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COMPARISON OF LARGE FENESTRA STAPEDOTOMY VS TINY FENESTRA STAPEDOTOMY FOR IMPROVING HEARING LOSS CAUSED BY OSTEOSCLEROSIS

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ABSTRACT

Background: Osteosclerosis is a condition that affects the otic capsule and middle ear ossicles, causing the production of new thick sclerotic bone and gradual hearing loss. It is treated by stapedotomy and a small/large fenestra. There is a scarcity of information comparing big and small fenestra stapedotomy.

Aim: The current study compared big fenestra stapedotomy to tiny fenestra stapedotomy for improving osteosclerosis-related hearing loss.

Methods: The study comprised 108 participants aged 18 to 15 years with conductive hearing loss, an air-bone gap of more than 30 dB, and an undamaged tympanic membrane. Osteosclerosis was diagnosed based on preoperative and 6-month audiometric evaluations, as well as a clinical history of progressive hearing loss. Also established the presence of a conductive hearing loss pattern on the pure tone average.

Results: The study found that the average age of individuals who underwent stapes surgery was 31.4±6.2 years. Among the 108 patients evaluated, 44.4% (n=48) and 55.56% (n=60) were male and female participants. Large fenestra stapedectomy and small fenestra stapedectomy were performed on 55.56% (n=60) and 44.44% (n=48) of the participants, respectively. Following surgery, both groups saw considerable improvements in hearing metrics such as air-bone gap and pure tone average. There was no significant difference between the small and big fenestra groups in terms of air-bone gap and pure tone average.
Conclusion: The current study suggests that both big and small fenestra stapedectomy operations are effective and safe for improving hearing loss in osteosclerosis patients.

Keywords: air-bone gap, hearing loss, osteosclerosis, PTA, fenestra, stapedectomy

INTRODUCTION

Osteosclerosis is a condition that affects the otic capsule and middle ear ossicles, causing the production of new thick sclerotic bone that leads to gradual hearing loss. The pathogenesis of osteosclerosis is not well known. However, other explanations have been proposed to explain the condition, including hormonal, viral, genetic, and other variables. Otosclerosis is usually inherited autosomally. However, alternative types of inheritance are also possible.1

Osteosclerosis can be found bilaterally in about 80% of cases. It primarily affects female patients in their second and third decades. Subjects often have progressively increasing conductive hearing loss. Stapes' footplate is the most typical genesis place. When the condition affects the otic capsule, SNHL (sensorineural hearing loss) might occur. Other osteosclerosis symptoms include dizziness and tinnitus.2

The diagnosis of osteosclerosis is based on a clinical history of audiometric examination and increasing hearing loss. Pure tone audiometry reveals a typical pattern of conductive hearing loss. Bone conduction exhibits a drop, particularly at 2kHz, which is a hallmark of osteosclerosis and known as Carhart's notch. This can be linked to the removal of elements that contribute to hearing sounds through bone conduction. Tympanoplasty produces a type As curve, which demonstrates the lack of the stapedial reflex and the stiffening of the ossicular chain. Surgery should be performed in Rinne negative (showing bone conduction rather than air conduction) with a 512 Hz tuning fork on people with a minimum of 15-20 dB conductive hearing loss.3

There are several management options for osteosclerosis, including surgical management, hearing aid usage, hormonal use with estrogen blockers, medicinal use using sodium fluoride, and wait-and-see therapy. Hearing aids are recommended for patients who do not want to undergo surgery or who have sensorineural hearing loss. The most common surgical options are stapedotomy or stapedectomy with small and large fenestras, respectively. Both surgical procedures are effective in controlling osteosclerosis. In large series of stapes surgeries, the success rate for achieving a postoperative ABG (air-bone gap) of <10 dB is close to 95%.4

After stapes surgery, a variety of problems may arise. However, the most serious consequence is SNHL (sensorineural hearing loss), which occurs in <0.5% of people who have surgery in a larger series and by competent surgeons.The current study aims to compare big fenestra stapedotomy to tiny fenestra stapedotomy for the treatment of osteosclerosis-related hearing loss.

MATERIALS AND METHODS

The current retrospective clinical investigation aims to compare big fenestra stapedotomy to small fenestra stapedotomy for the treatment of osteosclerosis-related hearing loss. The research subjects were members of the Institute's Department of ENT. All individuals provided verbal and written informed permission before participating in the study.

The research evaluated all participants with osteosclerosis who received stapes surgery during the study period. The study included 108 individuals of both genders. For study participants, information was gathered from hospital records and data, including sociodemographic information, illness, duration, afflicted ear side, presence of vertigo or tinnitus, operation side, and preoperative and postoperative pure tone audiograms for hearing outcomes.

The study's inclusion criteria were participants with little follow-up data for 6 months after surgery, subjects with ABG more than 30 dB, conductive hearing loss with intact tympanic membrane, and subjects aged 18 to 55 years. The research excluded patients having a history of past stapes surgery, those under the age of 18 or above the age of 55, and those suffering from chronic otitis media.

Osteosclerosis was diagnosed using the stapedius reflex test, impedance audiometry with tympanogram, tuning fork test, otoscopy results, and history. All participants were evaluated critically and tested for pure tone audiometry both before and after surgery. ACT (air conduction thresholds) were measured from 250 to 8000 Hz, and BCT (bone conduction thresholds) from 250 to 4000 Hz. ABG was determined using ACT and BCT at frequencies of 500 Hz, 1kHz, and 2kHz. Postoperative ABG was calculated by subtracting postoperative BCT from postoperative ACT.

An audiogram recorded before surgery and another taken 6 months later were used to calculate hearing findings. All audiologic investigations were performed in a conventional, soundproof environment using a calibrated clinical audiometer. All procedures were performed using 2% lignocaine and a 1:200,000 adrenaline solution as local anesthetic. The tymaonomeatal flap was raised using a transcanal technique. The posterosuperior wall was curetted to reveal the facial canal's tympanic segment, stapes footplate, and stapedius tendon. The Stapes suprastructure was removed when the incudostapedial joint dislocated, the posterior and anterior crura fractured, and the stapedius tendon was severed.

The rear section of the footplate included either a big or a tiny fenestra. The location of the fenestra was consistent in all participants since the danger of perilymph gusher appeared when the fenestra was constructed anteriorly. The study subjects employed a piston prosthesis, and its length was measured from the stapes footplate to the base of the long process of incus.

After determining the length, the piston was inserted in the oval window, and the hook was crimped using the long incus technique. The piston size for stapes ranged between 0.4mm and 0.6mm. All individuals underwent tissue sealing in the fenestra with fat or temporalis fascia graft from the ear lobule.

After checking the prosthesis's location and movement, the flap was restored to its proper position and fixed with gel foam. Subjects were released two days after their surgery. The identical surgical method was performed in all cases, with the exception that the dimensions of the excised footplate were variable.

RESULTS

The current retrospective clinical investigation aims to compare big fenestra stapedotomy to small fenestra stapedotomy for the treatment of osteosclerosis-related hearing loss. The study comprised 108 participants aged 18 to 15 years old who had conductive hearing loss, an air-bone gap of more than 30 decibels, and an undamaged tympanic membrane.

The bulk of the research respondents (44.4%, n=48) were between the ages of 26 and 35, followed by 24.1% (n=26) between the ages of 36 and 45, 20.4% (n=22) between the ages of 15 and 25, and 11.1% (n=12) between 46 and 55. The current study included 44.4% (n=48) men and 55.6% (n=60) women. The most prevalent impacted location in research individuals was bilateral, accounting for 75.39% (n=82), followed by right ear involvement in 14.81% (n=16) and left ear in 9.26% (n=10) (Table 1).

In bilaterally afflicted ears, 80% (n=48) were treated with a big fenestra, whereas 70.83% (n=34) were treated with a stapedotomy and a tiny fenestra. Among the left-side afflicted ears, 6.67% (n=4) were treated with big fenestra (stapedectomy), whereas 12.50% (n=6) and 12.50% (n=6) were treated with small fenestra stapedotomy respectively. In ears afflicted on the right side, 13.33% (n=8) were treated with big fenestra stapedectomy, and 16.67% (n=8) with small fenestra stapedotomy (Table 2).

The big fenestra (stapedectomy) group had a preoperative ABG of 36.82±4.54 dB, which dramatically lowered to 17.76±10.34 dB with p=0.001. The small fenestra stapedotomy group saw a statistically significant drop from 34.45±3.67 to 16.49±7.61 dB (p=0.001). However, the intergroup difference was statistically insignificant, with p=0.747 (Table 3).

The study found a substantial drop in preoperative pure tone average in the big fenestra (stapedectomy) group from 56.17±9.35 to 30.55±14.45 (p=0.001). The PTA decreased significantly from 55.26±10.07 preoperatively to 30.32±10.85 postoperatively (p=0.001). However, the intergroup difference in PTA change was statistically insignificant, with p=0.927 (Table 4).

DISCUSSION

The current investigation comprised 108 patients aged 18 to 15 years with conductive hearing loss, an air-bone gap of more than 30 decibels, and an undamaged tympanic membrane.

The bulk of the research respondents (44.4%, n=48) were between the ages of 26 and 35, followed by 24.1% (n=26) between the ages of 36 and 45, 20.4% (n=22) between the ages of 15 and 25, and 11.1% (n=12) between 46 and 55. The current study included 44.4% (n=48) men and 55.6% (n=60) women. The most prevalent impacted location in research individuals was bilateral, accounting for 75.39% (n=82), followed by right ear involvement in 14.81% (n=16) and left ear in 9.26% (n=10). These reports were comparable to those of Balu R et al6 in 2019 and Lippy WH et al7 in 2003, in which authors evaluated people with demographics and illness data similar to the current study with osteosclerosis.

According to the study's findings, in bilaterally afflicted ears, 80% (n=48) were treated with a big fenestra, whereas 70.83% (n=34) were treated with a stapedotomy and a tiny fenestra. Among the left-side afflicted ears, 6.67% (n=4) were treated with big fenestra (stapedectomy), whereas 12.50% (n=6) and 12.50% (n=6) were treated with small fenestra stapedotomy respectively. In ears afflicted on the right side, 13.33% (n=8) were treated with big fenestra stapedectomy, and 16.67% (n=8) with small fenestra stapedotomy. These findings were consistent with those of Vincent R et al8 in 2006 and Sobrinho PG et al9 in 2004, who obtained results comparable to the current study when comparing the operated side.

The big fenestra (stapedectomy) group had a preoperative air-bone gap of 36.82±4.54 dB, which decreased dramatically to 17.76±10.34 dB (p=0.001). The small fenestra stapedotomy group saw a statistically significant drop from 34.45±3.67 to 16.49±7.61 dB (p=0.001). However, the intergroup difference was not statistically significant (p = 0.747). These findings were consistent with the findings of Gristwood RE et al10 in 2003 and Al-Husban H11 in 2013, who found equivalent air-bone gap results to the current investigation.

The big fenestra (stapedectomy) group had a preoperative pure tone average of 56.17±9.35, which fell dramatically to 30.55±14.45 after surgery, with p=0.001 indicating statistical significance. The PTA decreased significantly from 55.26±10.07 preoperatively to 30.32±10.85 postoperatively (p=0.001). However, the intergroup difference for PTA change was statistically insignificant (p=0.927). These findings were consistent with the findings of McElveen JT et al12 in 2018 and Pauli N et al13 in 2020, who obtained results comparable to the current study in their separate investigations.

CONCLUSIONS

Within its limitations, the present study concludes that both large fenestra stapedectomy and small fenestra stapedectomy are effective and safe procedures concerning improvement in hearing loss in subjects with osteosclerosis. In the future, further longitudinal studies on larger sample sizes and longer assessments can help in better exploration of the topic.

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S. No	Demographics	Number (n=108)	Percentage (%)
1.	**Age range (years)**		
a)	15-25	22	20.4
b)	26-35	48	44.4
c)	36-45	26	24.1
d)	46-55	12	11.1
e)	Total	108	100
2.	**Gender**		
a)	Males	48	44.4
b)	Females	60	55.6
3.	**Affected ear side**		
a)	Bilateral	82	75.93
b)	Left	10	9.26
c)	Right	16	14.81

Table 1: Demographic and disease data in study subjects

S. No	Variables	Large fenestra (stapedectomy)		Small fenestra (stapedotomy)	
		n=60	%	n=48	%
1.	**Surgery side**				
a)	Bilateral	48	80	34	70.83
b)	Left	4	6.67	6	12.50
c)	Right	8	13.33	8	16.67

Table 2: Comparison of the operated side in the two groups of study subjects

S. No	ABG	Large fenestra (stapedectomy)	Small fenestra (stapedotomy)
1.	**Preoperative ABG**	36.82±4.54	34.45±3.67
2.	**Postoperative ABG**	17.76±10.34	16.49±7.61
3.	**p-value**	**0.001**	**0.001**
4.	**p-value**	0.747	

Table 3: Comparison of air-bone gap in the groups of study subjects

S. No	PTA	Large fenestra (stapedectomy)	Small fenestra (stapedotomy)
1.	**Preoperative PTA**	56.17±9.35	55.26±10.07
2.	**Postoperative PTA**	30.55±14.45	30.32±10.85
3.	**p-value**	**0.001**	**0.001**
4.	**p-value**	0.927	

Table 4: PTA in study subjects