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Original Research Article

Retrospective Clinico-Radiological Correlation of Stapes Footplate Thickness in Cases of Otosclerosis Undergoing Small Fenestra Stapedotomy and Stapes Prosthesis Insertion: An Indian Perspective

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ABSTRACT

Introduction - Small fenestra stapedotomy has now become a standard of care with minimal complications for successful treatment of stapedial otosclerosis. Definitive diagnosis of otosclerosis can only be made intraoperative inspection and confirmation of fixation of stapes foot plate. However, preoperative evaluation of stapes foot plate thickness by high resolution computed tomography (HRCT) scan of temporal bone can be done with high specificity and sensitivity. But there appears to be a discrepancy in stapes foot plate thickness as measured on HRCT temporal bone and what is found intraoperatively.

Methods - 80 ears diagnosed with otosclerosis and scheduled for small fenestra stapedotomy from January 2015 to December 2017 were taken in study as per inclusion and exclusion criteria of study. Preoperative HRCT temporal bone was done and Stapes foot plate thickness (SFTi) was calculated. Intraoperatively distance between medial surface of long process of incus to stapes footplate (L) and hence Ideal piston length was calculated. After making fenestra, actual piston length (APL) needed was recorded and actual stapes foot plate thickness (SFTo) was calculated. Comparison was made between measurement of stapes foot plate thickness preoperatively on HRCT temporal bone (SFTi) and intraoperatively (SFTo).

Results - Analysis of data revealed - Mean SFTi - 0.83 mm ranging from 0.5-1 mm, Mean L - 2.8 mm ranging from 2.2-3.6 mm. Mean IPL - 3.9 mm ranging from 3.25-4.75 mm, Mean APL - 4.06 mm ranging from 3 to 4.8 mm. Hence, Mean SFTo is calculated to be 1.04 mm ranging from 0.55-1.85 mm. With taking 95% confidence interval the difference between SFTi and SFTo ranged from -0.2629 to -0.0746. By taking standard error of difference as 0.047, two tailed P value is calculated as 0.0006 which was statistically extremely significant.

Conclusion - Preoperative HRCT evaluation of stapes footplate thickness benefits the patient as well as surgeon in view of decreased surgical time, selection of appropriate instruments and equipments and prevention of complications. However discrepancy in measurement of stapes foot plate thickness on HRCT and intraoperatively defeats the purpose and expose a lack of a definitive and well designed HRCT protocol to measure thickness of posterior part of stapes foot plate thickness which is invaluable for a successful surgery. Therefore, a felt need have risen to develop strict HRCT protocols taking into consideration the specific bony landmarks to measure stapes foot plate thickness, especially the posterior part, where stapedotomy is performed.

Key Words - Stapedial otosclerosis, Small fenestra stapedotomy, High resolution computed tomography (HRCT) scan temporal bone, Stapes foot plate thickness

INTRODUCTION

Among many conservative and surgical options for otosclerosis, small fenestra stapedotomy, either cold steel or with Laser, has emerged to be quite successful in deft hands with minimal or no complications and is now considered to be standard surgical approach. [1-3] Definitive diagnosis of stapedial otosclerosis is confirmed on middle ear exploration by visual assessment of footplate thickening and fixation is confirmed by palpation of malleus, incus and stapes. [4]

However, preoperative evaluation of stapes footplate thickness is possible as well as nearly becoming a essential procedure. [5,6] Current literature shows that sensitivity and specificity of high resolution CT scan (HRCT) in cases of otosclerosis is quite significant. [7,8] Successful prediction of stapes footplate thickness preoperatively will reduce time taken during surgery as stapedotomy is preferred to be done under local anaesthesia. However, as current literature is reviewed, there seems to be a lack or standard HRCT protocol for otosclerosis.

Calculation of the length of piston required for insertion during surgery is done by measuring distance between medial surface of incus and lateral surface of stapes footplate + thickness of stapes footplate + 0.25 mm for vestibular extension of piston. [9]

However, it was often found by surgeons that a discrepancy lays when it comes to preoperative and intraoperative stapes thickness measurement.

Aim of this study is to correlate pre operative HRCT evaluation of stapes footplate thickness with the intraoperative findings of the same. The study is also novel in that, hitherto there is no literature indicative of the average stapes foot plate thickness in Otosclerosis in the Indian population.

MATERIALS AND METHODS

Study population –

Patients diagnosed with otosclerosis that underwent unilateral small fenestra stapedotomy in the Department of Otolaryngology of a tertiary care centre in western Maharashtra during January 2015 to December 2017.

Study design – Retrospective descriptive study.

Objectives –

1. To correlate the intraoperative stapes footplate thickness of patients diagnosed as otosclerosis and undergoing small fenestra stapedotomy with the preoperative stapes footplate thickness as evaluated by High Resolution Temporal Bone computed tomography (HRCT) of the temporal bone.
2. To document the average intraoperative thickness of stapes footplate in cases of Otosclerosis undergoing small fenestra stapedotomy in the Indian population.

Methodology –

The study is conducted in a tertiary care hospital in western Maharashtra. The data pertaining to all diagnosed cases of Otosclerosis who underwent small fenestra stapedotomy at this centre from Jan 2015 to Dec 2017 were included in the study. A total of 80 cases were operated in this period, of both sexes and ages ranging from 16 to 67 years. Institutional ethical clearance was obtained.

***Inclusion Criteria*:**

a) Cases of both sexes.
b) Age group from 13 to 70 years.
c) Cases who underwent HRCT temporal bone with less than 1mm cuts and with multiplanar reconstruction.
d) Cases which achieved ideal insertion of stapes piston of 0.25 mm into the vestibule.
e) Cases operated only in this centre.

Exclusion Criterion

a) Revision stapedotomy.
b) Cases of otosclerosis that underwent HRCT temporal bone with more

than 1mm cuts or without multiplanar reconstruction.

c) Cases of otosclerosis who had less than ideal piston insertion (either too long/short of the vestibule) or with complications like a floating footplate.
d) Cases of otosclerosis operated outside this centre.

Preoperative evaluation of cases of Otosclerosis included clinical, audiological and imaging with HRCT Temporal bone in all cases. HRCT Temporal bone was done in SIEMENS Somatom Emotion 16 Slice CT Scanner with 0.6 mm slice thickness and a high resolution window width of 4000 centered around 700 Hounsfield units. Multiplanar reconstruction was done with a slice thickness of 0.6mm with an interval of 0.3mmto achieve adequate overlap. The foot plate thickness indicated by imaging was noted preoperatively (SFTi) in millimetres.

A small fenestra stapedotomy was done under local anaesthesia by a permeatal approach in all cases. All standard steps of the surgery were followed by all the operating surgeons.

An ideal insertion of stapes piston through the small fenestra is when the insertion is 0.25 mm into the vestibule. An Ideal piston length (IPL) for achieving this is the distance from the medial aspect of Incus long process to the lateral surface of stapes foot plate in millimetres (L), with an additional length added incorporating the stapes footplate thickness (SFTi) and achieving an entry of 0.25 mm of the tip of the piston into the vestibule. Thus ideal piston length can be denoted as:

Ideal Piston length (IPL)= L + SFTi + 0.25 mm

However IPL did not correlate most of the time with the Actual piston length (APL) fashioned by the surgeon for an ideal insertion. Intraoperative evaluation of Stapes foot plate thickness (SFTo) was taken as the Actual Piston Length (APL) fashioned by surgeon to achieve an ideal insertion of 0.25mm into the vestibule minus the distance from the medial surface of the long process of incus to the stapes foot plate (L). Thus the intraoperative Stapes foot plate thickness can be represented as:

SFTo (mm) = APL - (L+0.25mm)

The data available for SFTi and SFTo was scrutinised with statistical tools for the degree of correlation, retrospectively.

RESULTS

The study group consisted of 80 ears that were diagnosed as case of otosclerosis and operated on worse hearing ear. After thorough clinical, audiological and radiological examination they underwent small fenestra stapedotomy under local anaesthesia. Mean age of cases that underwent surgery was 35.2 years with standard distribution being 10.21. Sex ratio of male: female was 1.3.

Mean stapes footplate thickness as measured preoperatively by radiologist in high resolution CT scan (SFTi) was 0.83 mm ranging from 0.5-1 mm. Mean distance from the medial surface of the long process of incus to the stapes foot plate (L) as measured intraoperatively was 2.8 mm ranging from 2.2-3.6 mm. Mean Ideal piston length (IPL) which would have been needed had the SFTi been correct was 3.9 mm ranging from 3.25-4.75 mm. Intra-operatively mean Actual Piston Length (APL) which was required was 4.06 mm ranging from 3 to 4.8 mm. Hence, mean intraoperative stapes footplate thickness (SFTo) comes out to be 1.04 mm ranging from 0.55-1.85 mm in our study group (Figures 1 and 2).

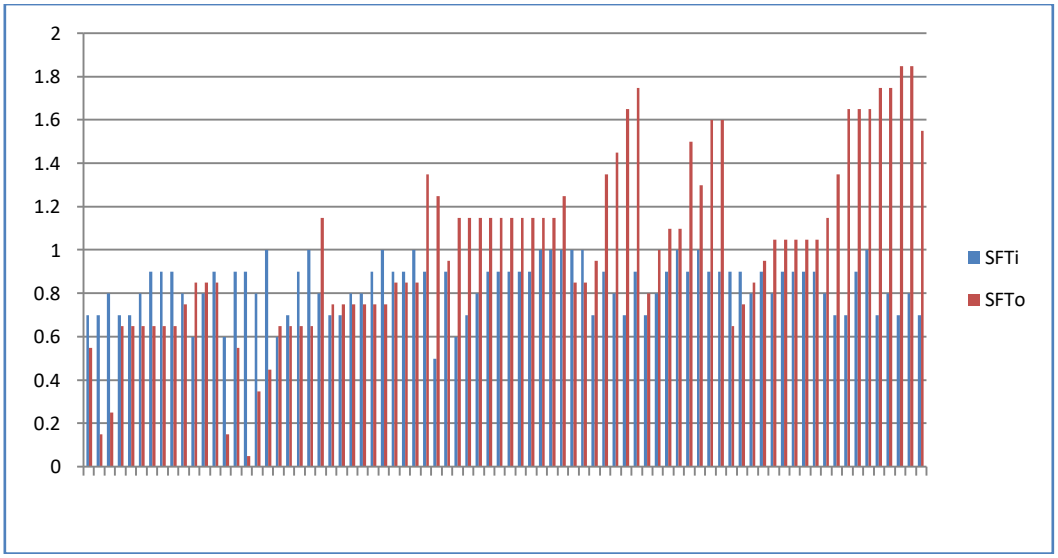

Figure 1 – Relationship between preoperative stapes footplate thickness measured with HRCT (SFTi) and actual stapes footplate thickness found intraoperatively (SFTo)

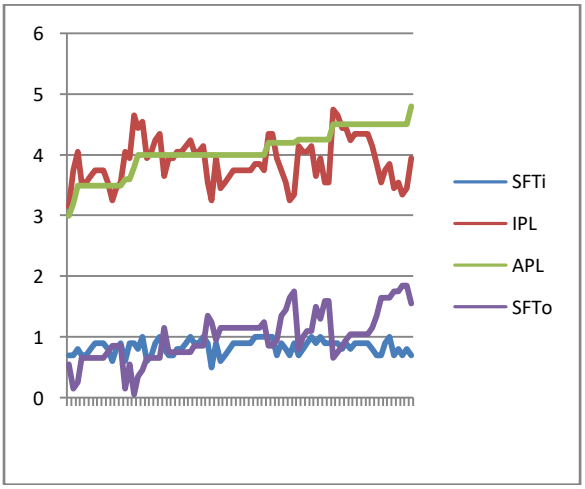

Figure 2 – Relationship between preoperative stapes footplate thickness measured with HRCT (SFTi) ideal piston length (IPL), actual piston length which was required during surgery (APL) and stapes footplate thickness found intraoperatively (SFTo)

Statistical analysis was done using Student's paired t test. Difference of mean of SFTi with SFTo was -0.1688. 95% confidence interval of this difference ranged from -0.2629 to -0.0746. By taking standard error of difference as 0.047, two tailed P value equals 0.0006 which was statistically extremely significant (Table – 1).

Table 1 – Comparison between different statistical values of SFTi and SFTo

n = 80				
SFTi (mm)		Mean SFTo (mm)		P value
Mean	0.8350	Mean	1.0038	0.0006
SD	0.1181	SD	0.4106	
SEM	0.0132	SEM	0.0459	

Abbreviations – SFTi - stapes footplate thickness as measured preoperatively in HRCT temporal bone, SFTo - stapes footplate thickness as calculated intraoperatively, SD – standard deviation, SEM – standard error of mean.

DISCUSSION

Otosclerosis is a primary focal osteodystrophy of the otic capsule that has a prevalence of 0.3% to 0.4% in the Caucasian population. There is paucity of literature regarding incidence of otosclerosis in Indian population. [7] The incidence in the Indian subcontinent is about 17.9% according to some literature. [10-12] In a study, Raman R et al., in Vellore, India found the male: female ratio in obliterative otosclerosis to be1.48:1. In our study, we found a similar preponderance of male patients, and the male: female ratio observed in our study was 1.3:1. [12] Many theories regarding etiology of otosclerosis have been proposed but it still remains unclear. [13]

Radiologic imaging is increasingly utilized with putative roles in diagnosis, staging/grading, prognosis, surgical planning, outcomes, and complications. High Resolution
Computed tomography (HRCT) of the temporal bone (less than 1 mm slices) with multiplanar reconstruction is the imaging modality of choice, when performed. [7,14]

Management options in otosclerosis are either use of hearing aids or surgery; latter of which is most commonly chosen by patients. Small fenestra stapedotomy, either cold steel or with Laser is most common surgical procedure performed for stapedial

otosclerosis. This technique, in experienced hands gives excellent long term results with minimal complications as well as quality of life. [1-3] Small fenestra stapedotomy includes creation of a 0.7 mm fenestra over posterior part of stapes footplate, insertion of piston and crimping of this piston over long process of incus. [9]

It is imperative to calculate exact length of piston required to be inserted before fenestra is made. This length is calculated by measuring distance between medial surface of long process of incus and lateral surface of stapes footplate. An additional 0.25 mm, the thickness of stapes footplate, is added to this length to allow extension of the prosthesis into the vestibule of the labyrinth which is considered as an ideal prosthesis insertion. [9]

Literature indicates sensitivity of HRCT temporal bone with multiplanar reconstruction for evaluation of stapes footplate thickness in otosclerosis up to 95% and specificity 99%. [7,15] Preoperative HRCT evaluation of all these parameters decreases operative time and also prevents inadvertent complications due to insertion of excessively long or short piston.

As far as the current literature goes, the bases for diagnosing otosclerosis are - an increase or decrease in width of oval window and sclerotic or hypodense foci on or around footplate, thickened, irregular or hypodense footplate or presence of demineralised areas in temporal bone and change in gray scale. [16-19]

Although current literature suggests that HRCT temporal bone is quite sensitive and specific enough to detect otosclerotic focus, however there exists a paucity of literature on standardized and validated HRCT evaluation protocols for measurement of stapes footplate thickness making these readings fraught with inter and intra-observer variations amongst radiologists, which, inadvertently translates into discrepancy when it comes to intra-operative measurement of stapes footplate.

Due to lack of specific protocols followed during CT imaging, the surgeon often finds disparity in HRCT evaluation and intraoperative assessment of stapes footplate thickness measurement, which defeats the purpose of performing preoperative imaging.

CONCLUSIONS

1. HRCT temporal bone, due to its good specificity and sensitivity, is an invaluable tool to detect otosclerotic foci.
2. The sensitivity of CT scan in detecting a truly thick footplate is 95%. Thus HRCT is a good tool to quantify otosclerotic thickening of footplate of stapes.
3. The determination of the site and size of the fenestral focus has significant influence on surgical planning.
4. There exists a discrepancy in preoperative HRCT measurement and intra-operative detection of stapes footplate thickness, defeating the purpose of performing HRCT temporal bone.
5. This discrepancy leads to understanding the felt need to develop strict HRCT protocols to accurately detect posterior part of stapes footplate thickness where stapedotomy is to be performed.

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