DOES PROSTHESIS DIAMETER MAKE A DIFFERENCE IN THE HEARING OUTCOME AFTER STAPEDOTOMY?

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ABSTRACT

Objective:

The objective of the study was to assess and compare the hearing improvement after stapedotomy using stapes piston of different diameters.

Materials and Methods:

The study was conducted in the department of ENT and Head & Neck Surgery, Tribhuvan University Teaching Hospital from January 2014 to December 2018. This five-year study was a retrospective chart review of the patients above 15 years of age who had undergone stapedotomy in the department. The patients had undergone stapedotomy surgery under local anaesthesia using either 0.4 mm or 0.5 mm diameter piston. Postoperatively, hearing was assessed using air conduction threshold improvement and air-bone gap improvement. The patients' hearing evaluation was done after six weeks of surgery and postoperative hearing was compared in patients using to the 0.4 mm, 0.5 mm or 0.6mm stapes piston.

Results:

There were 56 patients assessed in the study with a slight female preponderance. The commonest age group who underwent stapedotomy was in the range of 15-30 years of age. The majority of the patients had a piston size diameter of 0.4mm followed by 0.5mm then 0.6mm. On comparing the hearing status of the patients postoperatively, both the air conduction threshold and air-bone gap showed significant hearing improvement postoperatively more on the lower frequencies.

Conclusion:

The postoperative air conduction threshold and air-bone gap improvement were seen after stapedotomy. The difference in the postoperative status was more on the lower frequencies and on using the greater diameter piston size.

Keywords: Air-bone gap, Air conduction threshold, Otosclerosis, Piston, Stapedotomy.

INTRODUCTION

Otosclerosis is the hereditary disease of the otic capsule characterized by an area of bone resorption, and new bone formation in the enchondral bone.[1-2] It is divided into stapedial, cochlear or histological type. The location of the otosclerotic foci is responsible for the symptoms in the patients. The commonest site of foci is the 'fissula ante fenestrum'; site that is just anterior to the oval window and the involvement of the disease in this area leads to the conductive hearing loss due to the fixation of the stapes superstructure.[3]

The clinical manifestation of the otosclerosis is seen in 0.3%- 0.4% of the world's population[4] and commonly Caucasians are mostly affected.[5,6] The exact prevalence of the disease in our country is not yet mentioned in the literature but it is seen more commonly in the certain regions in the southern Terai belt of Nepal.

The disease usually causes conductive hearing loss and sometimes depending on the site of the disease involvement can cause mixed or sensorineural hearing loss as well. Otosclerosis is more common in females and bilateral involvement is seen in 70-85% of the patients.[7] Hereditary involvement is seen in 60% of the patients.[8]

The management of conductive hearing loss in these patients of otosclerosis can be done by either hearing aid or surgical approach. Surgery is the preferred treatment modality so far in otosclerotic patients with conductive hearing loss.

The surgical techniques have undergone many modifications over time and it has evolved from stapedectomy to stapedotomy. Literatures have mentioned the importance of small hole in the footplate via small fenestrae technique reducing the risk of inner ear damage highlighting the advantage of stapedotomy over stapedectomy.[9,10] The available choices of the piston are also many with various materials being used. Many variations in the piston shape, size and material have been made over time. There are studies mentioning the different diameter of the prosthesis during stapedotomy but studies haven't come to one unanimous opinion about the outcome of stapedotomy on using smaller or larger width of the piston.[11,12]

This study done in a tertiary care centre aims to assess the effect of the prosthesis diameter in the short-term hearing improvement in stapedotomy.

MATERIALS AND METHODS

Retrospective chart review of the patients who had undergone stapedotomy in the department of ENT and Head & Neck Surgery, Tribhuvan University Teaching Hospital was done from January 2014 to December 2018. All the patients above 15 years of age, stapedial otosclerosis with the air-bone gap of at least 30dB were included in the study. Revision cases and patients with mixed or sensorineural hearing loss were excluded from the study. The patients' record were retrieved from the record section of the department and both pre and postoperative audiograms and the details of the surgery were noted. Lost to follow up patients with incomplete data were excluded from the study.

Pre-operative pure tone audiometry (PTA) done within one month before surgery and post-operative PTA after 6-8 weeks of surgery were recorded. The audiogram was done in a sound treated room by trained and experienced audiologists. Air conduction included 250, 500, 1000, 2000, 3000, 4000 and 8000 Hz frequencies and bone conduction frequencies included 250, 500, 1000, 2000, 3000 and 4000 Hz. Average was calculated from 500, 1000, 2000, 3000 and 4000 Hz frequencies.

All the patients had undergone surgery in local anaesthesia by experienced consultant ENT surgeons. Apart from the demographic data, the surgical issues, special note was made regarding the piston diameter. Teflon piston was used in all the cases. The footplate was perforated using a Skeeter drill with a microburr or perforator. Teflon prosthesis with a diameter of 0.4, 0.5 or 0.6 mm x 3.75-4.5 mm were used according to the measurement done and crimped to the long process of the incus. In all the cases fat sealant was used around the piston base. Subjective on-table hearing was assessed in all the patients.

The patients were followed up after 6-8 weeks for hearing evaluation. The hearing assessment was done to assess improvement in postoperative air conduction threshold (AC threshold) postoperatively and the air-bone gap (AB gap). The air-bone gap was calculated as the difference between the pre-operative bone conduction and the post-operative air conduction thresholds. This pre and postoperative audiometry test results were compared according to the criteria published by the Committee on Hearing and Equilibrium if the American Academy of Otolaryngology-Head and Neck Surgery Foundation.[7]

All the data was entered and analysed using SPSS 22. The student t-test was used to compare the differences in means in the different groups. $P < 0.05$ was considered statistically significant.

RESULTS

In five-year duration, a total of 56 patients fulfilling all the inclusion criteria was analysed in this study. Among them 27 (48.2%) were males and 29 (51.8%) were females with the male to female ratio of 0.9:1 as shown in figure I.

The age range of the patients operated was from 21 years to 52 years and the distribution was shown in figure I. The majority of the patients were in the age group of 15-30 years of age forming 66% of the total patients followed by 28.6% in the age range of 31-45 years of age and 5.4% in the age range from 41-60 years of age.

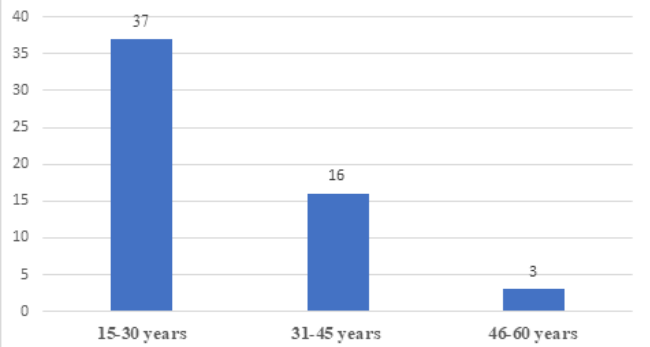

Figure I: Age distribution (n=56)

Among the total patients, forty-nine patients (87.2%) had bilateral otosclerosis. If not symmetrical then the ear with the larger air-bone gap was operated first. Total of forty-seven (84%) of them had operation of the right ear. Forty of them (71.2%) had Teflon piston of the size of 4.25mm piston length used as the prosthesis. Regarding the piston diameter size used, 0.4mm, 0.5mm and 0.6mm were used as shown in figure II. Majority of the patients had 0.4mm piston used followed by 0.5mm then rarely 0.6mm were used.

Postoperatively, one patient developed delayed high-frequency sensorineural hearing loss after 4 weeks and three other patients developed decrease loss of taste sensation in the side of the operation done.

Regarding the hearing status, it was assessed after a minimum of 6 weeks by repeating the pure tone audiogram. All the patients had short term hearing improvement on assessment. The average postoperative air conduction threshold improvement and air-bone gap improvement was assessed for hearing assessment in different diameter piston like 0.4mm, 0.5mm and 0.6mm pistons in 500, 1000, 2000 and 4000 Hz frequency as shown in table 1 and 2 for comparison.

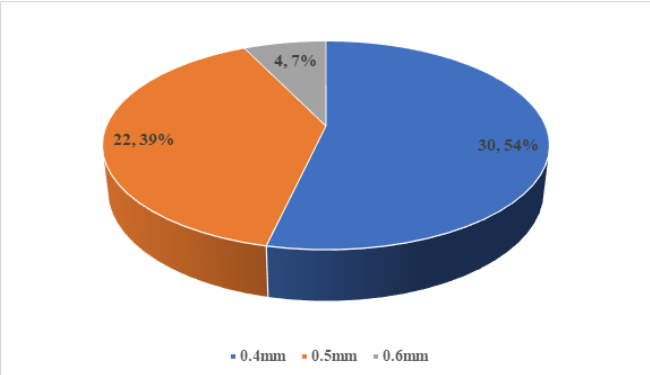

Figure II: Piston diameter used in stapedotomy

DISCUSSION

Stapes surgery has evolved over time towards small fenestra techniques. It has shifted from its initial phase of stapedectomy to more of stapedotomy nowadays in order to reduce the inner ear damage. Literatures have also mentioned the better hearing results after stapedotomy especially in the higher frequency ranges of hearing.[13,14]

This is a retrospective study evaluating the difference in postoperative hearing according to the difference in the piston diameter of 0.4mm, 0.5mm and 0.6mm over a period of five years. There is slight female predominance and the commonest age group between 15 to 30 years of age group which was comparable to a prospective study done by Gupta et al[13]. In our study hearing evaluation was done by the improvement in the air conduction threshold and air-bone gap postoperatively. Gupta et al[15] in their study have used air-bone gap closure and overclosure of air-bone gap as well in their hearing evaluation assessment.

Like in our study, various studies have evaluated the postoperative hearing status by using air conduction threshold and air-bone gap improvement. As in our study majority of the literatures have assessed hearing in the four

Table 1. Pre and postoperative air conduction threshold in different diameter piston (n=56)

Frequency	0.4mm piston		0.5mm piston		0.6mm piston		P value
	preop	postop	preop	postop	preop	postop	
500 Hz	52.38±11.45	28.56±10.49	51.90±10.36	27.87±11.58	51.65±12.45	25.94±11.45	0.000
1000 Hz	52.45±11.87	28.92±10.34	50.85±11.56	25.48±12.34	48.45±10.56	22.44±11.42	0.000
2000 Hz	44.39±10.76	25.56±10.87	42.86±11.71	24.92±10.58	43.96±10.97	21.89±10.39	0.000
4000 Hz	45.77±12.32	25.58±10.45	44.92±12.66	24.89±12.94	44.57±11.56	25.95±11.44	0.000

Table 2. Pre and postoperative air-bone gap in different diameter piston (n=56)

Frequency	0.4mm piston		0.5mm piston		0.6mm piston		P-value
	preop	postop	preop	postop	preop	postop	
500 Hz	42.46±10.34	18.56±10.56	44.38±11.69	20.87±12.45	42.56±10.78	18.67±12.67	0.000
1000 Hz	35.78±12.34	20.67±12.34	36.45±12.29	21.48±11.36	35.45±12.56	20.56±10.56	0.000
2000 Hz	24.46±10.65	12.56±10.42	22.56±10.56	12.02±12.67	24.46±11.57	11.67±10.42	0.000
4000 Hz	25.56±12.45	14.34±11.56	22.42±11.48	11.49±12.34	24.56±10.44	10.85±12.45	0.000

frequencies as in 500, 1000, 2000 and 4000 Hertz.

Gupta et al[15] in their study of 52 patients, showed satisfactory hearing improvement with good air-bone gap closure of speech frequencies at both of their piston size of 0.4mm and 0.6mm. The unique report made by their study was the better overclosure at speech frequencies using a smaller piston. Contrary to this, Marchese et al[13] in their large series of 212 stapedotomies showed better hearing results on using wider diameter piston at lower frequencies which were similar finding in our study too. Sennaroğlu et al[9] in their study of 100 patients with the use of Teflon piston of 0.6mm and 0.8mm diameter showed significant better air conduction hearing improvement at 500, 1000 and 2000 Hz in 0.8mm piston diameter than 0.6mm piston.

Laske et al[16] on their meta-analysis of using 0.6mm or 0.4mm piston on the effect of postoperative hearing showed that the postoperative bone conduction results did not differ much indicating no significant inner ear damage on using larger diameter piston. Similarly, no larger Carhart's effect was seen on using larger diameter piston. This meta-analysis showed that 0.6mm diameter piston prosthesis was associated with significantly better hearing results than 0.4mm prosthesis. The average postoperative AC threshold was 29dB versus 35dB in 0.6mm and 0.4mm piston and the difference was found to be statistically significant. In the postoperative AB gap, the results were 7dB versus 11dB which too was statistically significant. The postoperative AB gap showed statistically significant benefit for the 0.6mm piston at low and mid frequencies (upto 2000 Hz) but no difference at the high frequencies (4000 Hz). In this study, it was also observed that there was no difference in postoperative change of BC threshold in the 0.6mm and 0.4mm piston groups.

In the study done by Gristwood et al[17] in their large series of stapedotomy in 911 patients also studied the difference in the air conduction threshold using 0.6mm and 0.8mm diameter sized piston over a long period of ten years. The study concluded that the piston diameter had little effect on the outcome except at 6 and 8 kHz where the slimmer (0.6mm) piston had the advantage. Cavaliere et al[18] in their study of 98 stapedotomies studied the difference in the hearing gain on using 0.4mm and 0.6mm sized piston. They concluded that the piston diameter did not affect the functional results of surgery. They had opined that 0.4mm diameter mostly gave good results.

Similarly, Huttenbrink et al[19] concluded in their study the preference of 0.4mm piston on stating that there is a greater improvement of the bone conduction threshold and also has the added advantage of lower incidence of SNHL in the patients.

The lesser number of sample size, retrospective studies and multiple surgeons are the drawbacks of our studies as compared to other literatures. Similarly, long term hearing assessment would give us a better evaluation of hearing.

CONCLUSION

From the present study, we can conclude that that larger diameter pistons give better results, especially in lower frequencies. But since the study has less sample size better conclusion would be made with the larger sample-sized, prospective study with relatively equal distribution of the patients in different diameter pistons.

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