27.05 \pm 6.93$  dB.

## DISCUSSION

The aim of all stapes surgery is to correct the conductive component of a patient's hearing impairment so as to achieve a long-lasting hearing improvement. The stapes operation certainly offers predictable improvement of hearing in the short term with a low prevalence of complications. The practical trend of reducing the area of the fenestra in the fixed stapedial footplate was induced by considerations that a small-fenestra technique was less traumatic to the inner ear, (Schuknecht and Applebaum, , Fisch) (Schuknecht, 1969;



Fisch, 1982) had a lower incidence of immediate or delayed sensorineural hearing loss (Smyth and Hassard, 1978) had fewer complications such as perilymph fistulas at the oval window or vestibular disturbance, and gave better high-frequency hearing gains that were more stable over time and had a slower rate of decline than those of total stapedectomy.

In our study the average age at the time of surgery was  $28.5 \pm 8.5$  years the range was 16-44 years, also the maximum number of patients were in the age group of 21-30 and 31-40 years (50% each) which strongly correlates with a research by Adedeji *et al.* in 2016 The age of the patients ranged from 18 to 70 years with a mean age of  $30 \pm 12.87$  years and age group 31 – 40 year were the most affected group (31.2%) whereas in the series of Roychaudhuri *et al.* (2011) the average age incidence of the patients at the time of surgery was 34.8 years, minimum being 17 years and maximum being 48 years which was higher than that reported by us. The prevalence of otosclerosis in women is well known and our results are in good agreement with data published in the past. In our study females constituted 55% of the total patients and males 45% which closely correlates with the study conducted by Babighian *et al.* (2009) in their study 44% were males and 56% were females whereas Adedeji *et al.* (2016) in their series on 53 patients showed that 30 were males and 23 were females; male: female ratio was 1.3: 1.

In our study slow progressive hearing loss was the most common presenting symptom seen in 100% of patients and only 25% patients had associated tinnitus with hearing loss which strongly correlates with the study conducted by Kolo and Ramalingam (Kolo, 2013), the commonest presenting symptoms were hearing loss (96.5%) and tinnitus (48.4%) however Nandi *et al.* (2007) in their study stated that the most common clinical presentation among patients was hearing loss (54.3%), followed by a combination of hearing loss and tinnitus (37%). The mean preoperative Air bone gap was  $35.55 \pm 5.69$  dB. The pre and post operative hearing evaluation revealed marked improvement in the patients' hearing status as greater number had closure of their air-bone gap across all the frequencies tested (0.5, 1, 2 and 4 kHz). The mean Air bone gap at 1 month was  $28.00 \pm 6.56$  dB, at 2 months was  $17.40 \pm 4.80$  dB and was  $8.5 \pm 3.74$  dB at 3 months. The preoperative Air bone gap when compared to postoperative Air bone gap at 1, 2 and 3 months was found to be highly statistically significant ( $p < 0.05$ ). The mean Air bone gap closure obtained at 3 months in the patients was  $27.05 \pm 6.93$  dB. The aim of stapes surgery is to bring the Air bone gap to within 10 dB. In our study 80% patients showed Air bone gap within 10 dB postoperatively which was statistically significant. Only 20% patients showed Air bone gap between 11-20 dB.

The findings in our study are in accordance with the study conducted by Adedeji *et al.* (2016) in their study of 54 patients the mean preoperative Air bone gap was  $35.86 \pm 9.33$  dB and the mean postoperative Air bone gap was  $12.48 \pm 11.65$  dB. The mean Air bone gap closure in their study was  $23.38 \pm 12.37$  dB. The hearing gain postoperatively in their study was seen in 94.4%. Our outcome is similar to the findings of Vincent *et al.* (9) who reported Air bone gap closure of  $< 10$  dB in 63.4% and  $< 20$  dB in 74.6% of their patients, Bast *et al.* (2011) in 2011 reported Air bone gap closure ( $< 10$  dB) in 78% of their cases whereas Babighian *et al.* (2009) reported Air bone gap  $< 10$  dB in 54% of their series. In our study all the patients showed As type of curve on impedance audiometry preoperatively and the curve changed from As to A type at 3 months postoperatively showing an improvement in hearing in the patients operated by

stapedotomy which strongly supported by study conducted by Mazumdar *et al.* (1988) to evaluate the pre-operative and postoperative impedance audiometry after stapedectomy and stated that many of the patients had change in Tympanogram from 'As' to 'A' types which was again seen more often in patients with thick focus. Another research in support of our study is the one by Haldar and Roy Chaudhari (1990) who studied the role of tympanometry in otosclerosis before and after stapedectomy and stated that after a successful stapedectomy operation the compliance became normal in all the cases (0.4 to 0.9 c.c).

## Conclusions

Stapedotomy is the method of choice for the surgical treatment of otosclerosis since the comparison of pre- and postoperative results revealed the significant and statistically verified reduction of Air bone gap.

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