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Techniques and results of stapedial surgery

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Abstract:

Objective: To evaluate the improvement of hearing after stapedial surgery, to record the problems during surgery and to assess the complications of the same.

Study design: Retrospective review.

Setting: Department of Otolaryngology & Head and Neck Surgery ,Bangabandhu Shiekh Mujib Medical University.

Materials and Methods: This study included thirty two patients of otosclerosis that were surgically treated in the department of otolaryngolgoy and Head-Neck surgery at BSMMU from January, 2003 to June, 2005. The data of each patient included age, sex, educational & socio-economic status, mode of admission, types of dwelling, occupation, presenting symptoms and signs, preoperative investigations like PTA, tympanometric compliance, stapedial reflex, speech discrimination, HRCT temporal bone(in suspected cases of obliterated otosclerosis), operation notes, complications of surgery and state at follow up.

Results: Most common age group was 21-30 years (50%) and 68.75% patients were male .Most of the patients were primarily educated (31.25%) and middle class people was maximum (62.5%). Most patients came to hospital referred by outside doctor (62.5%) and most of them were from rural area of Bangladesh(62.5%).Main presenting symptoms were progressive deafness and duration of hearing loss for 2-5 years was 31.25%. Most of the tympanic membranes (86.75%) were normal. Rinne was negative in all cases and Weber lateralized to affected ear or more deaf ear in 93.75% cases. Patients mainly presented with 50-60 dB hearing loss. There was slightly reduced compliance in 29 cases (90%) and stapedial reflex were absent in 75% cases. Speech discrimination test was 100% in 90% of the patients. HRCT temporal bone was done in 3 cases and 2 showed thickening of foot plate of stapes. Stapedotomy was done in most of the patients (78.1%). Common problems encountered during operation was perilymph flooding (6.28%) and obliterated otosclerosis(6.28%) . Most common complication was injury to Chorda tympani nerve (9.37%).Improvement of hearing was in 28 patients (87.50%) and after surgery Air- Bone gap closure more than 10 dB was in 87% of patients. Most common prosthesis used was Teflon prosthesis.

Conclusion: In general the stapedotomy/stapedectomy is very successful with over 90% of people experiencing a good improvement in hearing. Sometimes the hearing remains unchanged and there is a small (approx 1-2%) chance of hearing loss .Rarely there is chance of dead ear also. Hearing results vary from surgeon to surgeon. As with all operations the best results tend to be achieved by those who do the procedure most frequently.

Key Words: *Otosclerosis, Stapedectomy, Stapedotomy*

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Introduction:

Otosclerosis is a primary disorder of the bony labyrinth and stapes known to affect only humans, leading to progressive conductive and sensorineural hearing loss[1]. Otosclerosis is a disease particularly widespread among Caucasian populations, while it is very rare among blacks, Asians and Native Americans[2]. Many studies have established that the period of onset is mainly between 15 and 40 years of age, with a higher prevalence in women than in men[3]. The disease is bilateral in about 75% of patients[4]. The most common site is anterior to the oval window, followed by the round window niche and the apical and medial cochlear wall, respectively[5].Otosclerotic bone undergoes a remodeling process in which normal bone is replaced by otosclerotic bone. Osteoclasts and osteoblasts can be seen within

active foci of otosclerosis. Stapes fixation begins with calcification of the annular ligament joining the oval window otosclerotic lesion with the stapedial footplate. The stapes subsequently becomes fixed by the lesion[6].Bruijn[7] reported loss of capillaries and pericapillary spaces in the spiral ligament and erosion of the cochlear capsular bone with a greater width of soft tissue endosteum separating the spiral ligament from the bony surface. Spiral ligament changes have been referred to as atrophy, fibrosis and thickening, especially when they are found adjacent to the endosteal bone surface[8].Tuning fork tests reveal a conductive hearing loss in individuals with footplate fixation. Results of tuning fork tests may be difficult to interpret in patients with mixed losses. The Rinne's test should demonstrate bone conduction to be better than air conduction (negative Rinne).The Weber test should lateralize to the ear with a greater degree of conducting hearing loss. The remainder of the physical examination findings should be normal. Abnormalities of the tympanic membrane, external ear canal or middle ear suggest other causes for conductive hearing loss, although they do not rule out the possibility of stapes fixation due to otosclerosis. The exception is the presence of a Schwartze sign. Upon physical examination, this is the finding characteristic of otosclerosis[9]. In 1957, Dr. John Shea invented the procedure of stapedectomy, which produced excellent hearing results, which remain good for many years after the surgery. This procedure allowed avoidance of hearing aids. It does not help the sensory component of the hearing loss and at best, may close the "air-bone" gap. It also does not affect the vertigo that is sometimes associated with otosclerosis. According to Jenkins[10], stapedectomy is indicated in patients with good bilateral inner-ear function, a bone conduction level of 0-25 dB in the speech range and air conduction of 40-60 dB. The air-bone gap should be at least 20 dB. Stapedectomy is unreasonable if discrimination scores are lower than 65% as this indicates that there is a substantial sensory component[11]. Patients with stapedectomy may attain better results with hearing aids because of the need for lesser amplification. Stapedectomy may fail for a number of reasons. It is a somewhat difficult and delicate procedure. There may be displacement of the prosthesis, reclosure of the fenestra (window) or erosion of the incus. Disease may progress so that correction of the conductive component is inadequate.

A variant procedure called a "small fenestra stapedotomy" is done in many institutions (House et al, 2002). This involves drilling a small opening in the footplate and insertion of a piston in the small fenestra (hole). This technique does not involve removal of the entire stapes footplate and avoids some complications related to the larger opening used for stapedectomy. Hearing results are about the same as or better than stapedectomy.

Methods

This study included thirty two patients of otosclerosis that were surgically treated in the department of otolaryngology and Head-Neck surgery at BSMMU from January, 2003 to June 2005. The data of each patient included age, sex, educational & socio-economic status, mode of admission, types of dwelling, occupation, presenting symptoms and signs, preoperative investigations like PTA, tympanometric compliance, stapedial reflex, speech discrimination, HRCT temporal bone(in suspected cases of otosclerosis), operation notes, complications of surgery and state at follow up. During operation type, size and length of the prosthesis were noted. At follow up, PTA has been done in all cases and have been compared the same with the preoperative one. Other investigations done as routine pre-requisite for operation.

Result:

Thirty two patients of otosclerosis were surgically treated in Otolaryngology dept of BSMMU, Dhaka, from January 2003 to June, 2005. All 32 patients had sufficient data to be included in this study. All information about the cases was compiled and relevant data were analyzed and shown in tabulated forms.

Table –I

Age of patients n= 32

	11-20 Years	21-30 Years	31-40 Years	41-50 Years
Number of patients	2	16	12	2
Percentage	6.25	50	37.5	6.25

Most Common Age group was 21-30 years (50%).

Table-II

Sex distribution of patients n = 32

Sex of Patients	No of patients	%
Male	22	68.75
Female	10	31.25

Table-II shows 68.75% patients were male.

Table-III
Educational Status n=32

Educational status	No. of Patients	%
No Education	2	6.25
Primary	10	31.25
Secondary	9	28.125
Higher Secondary	5	15.625
Graduation and above	6	19.875

Most common cases were primarily educated (31.25%)

Table-IV
Socio-economic conditions n= 32

Socio-economic status	No of patients	%
Poor	4	12.5
Middle	20	62.5
Rich	8	25

Most common cases were middle socio economic condition (62.5%)

Table-V
Mode of Admission Referred by Doctor/Direct n=32

Mode of Admission	Direct	Referred by outside Doctors
No. of patients	12	20
%	37.5	62.5

Most common patients came in the hospital referred by outside doctor (62.5%)

Table-VI
Type of dwelling n=32

Inhabitant	No of Patients	%
Rural	20	62.5
Urban	12	37.5

Most of patients came from rural area of Bangladesh (62.5%)

Table-VII
Occupation of the patient n=32

Occupation of the patient	No of patients	Percentage
Student	10	31.25
Business	7	21.87
Service holder	5	15.625
Cultivator	2	6.25
House wife	8	25.00

Most common occupations were students.

Table-VIII
Surgery in the ear n=32

Ear operated	No of patients	Percentage
Right ear	18	56.25
Left ear	14	34.75

Table-IX
Common Symptoms of patients

Symptoms	No of Patients	Percentage
Progressive deafness	32	100
Tinnitus	24	75
Vertigo	08	25
Paracusis Willisi	30	93

Most common symptom was progressive deafness (in all patients)

Table-X
Duration of hearing loss n=32

Duration of hearing loss	No of Patients	Percentage
Less than 1 year	4	12.75
1-2 years	8	25
2-5 years	12	37.25
5-10 years	8	25

Table X shows duration of hearing loss in 2-5 years was 37.25%

Table-XI
Tympanic membrane findings n=32

Condition of TM	Number	Percentage
Normal	28	86.75
Thick/retracted	02	6.25
Thin	02	6.25

Most of the tympanic membranes (86.75%) were normal

Table-XII
Tuning fork test n=32

Tuning fork test	Result	Case	Percentage
Rinne	Negative	32	100
Weber test	Lateralized to deaf ear	30	93.75
	Central	2	6.25
ABC	Equally	30	93.75
	Reduced	2	6.25

Rinne Negative in all cases and Weber lateralized to affected ear in 93.75% cases

Table-XIII
PTA n=32

Amount of hearing loss	No of Patients	Percentage
40-50 dB	4	12.5
50-60 dB	20	62.5
60-70 dB	8	20.5

Most common hearing loss was between 50-60 dB

Table-XIV
Tympanometry Compliance n=32

Compliance	No of Patients	Percentage
Normal	03	9.175
Reduce	29	90.625

Table shows slightly reduce compliance in 29 cases (90%)

Table-XV
Stapedial reflex n=32

Stapedial reflex	No of Patients	Percentage
Absent	24	75
Reduce	8	25

Table shows stapedial reflex was absent in 75% cases

Table-XVI
Speech Discrimination n=20

No of Patients	Percentage of patients	Score Percentage
18	90	100%
2	10	90%

Speech Discrimination test was 100% in 90% of the patients.

Table-XVII
CT Scan findings n=3

Findings	No of Patients	Percentage
Normal	1	33.33
Thickened foot plate of Stapes	2	66.66

HRCT temporal bone was done in 3 cases and 2 showed thickening of foot plate of stapes

Table-XVIII
No of surgery n=32

Type of Surgery	No of Patients	Percentage
Stapedotomy	25	78.1
Stapedectomy	6	18.75
Revision Stapedectomy	1	3.12

Stapedotomy was done in most of the patients(78.1%)

Table-XIX
Problems during surgery n=32

Name of problems	No	Percentage
Abnormal Facial nerve	1	3.125
Persistant stapedial artery	0	0
Perilymph flooding	2	6.28
Floating and submerged foot plate	0	0
Presence of blood in vestibule	0	0
Obliterated otosclerosis	2	6.28

Common problems were perilymph flooding (6.28%) and obliterated otosclerosis(6.28%)

Table-XX

Complications of Surgery n=32

Name of complications	No	Percentage
Dead ear	1	3.12
Tinnitus	0	0
Facial nerve palsy	1	3.12
Significant vertigo	0	0
Perilymph fistula	0	0
Taste disturbance	3	9.37
Tympanic membrane perforation	1	3.12
Infection	0	0
Reparative granuloma	0	0

Most common complication was injury to Chorda tympani nerve (9.37%)

Table-XXI

Hearing after surgery n=32

	No of Patients	Percentage
Hearing gain	28	87.50
No gain	3	9.375
Dead ear	1	3.125

Improvement of hearing was in 28 patients (87.5%) patients

Table-XXII

Closure of Air-Bone gap after Surgery n=32

No of Patients	Air-bone gap closure between 10-20 dB	Air-bone gap closure more than 20 dB
32	28(87%)	4(13%)

After surgery Air- Bone gap closure between10-20 dB was in 87% of patients

Table-XXIII

Size (Diameter) of the prosthesis n=32

Diameter	0.4 mm	0.5 mm	0.6 mm
No of patient	23	2	7

Most common diameter of the prosthesis used was 0.4mm in 23 patients

Table-XXIV

Sealing of fooltplate of Stapes n=32

	Fat	Gelfoam	Cubital venous blood	Fibrin Glue
No	24	8	0	0
%	75%	25%	0	0

Sealing of footplate of stapes was done mainly by fat in 75% of patients

Table-XXV

Use of prosthesis in Surgery n=32

Prosthesis	Teflon	Mac Gee
No of pt	30	02

Most common prosthesis was Teflon prosthesis used in 30 patients

Table-XXVI

Length of prosthesis n=32

Size	4 mm	4.25 mm	4.6 mm	5 mm
No	5	13	13	1

Length of prosthesis commonly used were 4.25 mm and 4.5mm

Table-XXVII

Comparison of hearing gain after Stapes surgery n= 32

Group	Hearing gain	No hearing gain	Total
A (n= 25) (Stapedotomy)	24	1	25
B (n= 7) (Stapedectomy)	4	3	7
Total	28	4	32
X2 = 4.56(P<0.05)			

P value of 4.56 at 1 df is <0.05 which is significant. So Null hypothesis rejected. This indicate hearing gain after stapedotomy is better than in stape-decctomy.

Discussion :

In the present series most common age group was 3rd decade. The next common group was 4th decade. This is supported by Gray[9] and Smyth[16]. The sex ratio varies from series to series. But our finding is almost similar to Li and Cao[13].

Education of the patients shows that most of the patients (32.5%) had a primary level education followed by secondary education. Majority of patients (64%) came from rural areas. Students (31%) and house wives (25%) were common in the series. Most of the patient was admitted in the otolaryngology dept by physicians.

In this series, the common symptoms were progressive hearing loss (100%), tinnitus (75%) and vertigo (25%).This is supported by most of the authors like Katjenmayer[12], Smyth[16] and Gray[9].

The Paracusis Willisi was noticed by most of the patients (93%). This finding is similar to other authors[15].

In the present study, 37.5% patients had a hearing loss for 2-5 years duration. 25% of patients had hearing loss of 5-10 years duration. In our series tympanic membranes were apparently normal in most of cases. Smyth also found normal tympanic membrane in most of his cases[16]. In tuning fork test, Rinne was negative in all cases(32 cases), Weber lateralized to right in 18 cases and to left in 14 cases. ABC tests were equal to examiner in 30 patients. This confirms the general rule of tuning fork test[14].

In our series, 50-60 dB hearing loss was found in 62.5% cases. This conforms to Yamamato[17]. Here the compliance was reduced in 91% cases, normal in 9% cases and middle ear pressure was normal in all cases.

In Impedance tests, 29 cases has reduced compliance and 3 cases had normal compliance. Middle ear pressure was normal in all cases. This is supported by Glasscock[14] and Gray[9].

Stapedial reflexes were unobtainable in 24 cases and reduced in 8 cases. This was documented in the study of Ozgirgin[15].

Speech Discrimination test was done in 29 cases. Here a good number of cases had a score of 100% which was reported by Fisch[8].

HRCT temporal bone was done in only 3 cases. 2 cases showed thickening of the footplate of Stapes.Comper[6] also found similar findings.

In our series, out of 32 cases of stapes surgery, 25 patients undergone Stapedotomy, 6 patients undergone Stapedectomy and 1 patient (3.1%) undergone revision surgery. Fisch[8] also did revision surgery in negligible occasions.

Abnormal facial nerve was seen in 1 case , perilymph flooding were seen in 2 cases (6.28%) and obliterated otosclerosis in 2 cases (6.28%) . This finding is similar to other series[15].

In this series, one patient (3%) experienced dead ear.1-5% of dead ear were also observed by Fisch[8]. One patient (3%) had facial palsy which was transient in nature and taste disturbances occurred in 3 cases due to injury to chorda tympani nerve. Li[13] observed similar type of injuries.

Hearing gain was obtained in 28 cases (87.5%), no gain in 3 cases (9.37%) and dead ear in 1 case (3.12%). This corresponds to the studies of Glasscock[14] and Katzenmeyer[12].

Air bone gap was reduced more than 10 dB in 28 cases (87%) and more than 20 dB in 4 cases (13%). This coincides with Li[13] and Fisch[8].

In our series, hearing gain was recorded in 24 patients out of 25 stapedotomy cases. Whereas hearing gain was recorded in 4 patients out of 7 stapedectomy cases. This indicates that hearing gain is better in stapedotomy than in stapedectomy. The hypothesis was tested by performing the Chi-square(X^2) test and found significant.

Treatment of otosclerosis relies on two primary options: hearing aids or surgery called stapedectomy. Hearing aids are usually very effective early in the course of the disease, but eventually a stapedectomy may be required for definitive treatment. Early attempts at hearing restoration via the simple freeing the stapes from its sclerotic attachments to the oval window were met with temporary improvement in hearing, but the conductive hearing loss would almost always recur. A stapedectomy consists of removing a portion of the sclerotic stapes footplate and replacing it with an implant that is secured to the incus. This procedure restores continuity of ossicular movement and allows transmission of sound waves from the eardrum to the inner ear. A modern variant of this surgery called a stapedotomy, is performed by drilling a small hole in the stapes footplate with a micro-drill and the insertion of a piston-like prosthesis. The success rate of either

a stapedotomy or a stapedectomy depends greatly on the skill and the familiarity with the procedure of the surgeon. Other less successful treatment includes fluoride administration, which theoretically becomes incorporated into bone and inhibits otosclerotic progression. This treatment cannot reverse conductive hearing loss, but may slow the progression of both the conductive and sensorineural components of the disease process.

Conclusion :

Most authors are able to obtain closure of the air-bone gap to within 10 dB of the preoperative bone conduction level in 90% of their patients. There has been much debate regarding results of stapedectomy vs. stapedotomy. Recent stapedotomy technique(with fewer complications) and thus there has been a recent shift towards this procedure. Most consider stapedotomy to be technically easier to perform and with less potential damage to the vestibule.

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