Prospective Study of ‘Otological Injury Secondary to Head Trauma’

Gurbax Singh · Baldev Singh · Dalbir Singh

Received: 29 July 2011 / Accepted: 24 November 2011 / Published online: 13 December 2011
© Association of Otolaryngologists of India 2011

Abstract The aim of study was to evaluate etiological factors, types of skull fracture and associated hearing loss in 50 cases of head injury. This was prospective study involving 50 cases of head injury. Each patient will be subjected to detailed history, otological and neuro otological examination, radiological study followed by audiological assessment by pure tone audiometry. Road traffic injuries were the most frequent cause of injuries in our patients comprising 64% of the total, personal accidents/domestic falls, assaults and agriculture and related injuries were responsible for 8% of the total injuries each. Other causes of the injuries were sports injuries (6%), industrial accidents (4%) and fire arm injuries (2%). Out of the 9 patients having temporal bone fracture 7 cases (78%) had longitudinal fracture and 2 cases (22%) had transverse fracture. Out of the 21 patients having hearing loss, 5 patients (23.8%) had conductive hearing loss, 9 patients (42.86%) had mixed hearing loss and 7 patients (33.34%) had sensorineural hearing loss. Facial nerve palsy was present in 2 patients (28%) among longitudinal fracture cases and 1 patient (50%) among transverse fracture cases. Motor Vehicular accident (MVA) are still the commonest cause of injuries compared to the other mode of injury.

Patients with longitudinal fracture showed conductive and mixed loss and patients with transverse fracture showed sensorineural hearing loss. Incidence of facial nerve paralysis was more with transverse fracture cases than with longitudinal fracture cases.

Keywords Head injury · Longitudinal fracture · Transverse fracture · Conductive hearing loss · Sensorineural hearing loss · Facial nerve palsy

Introduction

Motor vehicle accidents commonly result in head trauma of varying degrees of severity. In the past, 75% of motor vehicle accidents resulted in a head trauma; however, the increased use of seatbelts and the advent of airbags may alter these statistics in the future. When the head trauma is of sufficient magnitude to fracture the skull, 14–22% of injured patients sustain a temporal bone fracture. In the largest series of temporal bone fractures reported to date, 31% of the temporal bone fractures resulted from motor vehicle accidents. Assault is the second most common cause, followed by falls and motorcycle accidents. Pedestrian injuries, bicycle accidents, gunshot wounds, all terrain vehicle accidents, sports injuries, and miscellaneous injuries account for a quarter of the cases [1].

Head and neck injury without fracture can give rise to both peripheral and central lesions causing hearing loss. In the peripheral ones, which tend to be due to blows to a fixed head, a large pressure wave passes through the bones of the base of the skull and there is excessive movement of the stapes. As regards hearing this leads to a cochlear hearing loss of a traumatic type, that is, it is maximal at around 4 kHz [2].

G. Singh
GGs Medical College & Hospital, Faridkot, India

G. Singh (✉)
4-D Hira nagar, Patiala 147 001, India
e-mail: drgurbax@gmail.com

B. Singh
Government Medical College, Patiala, India

D. Singh
Mullana Medical College Ambala, Haryana, India

Temporal bone fractures have traditionally been divided into transverse and longitudinal categories on the basis of the relationship of the fracture line to the axis of the petrous ridge. Longitudinal fractures reportedly make up 70–90% of temporal bone fractures, with the remaining 10–30% categorized as transverse [1].

Longitudinal fractures result from blows to the temporal and parietal area. The fracture line starts at the squamous temporal bone, runs across the posterosuperior part of the external auditory meatus, over the roof of the middle ear, along the carotid canal to the region of the foramen spinosum [2].

Transverse fractures of the temporal bone result from blows on the occipital region. The fracture arises from the foramen magnum, passes around or through the jugular and hypoglossal foramina, through the internal auditory meatus and ends in the middle cranial fossa in the region of the foramen lacerum and foramen spinosum. As the fracture runs across the axis of the petrous temporal bone, the inner ear and the facial nerve are frequently involved and the patient complains of neurosensory deafness which is frequently total, vertigo and a lower motor neuron facial palsy [2].

It is a well known fact that longitudinal fracture of temporal bone produces conductive hearing loss and sensorineural hearing impairment results mostly due to transverse fractures. However, the combination of longitudinal and transverse fractures and associated central nervous system damage to auditory system may alter the clinical findings [3].

Facial paralysis following fracture of the temporal bone is classified broadly into two groups – immediate and delayed. Immediate paralysis usually indicates tearing of the facial nerve, injury of the nerve by bone or entrapment in a fracture line. Early surgical exploration is indicated if there is to be an reasonable prospect of good functional recovery [4].

Delayed onset of facial paralysis confirms that, anatomically, the facial nerve is intact and that there has not been direct gross trauma. The management of delayed traumatic paralysis is similar to that of idiopathic facial paralysis [4].

This study was to evaluate the otological injuries in various types of head injuries.

Materials and Methods

This prospective study of otological injuries in cases of head injury was undertaken on 50 patients, which were admitted in Emergency department of Rajindra Hospital/ Govt. Medical College, Patiala for whom ENT consultation was sought during period 2005–2006.

In this epidemiological study of head injury cases, with ear, nose and throat involvement special attention was paid to record age, sex, mode of trauma (i.e., road side accidents, personal accidents, domestic falls, assaults, sports injuries, agriculture and related injuries and industrial accidents). Analysis of road side accidents (i.e., motor vehicular accidents, bicyclists and pedestrians) was also done. Incidence of alcohol consumption and use of other intoxicants was also recorded as these have got an important bearing on all types of injuries particularly road side accidents.

Audiometric Assessment

Pure tone audiometry was done with audiometer Elkon eda 3N3 μ -Print. First examination was done when the patient was in hospital (as soon as patient regains consciousness, if the patient was unconscious. Second examination was done in cases having hearing loss after 3–4 months.

Various types of hearing loss i.e., conductive, mixed and sensorineural were detected. Their incidence in various types of head injuries was also recorded.

Incidence of recruitment and tone decay were recorded and analyzed.

The observations were made and recorded as follows:

1. Detailed clinical history was taken and ENT examination done and recorded on a Performa.
2. A detailed neurological examination in each case including cranial nerve functions, gait tests and appropriate cerebellar functions tests were taken.
3. Radiological investigation of each patient was reviewed and findings obtained were compiled.
4. All the subjects were subjected to tuning fork, and pure tone audiometry.
5. Follow up of the cases having hearing loss was done 3–4 months after the first examination.

Results

There were 6 patients (12%) in age group of 11–20 years, majority of patients are in age group of 21–30 years (i.e., 23, 46%), 18 patients (36%) in age group of 37–40 years and 3 patients (6%) in age group of 41–50 years. Males constituted 86% (43) of the total cases while females constituted 14% (7) of the total cases (Table 1). The maximum numbers were employees 14 (28%), farmers 10 (20%), students 7 (14%). Businessman 6 (12%), labourers 5 (10%), house-wives & drivers 2 (4%) each and non-working were 4 (8%) (Fig. 1).

The majority of patients (i.e., 32, 64%) were injured due to road side accidents, 4 patients (8%) each were injured

Table 1 Age and sex incidence

Age (in years)	No. of patients		Total
	Male	Female	
11–20	5 (10%)	1 (2%)	6 (12%)
21–30	20 (40%)	3 (6%)	23 (46%)
31–40	15 (30%)	3 (6%)	18 (36%)
41–50	3 (6%)	0 (0%)	3 (6%)
Total	43 (86%)	7 (14%)	50 (100%)

**Em-employees; Far- farmers; Stu- students; Bus-
businessman; Lab-labourers;**

No-nonworking ;Ho-house wives;Driv- drivers

Fig. 1 Distribution of cases according to occupation

due to the personal accidents/domestic falls, assaults, agriculture and related injuries. 3 patients (6%) got injured by sports injuries, 2 patients (4%) got injuries due to industrial accidents. 1 patient (2%) got head injuries due to fire arm. On further analysis of road side accidents, motor vehicle accidents (self and intervehicular) proved most dangerous, in which 27 patients (84%) were injured. Bicyclists (self and hit by other vehicles) were injured in 3 cases constituting 10% of the road side accidents. Pedestrians (hit by other vehicles) were involved in two accidents constituting 6% of the road side accidents (Table 2).

The eight patients (16%) had consumed alcohol before the accident and 2 patients (4%) were under the effect of opium.

Incidence of ear injuries were 46% (23 patients), out of that 21 patients (42%) suffered from hearing loss, there was temporal bone fracture in 9 cases (18%), laceration of pinna and external auditory canal in 7 cases (14%), bleeding from ear was present in 6 cases (12%), injury of the tympanic membrane 2 cases (4%), CSF otorrhoea in 2 cases (4%) and facial nerve injury in 3 cases (6%), haemotympanum was present in 2 patients (4%), mastoid tenderness and sagging of the posterior-superior wall in one

Table 2 Incidence of cause of mode of trauma

Case of injuries	No. of patients	Age (%)
Road side accidents		
Motor vehicular accidents	27	84
Bicyclists	3	10
Pedestrians	2	6
Personal accidents/domestic falls	4	8
Assaults	4	8
Agriculture and related injuries	4	8
Sports injuries	3	6
Industrial accident	2	4
Fire arm injuries	1	2

each case. Among the symptoms, dizziness was present in 34 patients (68%), headache in 23 patients (46%), unsteadiness and loss of consciousness 18 patients (36%) each, neck pain and/or stiffness in 14 patients (28%) and tinnitus 12 patients (24%). Disturbance of equilibrium were reported by 24 patients (48%). Disturbed balance with sudden movements was seen in 14 cases (28%), occasional difficulty in walking was seen in 8 cases (16%) and vertigo of ship deck type in 2 cases (4%) each (Table 3).

The vault fractures were seen in 14 (28%), 9 (18%) had fracture of the petrous part of the temporal bone, 4 cases (8%) had fracture of the squamous part of the temporal bone and there was fracture of the mastoid portion of temporal bone (Fig. 2). Among various types of head injuries, fracture skull not involving petrous part of the temporal bone was present in 5 (10%) cases, fracture petrous part of the temporal bone 9 (18%), head injury without fracture but with unconsciousness 20 cases (40%) and head injury without fracture and unconsciousness 16 (32%). On further analysis of fracture of the petrous part of the temporal bone, longitudinal fracture was present in 7 (78%) and transverse fracture in 2 (22%) cases (Table 4).

Two patients (28%) had facial nerve palsy among longitudinal fracture cases and one (50%) patient had facial nerve palsy among transverse fracture cases (Table 4). One patient among longitudinal fracture improved after medical management but rest did not.

All the head injury patients were subjected to tuning fork test, Rinnie's test was negative in 12 cases (24%) and positive in 29 cases 58% and positive but reduced in 12 cases (24%). Weber's test was lateralized in 21 cases (42%) out of these 21 cases, it was lateralized to right ear in 12 cases and to the left ear in 9 cases, it was centralized or indeterminable in 29 cases (58%). Schwabach test was shortened in 9 cases (18%) and lengthened in 12 cases (24%) and normal in 29 cases (58%). Absolute bone

Table 3 Incidence of ear, nose and throat injury

Injuries	No. of patients	Age (%)
Ear		
Hearing loss	21	42
Temporal bone fracture	9	18
Lacerations of pinna and external auditory canal	7	14
Bleeding from ear	6	12
Injury of the tympanic membrane	2	4
CSF otorrhoea	2	4
Facial nerve palsy	3	6
Nose		
Bleeding nose	17	34
Lacerations or fracture nose	7	14
CSF rhinorrhoea	1	2
Throat		
Bleeding from throat	2	4
Respiratory problem	4	8

Fig. 2 Fracture of various sites of skull bones**Table 4** Incidence of various types of fractures of the petrous part of the temporal bone and facial nerve paralysis

Fracture of petrous part of the temporal bone	No. of cases	Facial nerve paralysis
Longitudinal	7 (78%)	2 (28%)
Transverse	2 (22%)	1 (50%)

conduction was shortened in 9 cases (18%) and normal in 41 cases (82%).

Among various types of head injury cases patients with longitudinal fracture of the temporal bone hearing loss was

present in 7 cases out of which 3 cases had conductive hearing loss, 4 cases had mixed hearing loss. The sensorineural hearing loss was present in all cases with transverse fracture (i.e., 2, 4%) (Table 5).

Among other head injury cases, patients having fracture skull not involving temporal bone, one patient showed conductive hear loss, two had mixed hearing loss and one patient had sensorineural hearing loss. In patients with head injury without fracture but unconsciousness one patient showed conductive hearing loss, and two patients showed sensorineural loss. In head injury cases without fracture and unconsciousness one patient showed mixed loss and two patients showed sensorineural hearing loss (see Table 6).

The recruitment was seen in one case having longitudinal fracture of temporal bone. Among other head injury cases fracture skull not involving temporal bone, two patients had recruitment, among head injury without fracture but with unconsciousness one case had recruitment and among head injury without fracture and unconsciousness one case had recruitment. The incidence of recruitment as tested by short increment sensitive index (SISI) test. Two cases had tone decay and both of them were among transverse fracture cases. Patients with longitudinal fracture and other head injury cases showed no tone decay.

The Schirmer test was used as the indicator for the site of the facial nerve injury. Three patients had ipsilateral decreased tearing. No patient had bilateral decreased tearing and 6 patients had normal tearing.

Discussion

The most vulnerable age group of head injuries was between 21 and 30 years of age. 23 patients out of the total 50 were from this age group forming 46%. Chamyal [5] observed that the most common age group was 21–30 years. In this age group 25 patients (50%) out the total number of 50 patients they studies, were involved. Hilary and Brodie [1] observed that 70% of fractures occurring during second, third and fourth decades of life.

The male to female ratio in our study was 6.15: 1. Forty-three patients (86%) were males and 7 patients (14%) were females. The possible reasons for the male predominance in our study are:

- Ours is a male dominant society. Outdoor activity is much more in males as compared to the females.
- Females drive less as compared to males. Thus they are less involved in roadside accidents.
- Males are more aggressive, they drive fast, and are involved in violence, fights and assaults.

Table 5 Incidence of various audiometric patterns in head injury cases

Type of fracture	Conductive loss	Mixed loss	Sensorineural loss
Longitudinal fracture	3	4	–
Transverse fracture	–	–	2
Other head injury patients			
(a) Fracture skull not involving temporal bone	1	2	1
(b) Head injury without fracture but with unconsciousness	1	2	2
(c) Head injury without fracture & unconsciousness	–	1	2

Table 6 Summary of findings in all patients with hearing impairment

	Primary examination		4–8 weeks after trauma	
	No.	Age (%)	No.	Age (%)
Conductive hearing loss				
Tympanic membrane perforation	2	4	–	–
Hemotympanum	2	4	–	–
Lesion of auditory ossicles	1	2	1	2
Mixed hearing loss				
High frequency loss	4	8	4	8
Flat curve > 30 db	5	10	4	8
Sensorineural hearing loss				
High frequency sensorineural loss	3	6	3	6
Flat curve > 30 db	4	8	4	8

Gharpure et al. [6] in their analysis of 21,587 casualties due to accidents, male female ratio come to 7:1. Chamyal [5] in their study on 50 head injury cases has given male to female ratio of 9:1. Ishman et al. [7] in their study on 196 cases observed that majority of patient were male patients (81%).

Mode of Trauma

Out of the total 50, 32 (64%) patients were injured in roadside accidents. Out of these 32, 27 (84%) were injured in a variety of motor vehicles (self and intervehicular) accidents, 3 (10%) were the bicyclists (self and hit by other vehicles) and 2 (6%) were the pedestrians. Other modes of the injuries were the personal accidents/domestic falls in 4 cases (8%), sports injuries 4 cases (8%), agriculture related injuries 4 cases (8%), and industrial accidents 2 cases (4%). Chamyal [5] studied 50 head injury patients for audiovestibular derangements reported that maximum number of injuries were caused by vehicular accidents (62%) followed by accidental falls in 22% of the cases. Ishman et al. [7] in their study on 196 patients shows 45% cases due to MVA, falls account for 31%, assault accounts for 11% and gunshot accounts for 6%. Hilary and Brodie [1] observed that 31% of head injury cases are due to MVA, 16% due to assault, falls account for 15% cases, pedestrian 8%, bicycle 6%, gunshot 4%.

Incidence of Alcohol and Other Intoxicant Consumption

8 patients (16%) out of total 50 were either smelling of alcohol or reluctantly gave history of alcohol consumption. 2 patients (4%) admitted that they were the opium addicts. No specific medical test was carried out to ascertain the nature of intoxicant used. Baker [8] studied the deaths due to trauma from autopsy records and observed that elevated alcohol level in blood were present in 20.6% of the bodies. Richard and Blakeslee [9] documented alcohol consumption in 27.9%. At the same time he admitted that involved alcohol users were undoubtedly under estimated and the toxicology screenings were not routinely used.

Otological Symptoms and Signs

Dizziness was most common symptoms seen in 34 patients (68%), headache 23 patients (46%), hearing loss 21 cases (42%), loss of consciousness and unsteadiness in 18 cases (36%) and tinnitus in 12 cases (24%).

Among the signs were the bleeding from the ear 6 cases (12%), facial nerve palsy 3 cases (6%), tympanic membrane perforation 2 cases (4%), hemotympanum 2 cases (4%) CSF otorrhoea 2 cases (4%) mastoid tenderness, 1 case (2%) and sagging of the posterior-superior wall of the meatus 1 case (2%).

Chamyal [5] in their series of 50 cases of head trauma, reported the signs and symptoms in order of frequencies of occurrence as dizziness and equilibrium disturbance (44%) each, bleeding from the ear (40%), tinnitus (36%), CSF leak (4%) and hearing impairment in 44% cases.

Radiological Findings

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. Chamyal [5] 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. Out of these in temporal bone patients 10 (72%) had longitudinal and 4 (28%) had transverse fracture. Ishman et al. [7] in their study on 196 cases reported 99 (64%) were longitudinal fracture and 36 (23%) were transverse fracture.

Audiometric Findings

Among various types of head injury cases, patients with longitudinal fracture of the temporal bone hearing loss was present in 7 cases, out of which 3 cases had conductive hearing loss, 4 cases had mixed loss. Patients with transverse fracture of the temporal bone, two cases had sensorineural hearing loss. Among other head injury cases, patients having fracture skull not involving temporal bone, one patient showed conductive hearing loss and two had mixed hearing loss and one had sensorineural loss. In patients with head injury without fracture with unconsciousness one patient showed conductive hearing loss two patients showed mixed hearing loss and two patients showed sensorineural loss. In head injury cases without fracture and unconsciousness, one case showed mixed hearing loss, and two cases showed sensorineural loss. Chamyal [5] in their 50 head injury cases the hearing impairment was present in 22 cases (44%) which included 3 cases of conductive deafness and 19 of sensorineural and mixed hearing loss. The overall audiometric pattern in the series showed that large number of them (8 out of 19) had high tone loss whereas flat curve was found in 4 cases. Irwin [10] in his series of causes of hearing loss in adults following head injury described 80% of temporal bone fracture as longitudinal which might result in conductive hearing loss secondary to ossicular chain injuries. The remaining 20% were a transverse fractures and such injuries involved the cochleovestibular nerve either directly or by shearing forces.

Incidence of Recruitment and Tone Decay

5 patients (10%) showed evidence of recruitment indicative of cochlear type of deafness. 2 patients (4%) showed

evidence of tone decay indicative of retrocochlear type of deafness both the cases had transverse fracture as indicated by the CT scan.

Vestibular Lesions

The disturbed balance and vertigo was reported in 29 cases (58%). In most of these cases the disturbed balance accompanied sudden movements and some experienced merely difficulty in walking. Chamyal [5] in his study of 50 head injury cases reported disturbed balance and vertigo in 34 cases (68%).

Facial Nerve Injury

Out of the 7 longitudinal fracture cases 2 patients (28%) had facial nerve palsy, and out of the 2 transverse cases, 1 patient (50%) had facial palsy. Kerr and Toner [4] in his series described that facial nerve injuries are uncommon in longitudinal fracture and when they occur are usually delayed in onset. Facial nerve injuries occur in about 50% of these patients and the onset is usually immediate. Glasscock and Shambaugh [11] in their series, described that facial nerve may be injured in a longitudinal fracture, it is seldom severed. Transverse fractures, however, almost always result in a severely damaged and often severed nerve. Ishman et al. [7] in their study found 13.9% of patients with transverse fracture have facial nerve palsy 25 and 4% of the patients with longitudinal fracture and 25% of the patients with mixed temporal bone fracture.

Conclusion

Majority of the patients who sustained head injuries are the young males, injuries are less common in very young, very old and the females.

MVA are still the commonest cause of injuries compared to the other mode of injury. The unruly traffic, poor condition of the Indian roads, unexpected behaviour of the animals on the roads, lack of Alcohol and drug screening and the lack of seat belt and the helmet laws are the reasons in general, responsible of for the excessive MVA in our country. Patients with longitudinal fracture showed conductive and mixed loss and patients with transverse fracture showed sensorineural hearing loss. Incidence of facial nerve paralysis was more with transverse fracture cases than with longitudinal fracture cases. On follow up, there was more improvement in cases with conductive hearing loss than with, mixed hearing loss cases. There was no improvement among sensorineural hearing loss patient.

References

1. Hilary H, Brodie A (2005) Management of temporal bone trauma. *Otolaryngol Head Neck Surg* 3(4):28–48
2. Dale BAB, Kerr AIG (1999) Otological trauma. In: Maran AGD (ed) Logan Turner's diseases of the ear, nose and throat. 10th edn. Edward Arnold (publishers) Ltd, London pp 345–352
3. Ward PH (1969) Symposium on auditory and vestibular disorders in head trauma. *Arch Otolaryngol* 78: 227
4. Kerr AG, JG Toner (1997) Ear trauma. Textbook of Scott-Brown's otolaryngology, 6th edn. Butterworth-Heinemann, London pp 172–184
5. Ahluwalia CL (1983) Audiovestibular derangement in head trauma. *Indian J Otolaryngol* 35:55–60
6. Gharpure PV, Jhalla CI, Nair MB (1959) Accidents. *Indian J Med Sci* 13:232–236
7. Ishman SL, Friedland DR (2004) Temporal bone fractures: traditional classification and clinical relevance. *Laryngoscope* 114(10):1734–1741
8. Baker SP (1987) Injury, the neglected epidemic stone lecture (1985) at American Trauma Society Meeting. *J Trauma* 27(4):343–348
9. Richard AB, Blakeslee B (1989) The changing picture of facial fractures. *Arch Otolaryngol Head Neck Surg* 115:826–829
10. Irwin J (1997) Causes of hearing loss in adults. Text book of Scott Brown's otolaryngology, 6th edn. 2:127–156
11. Glasscock ME, Shambaugh GE Jr (1990) Diagnosis of ear diseases. In: Glasscock ME, Shambaugh GE (eds) Text book of surgery of the ear, 4th edn. pp 55–84