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Original Research Article

Hearing loss following temporal bone fractures- a study on classification of fractures and the prognosis

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ABSTRACT

Background: Temporal bone fractures are traditionally classified as transverse, longitudinal or mixed fractures depending on their relationship to the petrous pyramid. However recent studies show that classifying temporal bone fractures as otic capsule sparing (OCS) and otic capsule violating (OCV) types has more relevance with the prognosis of hearing loss and other associated complications. To assess the predictive value of two different types of temporal bone fracture classification systems with respect to hearing loss and its type.
Methods: This prospective study was done on patients attending a tertiary care hospital in the study period of one year. Temporal bone fracture patients satisfying inclusion and exclusion criteria were clinically and audiologically evaluated. All patients with temporal bone fractures were categorized into two groups - Longitudinal/ Transverse (old) and OCS / OCV (new). Hearing loss was evaluated audiologically on multiple intervals- initially following the injury once the patient is stable, later after a gap of 1 month and 3 months following the injury.
Results: During the study period, 45 patients presenting with temporal bone fractures who satisfied the selection criteria were evaluated. The correlation was statistically significant for new classification system (*P*- 0.000) with respect to severity and prognosis of hearing loss which was not the case with the old system (*P*- 0.450).
Conclusions: We found that classifying temporal bone fractures into OCV and OCS correlates well with the severity of the hearing loss, the prognosis of the patient and the residual hearing disability when compared to the traditional system.

Keywords: Temporal bone fracture, Hearing loss, Otic capsule violating, Otic capsule sparing

INTRODUCTION

Temporal bone fractures in adults are invariably due to motor vehicle accidents or road traffic accidents (RTA). Other causes contributing to it are injuries to head following assault to the head with a blunt object, industrial injuries or self-fall. Etiologies in children show a similar trend with RTA being the single most common cause, followed by injuries secondary to fall.[1]

Hearing loss is a common complaint following temporal bone fractures but attention to it is frequently overlooked as there may be other life threatening complications associated with it that may require immediate attention of the care giver.

Temporal bone fractures are traditionally classified as transverse, longitudinal or mixed fractures depending on their relationship to the petrous pyramid.[2] However recent studies show that classifying temporal bone fractures as otic-capsule sparing and otic-capsule

violating types has more relevance with the prognosis of hearing loss and other associated complications. [3]

Hence this study was undertaken to correlate the traditional and alternate classification systems of classifying the temporal bone fractures with respect to assessing the degree and type of hearing loss and also to assess the prognosis of the disease.

METHODS

This longitudinal prospective study was conducted on patients attending the ear nose throat (ENT) department of Karnataka Institute of Medical Sciences, Hubballi, Karnataka, India during the period of December 2013 to December 2014, after obtaining clearance from the institutional ethical committee.

A total of 45 patients who satisfied the inclusion and exclusion criteria were studied.

All patients diagnosed to have temporal bone fractures by computerized tomography scanning of the temporal bone were included in the study.

Patients with preexisting ear problems, and severe injuries to brain parenchyma (including brainstem) which hampered with their ability to give responses to pure tone audiometry were excluded. Also patients not able to follow up because of co-existing morbidities were left out of the study. A written informed consent was obtained from all the patients.

After obtaining demographic data, thorough history was taken eliciting the cause and the mode of injury. Clinical evaluation included general physical examination and ENT evaluation. Hearing was assessed by performing Tuning fork tests, Pure Tone Audiometry (PTA) at predetermined intervals.

In PTA, air conduction threshold, bone conduction threshold, air-bone gap were assessed to quantify the degree and type of hearing loss.

The hearing impairment was interpreted as below.[4]

Table 1: Clarks grading of hearing impairment.

Degree of hearing loss	Hearing loss range (dB)
Normal	–10 to 15
Minimal	16 to 25
Mild	26 to 40
Moderate	41 to 55
Moderately severe	56 to 70
Severe	71 to 90
Profound	91+

The data obtained was coded and entered into Microsoft Excel Worksheet. The categorical data was expressed as frequencies and percentages. Continuous data was expressed as mean ± standard deviation (SD). The comparison was done using chi-square test, paired student't' test. Statistical analysis carried out using IBM SPSS 21 software. A probability value (*P* value) of less than 0.050 was considered as statistically significant.

RESULTS

In the present study, 73.3% (33) of the patients were males and 26.7% (12) were females.

Table 2: Presenting symptoms and signs among patients.

Characteristics	Frequency (n=45)	Percentage (%)
Hearing impairment		
Absent	17	37.8
Present	28	62.2
Tympanic membrane perforation		
Absent	27	60.0
Medium	5	11.1
Small	13	28.9
Hemotympanum		
Absent	27	60.0
Present	18	40.0

Table 3: Hearing loss characteristics among patients.

Characteristics	Frequency(n=45)	Percentage (%)
Type of hearing loss		
Conductive	34	75.6
Mixed	7	15.6
Sensorineural	4	8.8
Severity of hearing loss		
Normal	02	4.4
Minimal	18	40.0
Mild	12	26.7
Moderate	7	15.6
Moderately Severe	6	13.3

By the end of 12 weeks, only 1 case had minimal residual hemotympanum.

Of the 45 patients, 75.6% (34 cases) had conductive hearing loss, 8.8% (4 cases) had sensorineural type of hearing loss and the rest 15.6% (7 cases) showed mixed type of hearing loss. 33 were longitudinal or oblique fractures, while 12 were transverse fractures. But if we were to classify the fractures according to the new

classification system, 35 cases were found to be Otic capsule sparing (OCS) and 10 were of Otic capsule violating (OCV) type.

In our study, out of 34 conductive hearing loss (CHL) patients, 24(70.6%) had longitudinal fracture, 10(29.4%) had transverse fractures. All the 4 sensorineural hearing loss (SNHL) patients had longitudinal fractures (100%). Among the 7 mixed hearing loss cases, 5 (71.4%) had longitudinal and 2(28.6%) had transverse fractures. The correlation was statistically insignificant (*P*= .450).

When the fractures were classified according to the new system, out of same 34 CHL patients, 33(97%) had OCS type of fracture and only 1 (3%) had OCV type of fracture. Of the 4 SNHL cases, 1(25%) had OCS and 3 (75%) had OCV type of fracture. In the MHL category, 1 out of 7 (14.3%) had OCS and the other 6 (85.7%) had OCV fractures. The correlation was statistically significant (p=.000).

Table 4: Old vs. new classification system of temporal bone fractures.

Old classification system	New classification system		Total
	OCS	OCV	
Longitudinal / Oblique	26	7	33
Transverse	9	3	12
Total	35	10	45

OCS = Otic Capsule Sparing, OCV=Otic Capsule Violating

Table 5: Correlation of old classification system with type of hearing loss.

Old classification system	Hearing loss type			Total	P value
	Conductive	Mixed	Sensorineural		
Longitudinal	24	5	4	33	.450[§]
Transverse	10	2	0	12	
Total	34	7	4	45	

[§]Pearson Chi-square value- 1.599, degree of freedom- 2

Table 6: Correlation of new classification system with type of hearing loss.

New classification system	Hearing loss type			Total	P value
	Conductive	Mixed	Sensorineural		
OCS	33	1	1	35	0.000[**]
OCV	1	6	3	10	
Total	34	7	4	45	

[**]Pearson Chi-square value- 30.086, degree of freedom- 2

DISCUSSION

Temporal bone fractures constitute a significant bulk of basilar skull fractures which in-turn are the commonest skull fractures following head injury. During our study period, a total of 3876 RTA cases were reported in the casualty department of our hospital. Of which 741 (19.1%) were temporal bone fractures.

In this study, 73.3% of cases were males and 26.7% were females with a male: female ratio of 2.75:1. Male preponderance can be explained by the fact that ours is a male dominant society with majority of the outdoor activities being carried out by males in the family and hence increased exposure to the risk factors. But there is a rising trend with females having temporal bone fractures, indicative of the changing role of women in the current society.

Hearing impairment was complained by only 62.2% of patients. This was identical to the incidence of hearing loss in a study by L Paul Emerson et al. (62%) which is in agreement with Griffiths (56%).[5,6] On further evaluation it was noted that those patients who did not complain of hearing loss (27.8%) during the initial checkup still had minimal hearing loss which was mainly of conductive type. Further they recovered well and subsequent audiograms showed the improvement.

Tympanic membrane perforation was present only in 18(40%) cases. Among these, 13 (72.3%) had small sized perforation while 5(27.7%) had medium sized perforation in the pars tensa. By the end of 4th week, only 10 cases

had persistent perforation. By 12th week, this had reduced by 66.7% with only 3 cases having a persistent small sized traumatic perforation. Traumatic perforations heal well as there is no associated middle ear pathology and eustachian tube function in these patients will be invariably normal.

Hemotympanum was observed in 18 cases (40%) in our study. Of these 12 had resolved by the end of 4th week and 5 more resolved by the end of 12 weeks. Only 1 case had minimal residual hemotympanum. According to Kahn JB and others, hemotympanum on HRCT alone has the highest positive predictive value for diagnosing temporal bone fracture.[7]

In this study, we observed that of the 45 cases, 34 (75.6%) were conductive, 4 (8.9%) were sensorineural and 7 (15.6%) were mixed type of hearing loss. Singh et al. in their study found that out of 9 cases of fracture of the petrous part of the temporal bone, longitudinal fracture was present in 7 (78%) and transverse fracture in 2 (22%) cases.[8] Chamyal in their study of 50 head injury cases, reported 22 cases (44%) of skull fracture, out of which 14 (28%) had fracture temporal bone on further breakdown.[9] Out of these in temporal bone patients 10 (72%) had longitudinal and 4 (28%) had transverse fracture. Ishman et al. in their study on 196 cases reported 99 (64%) were longitudinal fracture and 36 (23%) were transverse fracture.[3]

In the present study the severity of hearing loss was minimal in 40%, mild in 26.7%, moderate in 15.6% and moderately severe in 13.3%. Hugh O Barber in a similar study noted that of 42 cases studied by him 10 had mild, 4 had moderate and 8 had moderately severe hearing loss.[10]

We classified all temporal bone fractures in both traditional (longitudinal/ transverse) and new (OCV/OCS) systems of classification. All the oblique fractures were grouped into longitudinal fractures for the sake of simplicity and statistical ease. Of the 33 longitudinal fractures, 26 were OCS and 7 were OCV. Among 12 transverse fractures, 9 were OCS and 3 were OCV. In a study by Little SC and others, 30 temporal bone fractures were reviewed retrospectively.[11] In their study, according to the traditional classification system, 15 patients (50%) had longitudinal fractures, 8 patients (27%) had transverse fractures, and 7 patients (23%) had oblique fractures. According to the new system, 24 patients (80%) had otic capsule–sparing fractures, and 6 patients (20%) had otic capsule–violating fractures.

Traditional classification system involves classifying fractures in relation to long axis of the petrous bone. But fracture lines usually follow a complex trajectory and will involve more than one plane depending on the direction of trauma. This would explain the poor predictability of old classification system as was observed in our study. The new system takes into account the status of the otic capsule and hence correlates more efficiently with the complications associated with fractures.

In a similar study by Little SC and others, observations were as follows - Of the patients with SNHL, 3 had longitudinal fractures, 2 had transverse fractures, and 2 had oblique fractures.[11] In the new system, 6 of 6 patients had otic capsule–violating fractures and 1 of 24 patients had an otic capsule–sparing fracture. Patients with otic capsule–violating fractures were 25 times more likely to have SNHL than those with otic capsule–sparing fractures (100% vs 4%). Three patients with transverse fractures, 7 patients with longitudinal fractures, and 1 patient with an oblique fracture had CHL. Three patients with otic capsule–violating fractures and 8 patients with otic capsule–sparing fractures had CHL. There was no statistically significant difference between the classification schemes for CHL in their study.

All patients were followed up for 2 times. Initially after 4 weeks, later after 12 weeks. The above mentioned tests were repeated on both follow ups and documented. Patients with hearing loss were assessed for improvement or deterioration on PTA for each of the 3 types of hearing loss. Although literature is abound with studies on hearing loss in temporal bone fractures, none of them correlate the prognosis of hearing loss of different types as done in this study.

CHL showed improvement which was statistically confirmed by applying paired samples't' test. Among the 34 CHL cases, mean hearing loss was 26.54 dBHL at initial examination and at the end of 12 weeks the mean hearing loss was 19.90 dBHL. Paired samples't' test was applied to the above data and it was found to be statistically significant (p=0.000).

SNHL also showed a mean improvement of 6.13 dBHL but it was statistically insignificant. Among the 4 SNHL cases, mean hearing loss was 49.12 dBHL at initial examination and at the end of 12 weeks the mean hearing loss was 43.0 dBHL. Paired samples't' test was applied to the above data and it was found to be statistically insignificant (p=.159).

MHL showed a marginal mean improvement of 2.2 dBHL. Among the 7 MHL cases, mean hearing loss was 53.67 dBHL at initial examination and at the end of 12 weeks the mean hearing loss was 51.50 dBHL. Paired samples 't' test was applied to the above data and it was found to be statistically insignificant (p=0.058). In some of the cases the improvement in mixed hearing loss was observed as a result of resolution of the hemotympanum and as a result decreases in the conductive component.

We conclude that, newer classification systems of temporal bone fractures like otic capsule sparing and otic capsule violating or petrous and non-petrous fare better than the traditional classification system like longitudinal or transverse or oblique in terms of predicting the

complications like hearing loss, facial palsy. Also it was observed that CHL of all intensities will regress towards normal hearing to some extent as hemotympanum resolves. Persistent CHL even after 3 months is most likely to be secondary to the ossicular trauma. Mild SNHL may improve but moderate, moderately severe, severe SNHL invariably involves otic capsule or shearing of the cochlear nerve and is unlikely to improve. MHL may show initial improvement if it is associated with hemotympanum, but otherwise it will persist.

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