(International Print/Online Journal)

SJIF IMPACT FACTOR: 6.829
PUBMED-National Library of Medicine ID-101739732

ISSN (Print): 2209-2870
ISSN (Online): 2209-2862

International Journal of Medical Science and Current Research (IJMSCR)
Available online at: www.ijmscr.com
Volume 8, Issue 6 , Page No: 332-341
November-December 2025

IJMSCR

Otological Manifestations In Head Injury Patients Admitted In Tertiary Care Center- A Clinical Study

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Type of Publication: Original Research Paper
Conflicts of Interest: Nil

Abstract

Introduction

Otological injuries are a frequently overlooked consequence of head trauma. These manifestations, ranging from conductive and sensorineural hearing loss to facial palsy and CSF otorrhea, can have significant implications if undiagnosed. This study emphasizes the importance of early otological evaluation in head injury patients.

Objectives

To evaluate the prevalence of otological manifestations in patients with head injury.
To identify various types of otological manifestations and their sequelae in head injury patients.

Methods

This prospective observational study was conducted over 18 months on 150 head injury patients at a tertiary care hospital. Patients were evaluated clinically and audiologically using otoscopy, tuning fork tests, pure tone audiometry, and CT imaging. Associations between specific otological findings and types of hearing loss were analyzed statistically using the Chi-square test.

Results

Most patients were males (82.7%), predominantly aged between 21–40 years. Road traffic accidents accounted for 62.7% of cases. Ear bleeding was the most frequent finding (34%), followed by tympanic membrane perforation and temporal bone fractures. Conductive hearing loss was significantly associated with tympanic membrane rupture ($p < 0.001$), whereas sensorineural hearing loss showed a strong correlation with facial nerve palsy ($p = 0.002$).

Conclusion

Otological complications are common in head injury and require systematic evaluation. Early identification and timely intervention are essential for reducing long-term morbidity and ensuring better outcomes in such patients.

Keywords: NIL

Introduction

Head injuries have been recognized since the early stages of human history and remain a critical global health issue, affecting populations across socioeconomic boundaries. With increasing incidents of road traffic accidents, falls, and trauma, the incidence of head injuries has risen notably. In the acute phase, otological manifestations are frequently missed or underreported. Many patients later present

with symptoms such as hemotympanum, tympanic membrane perforation, conductive or sensorineural hearing loss, facial nerve palsy, cerebrospinal fluid (CSF) rhinorrhoea or otorrhoea, and benign paroxysmal positional vertigo (BPPV). Comprehensive evaluation of auditory and vestibular dysfunction, along with facial nerve integrity, is vital for guiding prompt and appropriate treatment. This study was undertaken to emphasize the importance of recognizing otological involvement in head injury patients and to facilitate early diagnosis and intervention.

Methodology

Hospital based study was done in a tertiary care centre at Chidambaram for a period of one year. Patients with head injuries were enrolled in the study within two days of their admission, either from the Emergency Room (Casualty) or upon referral from the Department of Surgery. Those excluded from the study were patients with previous head injury, previous ear pathology or previous neurological ailments. The sample size was calculated using N Master Sample Size Software. Relative precision was taken as 10%, Level of confidence 95%. Sample size taken was 150. Head Injury patients with otological manifestations were selected for this study. Enrolling of patients into the study was done after getting informed consent from patients or from attenders if patient was unconscious. Demographic information, including age, sex, and comorbid conditions was collected. The cause of head injury was documented and systematically entered into a data sheet. Otological evaluation was done including otological history taking, complete ear examination, tuning fork tests, Pure Tone Audiometry and CT Brain. HRCT was taken in cases of temporal bone fracture and associated ear manifestations.Patients enrolled in the study were examined at the time of admission, during discharge and during the period of follow-up after 2 weeks. These patients were followed for two months. The Chi-square test was employed to assess statistical significance and p-value less than 0.05 was considered statistically significant.

Fig-1: Head Injury patient with Ear Bleed

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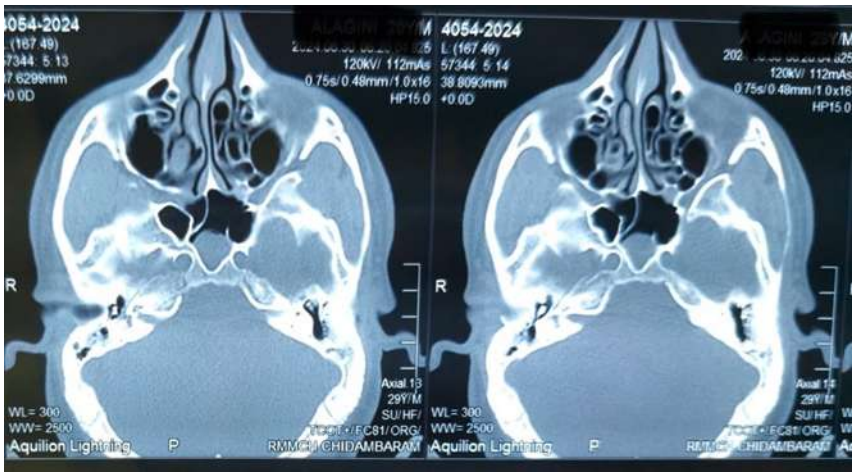
Fig-2: Patient with Ear Laceration

Fig-3: Patient with Facial Palsy

Fig-4: CT showing Right Temporal Bone Fracture



Result

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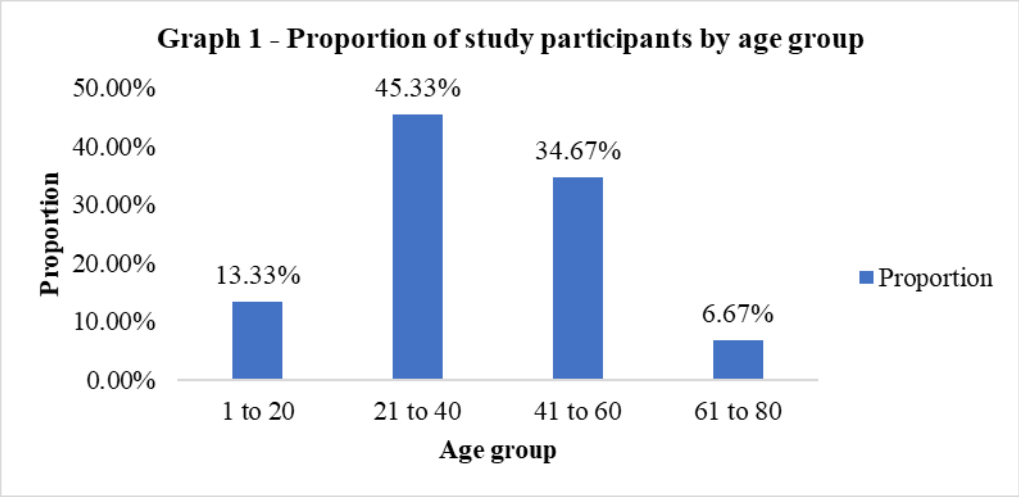
Fig-5: Bar diagram showing proportion of study participants by age group



The maximum number of patients with head injury were recorded within the age group of 21 to 40 years (45.33%), followed by 41 to 60 years (34.67%), suggesting a higher incidence of head injuries in younger to middle-aged adults.

Male patients represented a significant majority (82.67%), aligning with epidemiological patterns of trauma prevalence, likely due to increased risk exposures (e.g., occupational hazards, road use).

Table 1- Age and Gender-Wise Distribution of Patients

Age categorised	Gender	n	Proportion
1 to 20	Female	3	2.000 %
	Male	17	11.333 %
21 to 40	Female	16	10.667 %
	Male	52	34.667 %
41 to 60	Female	6	4.000 %
	Male	46	30.667 %
61 to 80	Female	1	0.667 %
	Male	9	6.000 %

Study shows that in all age groups, males significantly outnumber females, with the highest male proportion seen in the 21 to 40 (34.67%) and 41 to 60 (30.67%) brackets. This supports the male preponderance in trauma-related otological injury.

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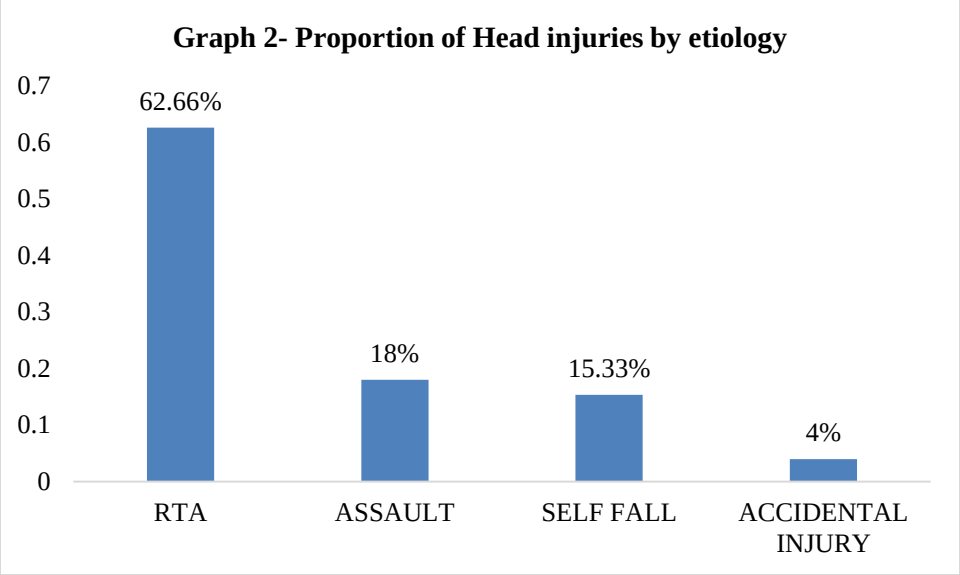

Fig-6: Bar diagram showing Proportion of Head injuries by etiology

The predominant cause of head injury was road traffic accidents (RTAs), accounting for 62.67% of cases. Assault (18%) and self-fall (15.33%) followed, while accidental injuries were least common (4%).

Table 2- Lateralization and Distribution of Otological Injuries

Type of Injury	Right		Left		Bilateral	
	n	Proportion	n	Proportion	n	Proportion
EAR BLEED	51	34.00%	45	30.00%	12	8.00%
TEMPORAL BONE FRACTURE	25	16.67%	9	6.00%	0	0.00%
FACIAL PALSY	3	2.00%	1	0.67%	0	0.00%
CSF OTORRHOEA	1	0.67%	0	0.00%	0	0.00%
EAR LACERATION	16	10.67%	10	6.67%	0	0.00%
TM RUPTURE	9	6.00%	9	6.00%	1	0.67%
HAEMOTYMPANUM	2	1.33%	2	1.33%	2	1.33%

The most frequent manifestation was ear bleeding, especially right-sided (34%), followed by temporal bone fracture (right: 16.67%) and ear laceration (right: 10.67%). Bilateral injuries were rare except for hemotympanum, which was evenly distributed across laterality.

Conductive hearing loss (CHL) was more common than sensorineural hearing loss (SNHL), predominantly on the right side. CHL occurred in 5.33% of cases on the right, while SNHL was documented only in 2% (right side).

Table 3- Gender Differences in Mechanism of Injury

Injury Type & Response	Female	Male	P-value
RTA - Present	10 (38.46%)	84 (67.74%)	0.0071

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RTA - Absent	16 (61.54%)	40 (32.26%)	
ASSAULT - Present	6 (23.08%)	21 (16.94%)	0.5739
ASSAULT - Absent	20 (76.92%)	103 (83.06%)	
SELF FALL - Present	7 (26.92%)	16 (12.9%)	0.08
SELF FALL - Absent	19 (73.08%)	108 (87.1%)	
ACCIDENTAL - Present	2 (8.0%)	4 (3.23%)	0.2645
ACCIDENTAL - Absent	23 (92.0%)	120 (96.77%)	

A statistically significant association was found between gender and road traffic accidents (RTAs) ($p = 0.0071$), with males being more frequently affected (67.74%) compared to females (38.46%). Other injury types like assault, falls, and accidental injuries did not show statistically significant gender-based differences ($p > 0.05$). This reinforces male vulnerability in high-impact trauma setting.

Table 4- Association between Otological Manifestations and SNHL

Otological Manifestation	Manifestation	SNHL – Present (n, %)	SNHL – Absent (n, %)	Total (n)	p-value	Odds ratio
Ear Bleed	Yes	2 (1.85%)	106 (98.15%)	108	0.95	0.77
	No	1 (2.38%)	41 (97.62%)	42		
Temporal Bone Fracture	Yes	2 (5.88%)	32 (94.12%)	34	0.12	7.18
	No	1 (0.86%)	115 (99.14%)	116		
Facial Palsy	Yes	2 (50.00%)	2 (50.00%)	4	0.002	145
	No	1 (0.68%)	145 (99.32%)	146		
CSF Otorrhoea	Yes	1 (100.00%)	0 (0.00%)	1	0.02	0.006
	No	2 (1.34%)	147 (98.66%)	149		
Ear Laceration	Yes	1 (3.85%)	25 (96.15%)	26	2.44	0.437
	No	2 (1.61%)	122 (98.39%)	124		
TM Rupture	Yes	2 (10.53%)	17 (89.47%)	19	0.042	15.29
	No	1 (0.76%)	130 (99.24%)	131		
Hemotympanum	Yes	0 (0.00%)	6 (100.00%)	6	1	3.11
	No	3 (2.08%)	141 (97.92%)	144		

In this study, significant associations were observed between sensorineural hearing loss (SNHL) and certain otological manifestations following head trauma. Notably, facial palsy exhibited a strong statistical association with SNHL ($p = 0.002$), indicating a likely shared pathological mechanism involving the petrous temporal bone where both the facial nerve and cochlear structures traverse. Similarly, CSF otorrhoea was significantly associated ($p = 0.02$), likely reflecting severe basal skull fractures that compromise the auditory nerve. Tympanic membrane rupture was also statistically significant ($p = 0.042$), suggesting that high-energy trauma is capable of rupturing

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the membrane. These findings emphasize the prognostic importance of facial palsy, CSF leak, and TM rupture in predicting underlying SNHL in patients with post-traumatic otological injury.

Table 5- Association between Otological Manifestations and CHL

Otological Manifestation	Status	CHL– Present (n,%)	CHL- Absent (n,%)	Total (n)	p-value	Odds Ratio
Ear Bleed	Yes	13 (12.04%)	95 (87.96%)	108	0.383	1.779
	No	3 (7.14%)	39 (92.86%)	42		
Temporal Bone Fracture	Yes	4 (11.77%)	30 (88.24%)	34	0.814	1.156
	No	12 (10.35%)	104 (89.66%)	116		
Facial Palsy	Yes	1 (25.00%)	3 (75.00%)	4	0.347	2.911
	No	15 (10.27%)	131 (89.73%)	146		
CSF Otorrhoea	Yes	0 (0.00%)	1 (100.00%)	1	1	0.371
	No	16 (10.74%)	133 (89.26%)	149		
Ear Laceration	Yes	3 (11.54%)	23 (88.46%)	26	0.874	1.114
	No	13 (10.48%)	111 (89.52%)	124		
TM Rupture	Yes	10 (52.63%)	9 (47.37%)	19	<0.001	23.148
	No	6 (4.58%)	125 (95.42%)	131		
Hemotympanum	Yes	2 (33.33%)	4 (66.67%)	6	0.066	4.643
	No	14 (9.72%)	130 (90.28%)	144		

The analysis of conductive hearing loss (CHL) in relation to otological injuries revealed a statistically significant association only with tympanic membrane rupture ($p < 0.001$), with an odds ratio suggesting a 23-fold increased risk. . This strong association underscores the critical role of the tympanic membrane in sound conduction, as any disruption to its integrity directly hinders the transmission of sound waves to the middle ear ossicles.

Other manifestations such as ear laceration, temporal bone fracture, and haemotympanum exhibited increased odds but did not achieve statistical significance. Haemotympanum, with a p-value of 0.066, indicated a potential trend and may contribute to temporary CHL due to blood accumulation in the middle ear. Overall, TM rupture stands out as the most reliable clinical predictor of CHL in head-injured patients.

Discussion

Our study revealed that the majority of patients with otological manifestations following head injury were young adults aged between 21–40 years, accounting for 45.3% of the study population. A significant male preponderance (82.7%) was observed, consistent with previous literature. This demographic trend underscores a critical public health concern, as young, economically productive individuals are disproportionately affected by head injuries. The observed male predominance can be attributed to greater occupational and recreational exposure, higher involvement in vehicular transport, and risk-taking behaviour among men. This pattern has been corroborated by previous studies, such as those by Sakthignanavel et al.[1] which identified young males as the demographic most commonly involved in road traffic accidents (RTAs), the leading cause of traumatic head injuries in India.

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In the present study, RTAs accounted for the majority of head injuries (62.7%), followed by physical assault (18%) and self-falls (15.3%). The association between male gender and RTAs was statistically significant (p = 0.0071), reinforcing the hypothesis that males are more frequently exposed to high-risk environments involving motor vehicles. National and international trauma registries have reported similar trends, indicating that motor vehicle collisions remain a predominant cause of cranial and otological trauma globally. In contrast, self-falls were more commonly observed among older adults in our study, albeit without reaching statistical significance. This trend is supported by Rubenstein et al.[4], who emphasized that falls occur in approximately 30% of individuals over the age of 65 annually, with about 10% resulting in serious injuries such as fractures or head trauma. Age-related neurosensory decline, impaired balance, and comorbidities contribute to fall risk in the elderly.

Otological findings were diverse in our study and ranged from external ear injuries to middle and inner ear involvement. The most common presentation was ear bleeding (34%), predominantly on the right side, followed by temporal bone fractures (16.7%) and ear lacerations (10.7%). Bilateral otological findings were uncommon, with the exception of hemotympanum, which was observed equally on both sides (1.33%). These findings are congruent with the results of Sakthignanavel et al.[1], who reported that otological manifestations occurred in 23.9% of head injury patients, with ear bleed (72.4%) and temporal bone fractures (46.6%) being the most frequent. This study also coincided with Patil et al.[10] with similar findings. The predominance of right-sided injuries in our study could reflect the directional impact of trauma or societal factors such as left-hand driving norms.

Temporal bone fractures, when present, significantly influenced otological and neurological outcomes. These fractures are typically categorized as longitudinal, transverse, or mixed based on their orientation relative to the petrous ridge. Longitudinal fractures, which are more common, often involve the external auditory canal, tympanic membrane, and ossicles, thereby causing conductive hearing loss (CHL). In contrast, transverse fractures, which traverse the otic capsule, are more likely to result in sensorineural hearing loss (SNHL) and vestibular dysfunction due to inner ear and nerve involvement.

Hearing loss was a significant sequela among patients with otological trauma. CHL was more prevalent than SNHL, a finding attributable to the high incidence of pathology such as tympanic membrane rupture and ossicular disruption. TM rupture showed a statistically significant correlation with CHL ($p < 0.001$; OR = 23.15), highlighting the importance of otoscopic examination in trauma settings. SNHL, though less frequent, was notably associated with facial nerve palsy ($p = 0.002$; OR = 145), CSF otorrhea ($p = 0.02$), and TM rupture ($p = 0.042$). TM rupture alone is the most reliable predictor of CHL if not associated with facial nerve palsy or CSF Otorrhea. These associations suggest that more extensive trauma involving the middle ear, inner ear and neurovascular structures correlates with poorer auditory prognosis.

Kaul et al. [7] reported a 34% prevalence of SNHL in head trauma patients, higher than observed in our cohort, where CHL predominated. The discrepancy may be due to variations in the mechanism of injury, promptness of intervention, and the proportion of temporal bone fractures involving the otic capsule. Nevertheless, our findings are supported by studies such as those by Browning et al.[3], who documented high-frequency SNHL in patients with occult fractures.

Further, our study reaffirmed the clinical relevance of facial nerve dysfunction as a prognostic indicator of inner ear involvement. Facial palsy was significantly associated with SNHL ($p = 0.002$), suggesting co-involvement of the facial and cochlear nerves within the petrous temporal bone. This anatomical proximity is well documented in temporal bone trauma literature, where injury to the labyrinthine segment of the facial nerve can simultaneously compromise cochlear structures.

CSF otorrhea is a potentially serious complication of temporal bone trauma and was observed in one patient (0.66%) in our series. Although rare, CSF otorrhea carries significant risks, including meningitis and persistent hearing loss. Notably, the presence of CSF leak was significantly associated with SNHL ($p = 0.02$), underscoring the need for careful evaluation of patients presenting with clear otorrhea following trauma. Our findings are consistent with those of Savva et al.[8], who, in a 22-year retrospective study, reported spontaneous resolution of trauma-related

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CSF leaks in nearly 90% of cases under conservative management.

Diagnosis of CSF otorrhea has evolved with the advent of specific biochemical markers. Traditional methods, such as glucose and protein analysis of the discharge, are limited by low specificity. Oberascher[5] introduced β2-transferrin assay, which remains the gold standard for confirming CSF leaks, offering near-perfect specificity (100%) and high sensitivity (~94%). Recent work by Avik Patel et al.[6] emphasized the utility of β2-transferrin along with radiological signs such as the 'halo sign' on absorbent materials and high-resolution imaging to localize the defect.

Importantly, Patel et al.[6] also differentiated between otic capsule-sparing and otic capsule-violating fractures. The former, which involve the squamosal portion and external auditory canal, are more likely to result in CHL, while the latter—often caused by high-velocity trauma involving the occiput—lead to SNHL, CSF leak, and facial palsy. This classification is not merely anatomical but carries strong prognostic significance. In our study, facial palsy, TM rupture, and CSF leak were all significantly associated with SNHL, affirming the link between otic capsule violation and poor auditory outcomes.

High-resolution CT (HRCT) scans of the temporal bone were instrumental in identifying fracture patterns and guiding management decisions. In our cohort, HRCT enabled precise classification of fracture orientation and extent of middle and inner ear involvement. HRCT also facilitated early diagnosis of ossicular dislocation, hemotympanum- pathologies that are often missed on clinical examination alone. Early imaging, coupled with prompt audiological assessment, is critical in improving functional outcomes in otological trauma.

Padmakumar et al.[10] reported temporal bone involvement in 8.5% of polytrauma patients, with 65% experiencing hearing loss, a trend mirrored in our cohort. Their meta-analysis also demonstrated pooled prevalences of 35% for SNHL and 44% for longitudinal fractures, validating our observations regarding fracture pattern distribution and hearing outcomes.

The identification of reliable clinical predictors for hearing loss post-trauma is essential for triaging and managing patients efficiently. In our study, TM rupture emerged as a robust indicator of CHL, while facial palsy and CSF otorrhea were the strongest predictors of SNHL. Interestingly, although ear bleed and temporal bone fracture had elevated odds ratios for hearing loss, these did not reach statistical significance—likely due to the limited sample size and the variability in fracture characteristics.

Hemotympanum, while traditionally considered a marker for CHL, did not show statistical significance in our analysis ($p = 0.066$). This could be attributed to the variability in the volume and pressure of accumulated middle ear fluid, spontaneous resolution in some cases, and coexisting ossicular or neural injury that alters the hearing profile.

Our study underscores the critical importance of integrating demographic profiling, clinical signs, and imaging findings in the evaluation of head injury patients with suspected otological involvement. Young males involved in RTAs remain the highest-risk group. Otological manifestations, particularly ear bleed, TM rupture, and facial palsy, are valuable clinical indicators of underlying temporal bone pathology. CHL is the most common form of hearing loss post-trauma, primarily due to mechanical disruption of middle ear structures. However, SNHL, though less frequent, is significantly associated with facial palsy and CSF leak, necessitating aggressive diagnostic and therapeutic strategies. HRCT and β2-transferrin analysis are indispensable tools for comprehensive evaluation. Early audiological assessment and vigilant monitoring of high-risk clinical signs can substantially improve long-term outcomes in this vulnerable patient population.

Conclusion

Young adult males are the most affected population in head injuries, predominantly due to road traffic accidents. Otological manifestations such as ear bleeding, tympanic membrane rupture, and temporal bone fractures are common. Conductive hearing loss is frequently linked to TM rupture, while sensorineural hearing loss is strongly associated with facial palsy and CSF otorrhoea. Early identification of these clinical indicators will aid in prompt diagnosis and targeted management, improving auditory outcomes in head injury patients.

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