A STUDY OF TEMPORAL BONE FRACTURES WITH OTOLOGICAL MANIFESTATIONS

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ABSTRACT

BACKGROUND

The temporal bones form parts of the middle and posterior cranial fossae and contribute to the neurocranium or skull base.¹ Temporal bone trauma is usually the result of blunt head injury and patients commonly suffer from multiple other body injuries. Temporal bone fracture may result in potentially serious injuries as the facial nerve, middle ear, inner ear and intracranial contents are at risk. Immediate and long term sequelae can be devastating. Motor vehicle accidents are the most common cause. This study focus on the diagnosis and treatment of temporal bone trauma, its complications and management as these injuries can have drastic consequences if they are not recognized and treated promptly and effectively.

The aim of this study was to find out the various otological manifestations in patients with CT head proven temporal bone fracture following head injury presenting to Govt. Medical College Kottayam ENT casualty/OP during a period of 18 months.

MATERIALS AND METHODS

A hospital based descriptive study was conducted in a tertiary centre in Kottayam. 60 cases of CT Head proven temporal bone fracture during the period of 18 months were included in the study. Data was collected by proper history taking followed by general examination, systemic examination and ENT examination. CT findings were interpreted. Patients were followed up after his/her general conditions get improved. Pure tone audiogram was done to assess type and degree of hearing loss if any during their follow up visit usually after 6 weeks of injury. All findings were properly recorded and analysed.

RESULTS

Temporal bone fracture occurs commonly in young males following road traffic accident and mostly involves right temporal bone with longitudinal type constituting majority of cases. 38 patients sustained hearing loss and 17% patients had facial palsy of which 10 patients had delayed onset facial palsy and rest 7 had facial palsy immediately after trauma. 10 patients had CSF otorrhoea and 4% patients suffered from meningitis. 15 patients sustained traumatic perforation of tympanic membrane. 20 patients had haemotympanum and 9 patients had post trauma tinnitus.

CONCLUSION

The present study was carried out to find out the various otological manifestations of temporal bone fracture. Since temporal bone fracture can lead to serious long term morbidity and sequelae this knowledge will help in early detection of complication which helps in subsequent management and rehabilitation of patients.

KEYWORDS

Temporal Bone Fracture, Facial Palsy, Hearing Loss.

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BACKGROUND

The temporal bone is a complex portion of the skull base that contains the labyrinth with its nerve supply (cranial nerve VIII) and other cranial nerves such as the facial, trigeminal, vagus, glossopharyngeal, spinal accessory, and hypoglossal nerve. Temporal bone trauma is usually a result of blunt head injury. Fractures involving temporal bone occurs in nearly 20% of all head injury patients Road traffic accidents are the most common cause of temporal bone fracture. Personal accidents like falls, assaults, gunshot injuries, and iatrogenic injuries contribute to a lesser extent.

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Given the great forces involved, temporal bone fractures rarely occur in isolation and initial evaluation must focus on the fundamental ABCs of Advanced Trauma Life Support with special attention to Glasgow Coma Scale, intracranial injury, and cervical spine injury. In the initial acute phase, otological manifestations are often overlooked and later forgotten.

It is important to identify and manage non-life threatening injuries in an attempt to try and improve the subsequent quality of life. Unrecognized otological injuries are one such group of injuries which if left uncorrected may add to difficulties in rehabilitation and adversely affect the overall quality of later life.

The more common sequelae of temporal bone fracture include injury to the facial nerve with facial paresis or paralysis; disturbance of the cochleovestibular apparatus with associated sensorineural hearing loss, conductive hearing loss, balance disturbance, tinnitus, and vertigo; and cerebrospinal fluid (CSF) leak. Less common otologic manifestations include conductive hearing loss secondary to ossicular chain damage, sympathetic sensorineural hearing loss, perilymphatic fistula, posttraumatic endolymphatic

hydrops, cholesteatoma, meningocoele/encephalocele, and late otogenic meningitis.

The purpose of this study is to look at the various otological manifestations and complications in temporal bone fracture patients and subsequent patient management.

MATERIALS AND METHODS

This is a descriptive study conducted in 60 patients for 18 months.

Inclusion Criteria

Patients with temporal bone fracture following head injury proven by CT Head presenting to Govt. Medical College, Kottayam ENT casualty/OP during the study period.

Exclusion Criteria

Patients with serious systemic illness and or severe neurological illness.

Patients with chronic ear diseases in the past.

Patients not willing to participate.

Sample Size

According to D. Bradley Welling, and Mark D. Packer's "Trauma to middle ear inner ear and temporal bone fracture" in Ballenger's Otorhinolaryngology Head and Neck Surgery; 17th edition temporal bone fracture occurs in 4-5% of traumatic head injury.

Study Procedure

Patients presenting with head injury whose CT brain showing temporal bone fracture was enrolled in the study after obtaining consent from the patient and bystanders a proper history was taken. After taking history, a methodological general examination, systemic examination and ENT examination was done. CT Head findings were interpreted. Patients were followed up after his/her general conditions get improved. Pure tone audiogram was done to assess type and degree of hearing loss if any during their follow up visit usually after 6 weeks of injury. All findings were properly recorded.

Data Entry and Statistical Analysis

After the completion of data collection, the values were properly coded and entered in Microsoft excel. Analysis of the data was done using the software statistical package for the social science (SPSS) version 16.0.

RESULTS AND ANALYSIS

The study was conducted in 60 patients for a period of 18 months. The results analysed are as follows:

Age Distribution of Study Population

Age Group	Frequency	Percentage
<20	2	3.3
20-40	35	58.3
40-60	16	26.6
60-80	7	11.8
Total	60	100.0

Table 1. Distribution of the study population based on age

The largest group of study subjects comprised between 20–40 (58.3%) years of age followed by 40–60 (26.6%) years of age.

Sex Distribution of Study Population

Gender	Frequency	Percentage
Male	42	70.0
Female	18	30.0
Total	60	100.0

Table 2. Distribution of the study population based on gender

Majority of the patients (42) were 2 males which constitutes 70% of the total study population.

History Distribution of the Study Population

History	Frequency	Percentage
RTA	39	65.0
Fall from Height	10	16.7
Assault	10	16.7
Sports Injury	1	1.7
Total	60	100.0

Table 3. Distribution of the study population based on history of trauma

The most common cause which resulted in temporal bone fracture in this study was road traffic accident which is the history in 39 patients (65%).

Side Distribution in Study Population

Side	Frequency	Percentage
Right	33	55.0
Left	27	45.0
Total	60	100.0

Table 4. Distribution of the study population based on side of trauma

Majority of patients (55%) sustained right sided temporal bone fracture.

Distribution of Temporal Bone Fracture Based on the Type of Fracture

Type of Temporal Bone Fracture	Frequency	%
Longitudinal	38	63.3
Transverse	10	16.7
Mixed	12	20
Total	60	100

Table 5. Distribution of temporal bone fracture based on the type of fracture

38 (63.3%) temporal bone fractures were longitudinal type. 10 fractures (16.7%) were transverse type and the rest 12 (20%) were mixed type with both longitudinal and transverse components.

Distribution of Patients Based on Type of Hearing Loss Out of 52 Patients who were Tested for Hearing Loss

Type of Hearing Loss	Frequency	Percentage
Conductive	18	34.6
Sensorineural	13	25
Mixed	7	13.5
Normal	14	26.9
Total	52	100.0
Table 6. Distribution of the study population based on the type of hearing loss		

Among the patients with hearing loss 34.6% [18] having conductive hearing loss, 25% [13] having sensorineural hearing loss and 13.5% [7] having mixed hearing loss. Hearing was normal in 14 patients. (26.9%).

Distribution of Patients Based on the Degree of Hearing Loss

Degree of Hearing loss	Frequency	Percentage
Minimal	9	23.7
Mild	11	28.9
Moderate	7	18.4
Moderately Severe	5	13.2
Severe	6	15.8
Profound	0	0
Total	38	100.0
Table 7. Among those who had hearing loss, the degree of hearing loss is as follows		

Degree of hearing loss were minimal 23.7% [9], mild 28.9% [11], moderate 18.4% [7] moderate severe 13.2% [5], and severe 15.8% [6] of patients. Majority of the patients suffered from mild degree of hearing loss.

Most of the patients (38.9%) with conductive hearing loss suffered minimal degree of conductive loss.

Among the total 13 patients who suffered sensorineural hearing loss following temporal bone fracture 4 patients (30.8%) had minimal degree of hearing loss and same number of patients suffered mild degree of hearing loss.

Among the patients with mixed hearing loss 3 (42.9%) suffered severe degree of hearing loss.

Distribution of Patients with Clinical Finding of Facial Palsy

History of Facial Palsy	Frequency	Percentage
Present	17	28.3
Absent	43	71.7
Total	60	100.0
Table 8: Distribution of the population based on clinical finding of facial palsy		

17 out of 60 patients (28.3%) sustained facial palsy following temporal bone fracture.

Distribution of the Study Population with Facial Palsy Based on the Onset of Facial Palsy

Onset	Frequency	Percentage
Immediate	7	41.2
Delayed	10	58.8
Total	17	100
Table 9. Distribution of the study population with facial palsy based on the onset of facial palsy		

10 out of 17 patients (58.8%) with facial palsy had a delayed onset of facial palsy while the rest 7 patients (41.2%) had immediate onset of facial palsy following temporal bone fracture.

Distribution of the Study Population with Facial Palsy Based on Their Recovery

Recovery	Frequency	Percentage
Recovered	10	58.8
Not recovered	3	17.7
Not followed up	4	23.5
Total	17	100.0
Table 10. Distribution of the study population with facial palsy based on their recovery from facial palsy		

10 patients completely recovered from facial palsy within 3 months. Out of the rest 7 patients 3 patients had not recovered from facial palsy.

Distribution of Facial Palsy in Various Types of Temporal Bone Fractures

Type of Temporal Bone Fracture	Frequency of Facial Palsy	Percentage
Longitudinal	8	47.1
Transverse	3	17.6
Mixed	6	35.3
Total	17	100
Table 11. Distribution of facial palsy in various types of temporal bone fracture		

Of the 17 patients with facial palsy 8 patients (47.1%) sustained longitudinal temporal bone fracture 3 patients (17.6%) had transverse temporal bone fracture and the rest 6 patients (35.3%) sustained mixed type of temporal bone fracture.

Distribution of Study Population with Longitudinal Fracture Based on the Occurrence of Facial Nerve Palsy

History of Facial Palsy	Frequency	Percentage
Present	8	21.1
Absent	30	78.9
Total	38	100.0
Table 12. Distribution of study population with longitudinal fracture based on the occurrence of facial nerve palsy		

Out of the total 38 patients who sustained longitudinal temporal bone fracture following head injury 8 patients suffered from facial palsy constituting 21.1% of the study population.

Distribution of Study Population with Transverse Fracture Based on the Occurrence of Facial Nerve Palsy

History of Facial Palsy	Frequency	Percentage
Present	3	33.3
Absent	7	76.7
Total	10	100.0

Table 13. Distribution of study population with transverse fracture based on the occurrence of facial nerve palsy

3 patients out of the total 7 patients with transverse temporal bone fracture sustained facial nerve palsy which constitutes 33.3% of the total.

Distribution of the Study Population Based on the Presence of CSF Otorrhoea

History of CSF Otorrhoea	Frequency	Percentage
Present	6	10.0
Absent	54	90.0
Total	60	100.0

Table 14. Distribution of the population based on the presence of CSF otorrhoea

Out of the 60 patients with temporal bone fracture 6 patients (10%) sustained CSF otorrhoea.

Distribution of Study Population Based on History of Vertigo

History of Vertigo	Frequency	Percentage
Present	20	33.3
Absent	40	66.7
Total	60	100.0

Table 15. Distribution of the study population based on history of Vertigo

20 patients (33.3%) with temporal bone fracture gives history of vertigo.

Distribution of the Study Population Based on History of Tinnitus

History of Tinnitus	Frequency	Percentage
Present	9	15.0
Absent	51	85.0
Total	60	100.0

Table 16. Distribution of the study population based on history of Tinnitus

15% patients (9) gives history of tinnitus following temporal bone fracture.

Distribution of the Study Population Based On the Occurrence of Meningitis

History of Meningitis	Frequency	Percentage
Present	4	6.7
Absent	56	93.3
Total	60	100.0

Table 17. Distribution of the study population based on the occurrence of Meningitis

4 patients out of the 60 patients with temporal bone fracture suffered from meningitis which constitutes 6.7% of the study population.

Distribution of the Study Population Based on Clinical Finding of Nystagmus

History of Nystagmus	Frequency	Percentage
Present	4	6.7
Absent	56	93.3
Total	60	100.0

Table 18. Distribution of the study population based on clinical finding of Nystagmus

Out of the 60 patients with temporal bone fracture, on clinical examination 4 patients (6.7%) had nystagmus.

Distribution of the Study Population Based on Tympanic Membrane Perforation on Otoscopy

History of Perforation	Frequency	Percentage
Present	15	25.0
Absent	45	75.0
Total	60	100.0

Table 19. Distribution of the study population based on tympanic membrane perforation on otoscopy

15 patients (25%) on otoscopic examination showed the presence of tympanic membrane perforation following temporal bone fracture.

Distribution of the study population Based on Presence of Haemotympanum on Otoscopy

History of Haemotympanum	Frequency	Percentage
Present	20	33.3
Absent	40	66.7
Total	60	100.0

Table 20. Distribution of the study population based on presence of Haemotympanum on otoscopy

On otoscopic examination of the 60 temporal bone fracture patients 20 patients (33.3%) showed haemotympanum.

Distribution of Patients with Haemotympanum based on the Degree of Hearing Loss

Degree of hearing loss	Frequency	Percentage
Normal	8	47.1
Mild	1	5.9
Moderate	4	23.5
Moderately Severe	4	23.5
Total	17	100

Table 21. Distribution of patients with Haemotympanum based on the degree of hearing loss

Out of the total 20 patients with persistent haemotympanum on follow up visit PTA was advised for all. Only 17 patients reported back with PTA. After pure tone audiometric examination, it was found that hearing was normal in 8 patients. 1 patient had mild hearing loss and 4 patients had moderate and another 4 had moderately severe hearing loss.

DISCUSSION

The study was conducted among 60 CT head proven cases of temporal bone fracture during the study period.

The analysis included demographic characteristics like age and sex distribution, history of occurrence of fracture, side of fracture, type of fracture. The clinical parameters associated with temporal bone fractures like hearing loss, facial palsy, tinnitus, vertigo, nystagmus, CSF otorrhoea, meningitis, haemotympanum has been studied in detail.

Age

In this study majority of patients were in the age group of 20-40 years, which constitutes 58.3% of total study population. Study by Bordie and Thompson⁶ states that temporal bone fractures were more in 2nd and 3rd decade of life. This is due to the fact that this is the most active age group in life.

Sex

Present study shows that 70% persons with temporal bone fracture are males. According to Hilary A. Brodie and Brent J. Wilkerson in the chapter 'management of temporal bone trauma' in Cummings Otolaryngology 6th edition 71-81% of temporal bone fractures are for males. This may be due to the fact that male drivers are more than female drivers.

Side of the Fracture

In this study 55% were Right sided fractures and 45% were left sided fractures. Study by Z. amin et al at Malaysia found a slight higher incidence on right side than left.² They attributed the result to the right hand side drive vehicle, and the right side is more exposed to lateral crashing in accident.

Mechanism of Injury

The main mechanism causing temporal bone fracture are road traffic accidents³ which accounts for 65% of total cases. Rest 16.7% was due to fall from height and assault. One case was reported due to sports injury.

According to Ki Hong Kevin Ho's study motor vehicle accidents accounts for 12-47% cases of temporal bone fracture followed by assaults which constitutes 10-37% then falls 16-40% followed by gunshots which is the history in 3-35% of patients. With improved automobile safety the incidence of fractures due to accidents are decreasing.

Type of Temporal Bone Fracture

In the present study the most common type of temporal bone fracture is longitudinal temporal bone fracture which constitutes 38 patients (63.3%). In the previous study by Brodie and Thompson, Cannon CR, and Jahrsdoerfer RA also reports longitudinal fracture as the most common temporal bone fracture.⁴ Transverse fractures constitute 16.7% [10] patients and the rest 20% [12] cases were mixed fractures.

Hearing Loss

In this study 52 patients were tested for hearing loss by pure tone audiometry during their follow up visits after 6 weeks

of which 38 had hearing loss. According to study- "Otolological complications following basilar skull fracture" conducted by J. L. Lancaster, D. J. Anderson, and J W A Curley in U K about 42 % patients had hearing loss following temporal bone fracture.⁵

Among the patients with hearing loss 34.6% [18] having conductive hearing loss, 25% [13] having sensorineural hearing loss and 13.5% [7] having mixed hearing loss. Hearing was normal-(Less than 15 dB) in 14 patients. (26.9%). This is in accordance with the study conducted by Yetiser S, Hidir Y and Gonul E, where 18 (51.4%) of patients had conductive hearing loss, 6 (17.14%) of the patients had sensorineural hearing loss, and 11 (31.42%) had normal hearing.⁶

Degree of hearing loss was minimal in 23.7% [9], mild in 28.9% [11], moderate in 18.4% [7], moderately severe in 13.2% [5], and severe in 15.8% [6] patients.

Facial Nerve Palsy

In this study 28.3% [17] patients sustained facial nerve palsy following temporal bone fracture. In the study of Facial nerve problems and hearing loss in patients with temporal bone fracture by Yetiseretal⁶ facial paralysis was detected in 24 of 35 patients (68.57%). According to Brodie HA, Thompson TC⁴ among 7% of patients who had temporal bone fracture sustained facial paralysis.

Among the patients with facial nerve palsy the onset of facial palsy in 41.2% [7] was immediate and 58.8% [10] was delayed. In the study conducted by Brodie HA and, Thompson TC⁶ in 820 temporal bone fractures 27% were immediate onset and 73% were delayed onset facial palsy.

Facial nerve palsy was present in 8 patients out of the total 38 patients with longitudinal fracture and 3 out of 7 patients with transverse temporal bone fracture. So the incidence of facial palsy in longitudinal fracture in this study is 21.1% and in transverse temporal bone fracture is 33.3%. Using the traditional classification system, facial nerve injury occurs in 10% to 25% of longitudinal fractures and 38% to 50% of transverse fractures.

Of the 17 patients 14 were followed up and 58.8% [10] were recovered completely. 41.2% [4] patients had persistent facial palsy or incomplete recovery to lesser grades of House-Brackman grading.

McKenna and Chole⁷ had described their experience of 17 patients with immediate-onset facial paralysis and 19 with delayed-onset paralysis. Complete spontaneous recovery of facial function occurred in 94% of the patients with delayed-onset paralysis; the one remaining patient had a House Brackmann grade II recovery. In contrast, 8 of the 17 immediate-onset paralysis patients had facial nerve transection, with no recovery.

CSF Otorrhoea

Present study showed CSF otorrhoea in 10% [6] patients. Study by J L Lancaster and DJ Anderson states CSF otorrhoea for 18% patients.⁵ According to Brodie HA, Thompson TC⁴: 'Management of complications from 820 temporal bone fractures', CSF fistulae and the potential for meningitis are among the most serious complications of temporal bone fractures and occur in 17% of such fractures.

Vertigo

Present study shows 20 patients [33.3%] having post traumatic vertigo. According to study by J.L. Lancaster, D.J.

Alderson, J. W. A. Curley in UK vertigo was present for 20% of patients.⁵

Tinnitus

This study shows 15% [9] of patients having post fracture tinnitus. Study by J. L. Lancaster, D. J. Alderson, J. W. A. Curley in UK shows about 2% of patients having this symptom.⁵

Meningitis

Four patients [6.7%] have featured signs of meningitis. It usually depends on CSF leakage.

Leech and Paterson⁸ compared the incidence of meningitis in patients with CSF leaks that lasted 7 days or less with those that persisted for more than 7 days. Leech and Paterson found only a 5% incidence of meningitis in patients with CSF fistulae of less than 7 days duration. The incidence of meningitis in patients with leakage for more than 7 days in Leech and Paterson's series was 55%.

In this study all patients developed meningitis within the first week of trauma and 3 patients had associated other skull base fractures. Only one had isolated temporal bone fracture.

Tympanic Membrane Perforation

This study showed perforation for 25% [15] patients.

Haemotympanum

Present study showed 33.3% [20] patients had haemotympanum as a clinical finding on otoscopy. According to study by J.L. Lancaster, D. J. Alderson, J. W. A. Curley in UK, haemotympanum was present for 28% of patients.

Hearing Loss in Haemotympanum

In the present study after pure tone audiometry in 17 patients with haemotympanum it was found that hearing was normal in 8 patients. 1 patient had mild hearing loss and 4 patients had moderate and moderately severe hearing loss. Residual conductive hearing loss following resolution of the haemotympanum and healing of the tympanic membrane suggests the possibilities of ossicular fracture or discontinuity. Injury to ossicular chain resulting from skull fracture in the living was reported first by Thorburn in 1956 and later by J. V. D. Hough.⁹

Summary

Among the 60 patients, majority of the patients were young male of the age group of 20-40 years with history of road traffic accident. Most of them sustained right sided temporal bone fracture. The most common type of fracture was longitudinal type of temporal bone fracture.

The commonest otological manifestation following temporal bone fracture was hearing loss. Pure tone audiometry was conducted in 52 patients during their follow up visit and 38 patients had hearing loss following temporal bone fracture. 18 out of 52 patients sustained conductive hearing loss, while 13 patients suffered sensorineural and 7 patients suffered mixed hearing loss following temporal bone fracture. Majority of them sustained mild degree of hearing loss between 26 – 40 db of hearing loss.

Facial nerve palsy which is the most socially incapacitating complication following temporal bone fracture occurred in 17 patients which constitutes 28.3% of the study population. 10 patients presented with delayed onset facial

palsy and rest 7 had facial palsy at the initial stage of presentation itself. Of the 17 patients 14 were followed up and 10 patients were recovered completely, while 4 patients had persistent facial palsy or incomplete recovery to lesser grades of House-Brackmann grading of facial nerve palsy. Facial palsy occurred in 21.1% of longitudinal fractures and in 33.3% of transverse temporal bone fractures.

CSF otorrhoea was found in 6 patients and of this 4 patients suffered meningitis. 20 patients had post traumatic vertigo and 9 patients had tinnitus following temporal bone fracture. 15 patients sustained traumatic tympanic membrane perforation and 20 patients showed haemotympanum on otoscopy following temporal bone fracture.

CONCLUSION

Careful evaluation of patients with temporal bone fracture is very important to identify the complications at the earliest which is very essential for the management and rehabilitation of these patients.

Otological referral of all patients with clinical or radiological evidence of a temporal bone fracture is a must. Screening would initially involve a thorough history, examination, and high resolution computerised tomography scans of the temporal bones should be requested if indicated.

Early management focuses on stabilization of the patient, with subsequent efforts focused on treating complications. Hearing loss is the most common complication following temporal bone fracture and facial palsy is a severely disfiguring complication of facial palsy.

Early conservative management is recommended for hearing loss, CSF leak, and facial paresis. Long-term follow up is necessary to address hearing loss and monitor for intratemporal and intracranial complications

REFERENCES

- [1] Patel A, Groppo E. Management of temporal bone trauma. *Cranio* 2010;3(2):105-13.
- [2] Zamin A, Sayuti R, Kahairi A, et al. Head injury with temporal bone fracture one year review of case incidence, causes, clinical features and outcome. *Med J Malaysia* 2008;63(5):373-6.
- [3] Kirtane MV, Medikeri SB, Karnik PP. ENG after head injury. *Journal of Laryngology and Otology* 1982;96(6):521-8.
- [4] Brodie HA, Thompson TC. Management of complications from 820 temporal bone fractures. *Am J Otol* 1997;18(2):188-97.
- [5] Lancaster JL, Alderson DJ, Curley JW. Otological complications following basal skull fractures. *J R Coll Surg Edinb* 1999;44(2):87-90.
- [6] Yetiser S, Hidir Y, Gonul E. Facial nerve problems and hearing loss in patients with temporal bone fractures: demographic data. *J Trauma* 2008;65(6):1314-20.
- [7] McKennan KX, Chole RA. Facial paralysis in temporal bone trauma. *Am J Otol* 1992;13(2):167-72.
- [8] Leech PJ, Paterson A. Conservative and operative management for cerebrospinal fluid leakage after closed head injury. *Lancet* 1973;301(7811):1013-6.
- [9] Hough JV, Stuart WD. Middle ear injuries in skull trauma. *Laryngoscope* 1968;78(6):899-937.