

Original Article

Hearing Status after Stapedotomy in Otosclerotic Patients

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Abstract:

Otosclerosis is the most frequent cause of conductive hearing loss in patients with intact tympanic membrane. It can be treated by surgery with various techniques. Because of limited manipulation and comparably similar results, stapedotomy at present is preferred over other surgical techniques by most surgeons. Here we present the operative results of 35 otosclerotic patients who underwent stapedotomy between January 2009 - October 2010 in the department of Otolaryngology- Head & Neck Surgery of Bangabandhu Sheikh Mujib Medical University, Dhaka Medical College Hospital and Shahid Suhrawardhy medical college & hospital, Dhaka. The aim of this study was to evaluate the hearing results following stapedotomy in otosclerosis surgery. The average air-bone gap of patients improved significantly to 21.74 dB after operation. Other hearing parameters of patients (including air conduction, bone conduction, speech discrimination score, and tinnitus) also improved. No patient experienced persistent vertigo after the operation and pre operative tinnitus resolved in 12 out of 22 patients. Stapedotomy is a safe and effective modality for improving conductive hearing loss in otosclerotic patients.

Introduction:

Otosclerosis is the most common etiology of conductive hearing loss with an intact tympanic membrane in 15-50 years old patients.¹ This is a disorder of bone which is absolutely confined to otic capsule of the

temporal bone.² It causes conductive or mixed hearing loss as well as sensorineural hearing loss.

Surgical correction of conductive hearing loss in otosclerosis is one of the most successful procedures in otology. Surgical management requires replacement of all or part of the fixed stapes with or without footplate. Since Shea introduced the procedure of stapedectomy in 1958, much different prosthesis has become available³. At present the Teflon piston is the most widely used prosthesis for reconstruction of the ossicular chain in cases of otosclerosis. The initial surgical technique of removal of the complete stapes footplate (stapedectomy) has been altered in the so called small fenestra method.⁴ This trend reflects the thoughts that the limited opening of the vestibule carries a reduced risk of damage

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to the inner ear.⁵ Some surgeons have reported better closure of the air bone gap at higher frequencies and better post operative speech discrimination scores (SDS) with small fenestra technique (stapedotomy) compared with stapedectomy.⁶

There are several factors which influence the surgical outcome after stapedotomy. Literature advocates good outcome with few complications in hands of expert otologists. Stapedotomy has been suggested over stapedectomy to protect the damage to the inner ear and also to improve the long term hearing.

Regardless of the technique, it is anticipated that hearing level in otosclerotic patients should improve after surgery in approximately 90% of the cases. Less than 1% of the cases should have severe sensorineural hearing impairment following surgery.⁷

Historically closure of the air bone gap (ABG) is considered to be the main measure of success for stapes surgery. ABG closure was calculated by comparing post operative pure tone audiometry thresholds for air conduction with pre operative bone conduction thresholds at 3 frequencies (0.5, 1 & 2 KHz). Early reports on large series of stapedotomies demonstrated excellent results, with ABG closure of 10 dB or more in greater than 90% of the patients.^{8,9} A review of recent studies that included higher frequencies for ABG calculation demonstrated that ABG closure to within 10 dB was achieved in 62 to 94 per cent of patients in recent comparable studies (See Table).

In Bangladesh, the incidence of otosclerosis is underdiagnosed as all the cases do not manifest clinically. The patient is relatively unaware of his/ her deafness until it reaches handicap level. Progressive otosclerosis

does not associate with earache or discharge, which is a major symptom of ear disease that drives the patient to his physician. Moreover female population is affected twice who is shy to reveal their shortness of hearing and seek attention of her family regarding proper treatment. This study was performed with an intend to see the hearing result of stapedotomy in respect of age, sex and preoperative hearing of the patients.¹⁰

Conductive hearing loss arising from otosclerosis is a burden to the individual and also to the family and entire society. Surgical attempt to correct the immobile footplate of stapes is relatively new in our country; few otologic surgeons are doing this operation. Among the learners this operation has gained much popularity considering patient's hearing improvement, often observed per operatively.

There are very few studies regarding outcome of stapes surgery in our country. The aim of the present study was to evaluate the effectiveness of this surgery in management of conductive hearing loss due to otosclerosis in Bangladesh. Results were reviewed regarding hearing improvement and incidence of complications on the background of scientific research methodology. It may guide the future researchers working in this field.

Objectives:

1. To find out the improvement of hearing following stapedotomy in otosclerosis patients.
2. To find out hearing gain in relation to preoperative air-bone gap.

Methods:

Type of study : Cross sectional study
Period of study: January 2009-October 2010

Place of study: Patients were collected from Department of ENT & Head Neck Surgery of Bangabandhu Sheikh Mujib Medical University, Dhaka Medical College Hospital and Shahid Suhrawardhy medical college & hospital, Dhaka.

Study population: All patients of otosclerosis managed by stapedotomy.

Sample size: 35

Inclusion criteria:

1. Patient with clinical otosclerosis having conductive or mixed type of hearing loss (>30 dB)
2. Good air bone gap >25dB.

Exclusion criteria:

- 1) Patients with cochlear otosclerosis where sensorineural component was involved (AB gap < 15dB).
- 2) Conductive hearing loss > 70dB
- 3) Conductive hearing loss with intact TM due to OME- diagnosed by impedance & PTA, ossicular fixation/ disruption- by impedance audiometry.
- 4) Otosclerosis patients with diabetes mellitus & hypertension
- 5) Otosclerosis involving only hearing ear
- 6) Tympanosclerotic change in middle ear

Data collection

1. Data was collected from patients admitted in the hospitals in a constructed data collection sheet through personal meeting and formatted questionnaire.
2. Preoperative PTA and SRT were recorded to confirm the diagnosis of clinical otosclerosis.
3. Post operative PTA to see hearing results.

Method of sampling

All consecutive cases of stapes surgery were evaluated properly by detailed history taking, clinical examination and investigations. On examination of the ear condition of the pinna, preauricular region, post auricular region and external auditory canal were noted. On otoscopy, the tympanic membrane condition was noted. Tuning fork test, test for facial nerve integrity were performed in every case. Then through examination of the nose and throat was carried out.

Hearing impairment was assessed by pure tone audiometry with or without masking. X-ray para nasal sinuses and soft tissue nasopharynx were also done for younger patients to exclude OME.

Majority of the patents were operated under general anaesthesia and rest under local anaesthesia. In all cases, per meatal approach was used. Teflon piston of different diameter was used as prosthetic material. Footplate was preserved in all cases. In patients with bilateral otosclerosis operation was performed in one ear.

Patients were followed up postoperatively for 3 months and after that as per required. During follow-up period condition of the external auditory canal and tympanic membrane was noted. Surgical outcome of the stapedotomy was measured on the basis of subjective improvement of hearing, postoperative hearing gain by PTA, outcome of tinnitus, any relevant complications.

Analysis of data & presentation of results

Hearing gain was assessed by closure of air-bone gap ¹⁰. For testing the hypothesis, closure of air bone gaps were studied in two groups ≤ 30 dB and > 30 dB on the basis of preoperative PTA. All air bone gaps > 30 dB were considered as wide AB gap and All air bone gaps ≤ 30 dB were considered as

narrow AB gap (Table- XVII). Then, closure of air bone gap between two groups measured statistically. All data were compiled, checked and verified thoroughly to reduce the inconsistency. The numerical

data obtained were compiled and analyzed using standard statistical tests using scientific calculator and SPSS (ver.15). The results presented in the forms of tables and graphs.

Results:

Table I :

Distribution of patients by age (n = 35)

Age group (years)	Male	Female	Total	Percentage (%)
15- 20	02	02	04	11.42
21- 30	15	04	19	54.28
31- 40	07	02	09	25.71
41- 50	03	0	03	8.57
Total	27	08	35	100

Table II :

Distribution of patients according to clinical feature (n=35)

Symptoms	No. of patients	Percentage (%)
Progressive hearing loss	35	100
Tinnitus	22	54.54
Vertigo	3	8.57

Table-III all patients (100%) presented with progressive hearing loss, 54.54% with tinnitus and 8.57% with vertigo.

Table III :

Distribution of patients according to duration of hearing loss (n=35)

Duration of hearing loss	No. of patients	Percentage (%)
Less than 2 years	12	34.28
2-5 years	16	45.71
5-10 years	07	20

Table IV :

Distribution of patients according to tympanic membrane findings (n=35)

State of tympanic membrane	No. of patients	Percentage (%)
Normal	32	91.42
Retracted/ thin	2	5.71
Thick/ tympanosclerosis	1	2.86
Total	35	100

Table V :*Distribution of patients according to condition of the chorda tympani during operation (n = 35)*

Condition of Chorda tympani	No. of patients	Percentage (%)
Preserved	31	88.57
Cut	03	8.57
Severed	01	2.86

Table VI :*Difficult situations faced during surgery (n = 35)*

Special situations	Number of patients	Percentage (%)
Narrow external auditory canal	07	20
Obliterative footplate	04	11.43
Overhanging facial nerve	02	5.71
Perilymph flooding/gushing	01	2.85
Haemorrhage in the labyrinth	01	2.85

Table VII :*Distribution of perforation of footplate during surgery (n = 35)*

Perforation of footplate	Number of patients	Percentage (%)
Hand perforator	29	82.85
Micro drill	06	17.14
Total	35	100

Table VIII :*Distribution of preoperative and postoperative hearing threshold (n=35)*

PTA	Air conduction threshold	Bone conduction threshold
	Mean (dB)	Mean (dB)
Preoperative	59.86	24.42
Postoperative	40.39	18.65

Table IX :*Distribution of outcome of hearing following surgery (n=35)*

Hearing status	No. of patient	Percentage (%)
Hearing gain	31	88.57
Same as before/ no gain	03	8.57
Worsened	01	2.86

Table X :*Distribution of air bone gap ≤ 30 dB & >30 dB*

Air-Bone gap	≤ 30 dB	> 30 dB
Preoperative air bone gap (mean dB)	25.37	38.95
Postoperative air bone gap closure (mean dB)	16.75	23.05

Table XVIII shows that mean preoperative air-bone gap was 25.37 dB and 38.95 dB; mean postoperative air bone gap was 16.75 dB and 23.05 dB in two groups ($d < 30$ dB & > 30 dB). Closure of air bone gap between two group was not statistically significant ($p = 0.0706$, $t = 1.8687$, $SE = 3.371$).

Table XIX shows that 62.85% patients had tinnitus preoperatively and 34.28% patients improved, 22.85% had tinnitus as before the operation.

Table XI :
Tinnitus following surgery (n=22)

Tinnitus status	No. of patient	Percentage (%)
Preoperative	22	62.85
Improved	12	34.28
Same as before	08	22.85
Worsened	02	5.71

Table XII :
Hearing results in otosclerosis patients treated by stapedotomy (n = 35)

Parameter	Hearing status			P value
	Pre operative	Post operative	Improvement	
AC	59.86 dB	40.39 dB	19.47 dB	0.001
BC	24.42 dB	18.65 dB	5.77 dB	0.001
ABG	35.44 dB	21.74 dB	13.70 dB	0.001
Tinnitus	62.85%	28.57%	34.28%	0.01

Discussion:

A prospective study was carried out from January 2009 to October 2010 at the Department of Otolaryngology- Head & Neck Surgery, BSMMU, with the aim to assess the results of surgical outcome following stapedotomy. This study was done over a limited period of time, with a short follow up and small number of cases. The facts and figures mentioned here may vary from large series. It may have some value in reflecting facts regarding patient's benefit of hearing as well as how we are doing.

Age of the patients ranged from 15 to 50 years. The commonest age group was of 21-30 years (54.28%). Next common group was 31-40 years (21.71%). This resembles to findings of Gray¹¹ & Smyth.¹²

Almost all studies shows, clinical otosclerosis is more frequent in female with approximate

male-female ratio of 1:2.¹³ In our series, majority of the patients were male (77.15%) with a male-female ratio 3.5:1. This reflects that female patients are under-treated in our country. Majority of the patients were students (42.86%) which resemble a Bangladeshi series.

Progressive hearing loss (100%) and tinnitus (60%) were the major symptoms of this series. Few patients presented with vertigo (14.28%). This findings are similar to Gray,¹¹ Smyth,¹² and Katjenmayer.¹⁴

In the present study, 45.71% patients had hearing loss for 2-5 years and 34.28% had hearing loss < 2 years. Tympanic membrane was normal in most of cases (91.42%). Smyth¹² also found normal tympanic membrane in most of his cases. In tuning fork test, Rinne was negative in all cases (100%). Weber lateralized to deafer ear in

32 cases and central in 3 cases. Absolute bone conduction was equal in all 35 cases. This confirms the clinical diagnosis of otosclerosis.^{15,16}

Upon exposure of tympanomeatal flap middle ear mucosa was found normal in majority (94.28%) of cases. Mucosal adhesion and tympanosclerosis found in 2 cases (5.12%). This corresponds to the findings of Causse & Causse.¹⁷

In majority of patients, chorda tympani was preserved in 30 cases (85.71%) after releasing. It was deliberately cut in 3 cases (8.57%) and accidentally severed in 1 case (2.86%). Although literature advocated preservation of chorda tympani in all cases.¹⁸

Per operative findings revealed obliterative otosclerosis in 4 cases (11.43%), overhanging facial nerve in 2 cases (5.71%), and escape of perilymph gushing in 2 cases (5.71%). This findings are similar to Ozgirgin¹⁹, and Gersdorff.²⁰

Perforation of footplate was done by hand perforator (peak) in 29 cases (82.85%) and micro-drill in 6 cases (17.14%). In all cases Teflon piston prosthesis (TPP) was used which is popular, available and retains for long duration.²¹ Stapedius tendon was cut in all cases. Sealing of the footplate was done by fat goblets from the ear lobule in 21 cases (60%). Gilli,¹⁶ also advocated using autologous fat.

Surgical outcome was measured on the basis of post operative hearing gain. Hearing improvement was obtained in 31 cases (88.57%), no improvement in 3 cases (8.57%), and worsened in 1 case (2.86%). This corresponds to the House.²²

Success, defined as closure of air-bone gap <10-15 dB, as recommended by most of the authors i.e. Vincent *et al*,²³ Quaranta *et al*,²⁴ unfortunately, was not obtainable in most of

our patients. Closure of post operative air bone gap was 21.74 dB in this series. Preoperative air bone gap was 35.44 dB. Difference between two group was statistically significant by paired t-test ($p=0.001$, $SE=1.5$, $x'=14.69$). However, post operative air-bone gap <25 dB was considered acceptable by some of the authors.¹⁶

All air bone gaps >30 dB were considered as wide AB gap (Table- XVIII). Closure of air bone gaps were studied in two group dŠ 30 dB and >30 dB. Closure between two groups was tested by unpaired t test and found not statistically significant ($p=0.0706$, $t=1.8687$, $SE=3.371$); though most of the authors suggest closure of air bone gap to be more in wide air bone gap.^{10,18}

Sensorineural hearing loss and permanent vertigo are rare following stapes surgery,^{1,2} it remains a serious side effect when occurs. In our series none of the patients suffered from total loss of hearing or persistent vertigo. In one case (2.86%) hearing deteriorated and in 3 cases (8.57%) no improvement of hearing observed. Many authors preferred stapedotomy to stapedectomy as there is lesser manipulation of the footplate i.e. the inner ear.²²

Surgery has an unpredictable effect on tinnitus and it may worsen after operation.²⁵ In our study, 22 (62.85%) patients had tinnitus preoperatively. Of them, 12 (34.28%) patients' tinnitus improved; in 8 (22.85%) patients tinnitus was same as before operation and in 2 (5.71%) patients tinnitus increased.^{20,26}

As the study was performed over a short period of time with a small number of cases, the results vary considerably from large series. It demonstrates some successful hearing results with low complication rate.

There are few studies regarding outcome of stapes surgery in our country. It may help the future researchers giving a guideline working in this field.

Conclusion:

Stapedotomy is a safe and effective treatment for conductive hearing loss in otosclerosis patients. With regard to good results and relative safety of the procedure, it may be offered to otosclerotic patients instead of wearing hearing aids for long terms that has its own limitations. Success in otosclerosis surgery does not depend on extent of hearing loss. Experience of the surgeon plays a major role in the results of stapes surgery. Patients with moderate hearing loss improved to normal hearing. Other patients with severe hearing loss gained improvement to a moderate loss, allowing more benefit from use of a hearing aid and achieving an important discriminatory improvement.

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