



Assessment of Hearing Loss in Minor Head Injury: A Prospective Study

Sumit Bansal¹ Chappity Preetam² Ashis Patnaik¹ Rabi Narayan Sahu¹

¹ Department of Neurosurgery, All India Institute of Medical Sciences, Bhubaneswar, Orissa, India

² Department of ENT, All India Institute of Medical Sciences, Bhubaneswar, Orissa, India

Address for correspondence Sumit Bansal, MCh (Neurosurgery), Department of Neurosurgery, All India Institute of Medical Sciences, Bhubaneswar, 751019, Orissa, India (e-mail: drsumitbansal@gmail.com).

AJNS 2022;17:595–599.

Abstract

Introduction Hearing loss following a head injury is common and well known. The numbers of road traffic accidents have increased recently, with minor head injuries being very common, and usually go unreported. Hearing loss after a minor head injury is often unnoticed. Available literature is limited in this regard.

Objective This study was done to assess hearing loss in patients with minor head injuries and to define its natural history and progression/regression by a serial assessment of hearing.

Methods This prospective study was done in the Department of Neurosurgery, AIIMS, Bhubaneswar, Odisha, India, for a period of 24 months to look at the profile of hearing levels of patients presenting with history suggestive of minor head injury.

Results This study has shown that some form of hearing loss is common after a minor head injury and should be evaluated in all patients to detect subclinical hearing loss. A significant number of patients having minimal or a mild degree of hearing loss, if managed properly, improve to preinjury status. Distortion product oto-acoustic emission testing should be used as the screening and follow-up tool.

Conclusion This study highlights the importance of hearing assessment in minor-head-injury patients and the prognosis of recovery as per the severity of hearing loss and head injury.

Keywords

- road traffic accidents
- hearing loss
- minor head injury
- outcome
- hearing assessment

Introduction

Hearing loss following head injury is well known since ancient times. The numbers of road traffic accidents have increased with minor head injuries being very common and usually go unreported. Hearing impairment following head injury can be due to central or peripheral causes, middle ear or cochlea being the most common site of peripheral injury. Clinical and animal experimental studies have shown that

there are various sites of pathology ranging from hair cell damage and degeneration of the organ of corti,¹ ischemia of the eighth nerve to damage of central auditory pathways (due to compromise of blood supply to the inner ear) either partly or totally. Hearing loss after minor head injury is often unnoticed. Available literature is limited in this regard.^{2–5}

Damage to the peripheral auditory structures has long been recognized as a common component of head injury. Damage to the peripheral and/or central auditory pathways

article published online
October 28, 2022

DOI <https://doi.org/10.1055/s-0042-1757431>.
ISSN 2248-9614.

© 2022. Asian Congress of Neurological Surgeons. All rights reserved.

This is an open access article published by Thieme under the terms of the Creative Commons Attribution-NonDerivative-NonCommercial-License, permitting copying and reproduction so long as the original work is given appropriate credit. Contents may not be used for commercial purposes, or adapted, remixed, transformed or built upon. (<https://creativecommons.org/licenses/by-nc-nd/4.0/>)

Thieme Medical and Scientific Publishers Pvt. Ltd., A-12, 2nd Floor, Sector 2, Noida-201301 UP, India

can occur as a primary or secondary insult after head injury. Primary audiological deficit after head injury can appear not only as a result of direct trauma to the middle and inner ear, as in fractures of the base of the skull, but also as a result of rupture or tearing of central neuronal pathways. Early secondary injury can result from raised intracranial pressure secondary to bleeding and hematoma and later in the course because of diffuse axonal degeneration.⁶

The risk of hearing impairment as sequelae of head injury has been demonstrated in several studies.⁷ There is a relatively high incidence of hearing impairment in the early recovery phase, even after minor head injuries. The influence on hearing seems to be most prominent in the higher frequencies, especially at 4,000 Hz, but the whole frequency range can be affected.⁷

Aims and Objectives

This study was done to assess the hearing loss in patients with minor head injury and to define its natural history and progression/regression by serial assessment of hearing.

Materials and Methods

This prospective study was done in the Department of Neurosurgery, AIIMS, Bhubaneswar, Orissa, India. This study was done for a period of 24 months to look at the profile of hearing levels of patients presenting with history suggestive of minor head injury. Institute ethical clearance was taken (Registration No. T/IM-NF/NS/17/06) to conduct the study. Patients were recruited in the study based on following inclusion and exclusion criteria:

Inclusion Criteria

- All patients with history suggestive of minor head injury Glasgow coma scale scoring system (GCS) 13 to 15 and improving.
- Age between 18 and 60 years.
- Patients discharged from ward after observation period of 24 hours.
- History of loss of consciousness of less than 20 minute.

Exclusion Criteria

- Patients with past history of ear disease, previous head injury, or noise trauma.
- Patients having family history suggestive of autoimmune disease and hearing loss.
- Patients with chronic systemic disease such as diabetes and renal disease.

Each patient was evaluated and a thorough neurological examination was done and assigned a score according to GCS scale.⁸ A detailed neuro-otological examination was done. Computed tomographic scan was done to detect skull fractures and intracranial brain injuries. Routine blood investigations were done and vital signs were monitored during the entire observation period.

Patients were specifically asked for symptoms of hearing loss, tinnitus, and vertigo. Patients were called to audiology laboratory situated in the ENT department and a detailed hearing assessment was done, after taking an informed consent.

Pure tone audiometry (PTA) was done using audiometers. Audiometers were calibrated daily with subjective calibrations with normal. Hearing thresholds of up to 15 dB across the frequencies were considered to be as normal. Hearing loss was graded as minimal (16–25 dB), mild (26–40 dB), moderate (41–60 dB), severe (61–80 dB), and profound (> 81 dB).

Distortion product oto-acoustic emission (DpOAE) testing was done with the Smart DpOAE package. Results were graded as 'pass' or 'refer'.

Repeat evaluation was done after a period of 3 and 6 months. A detailed otoneurological evaluation was done in all three visits and patients were specifically asked for symptoms of hearing loss, tinnitus, and vertigo.

Results

Data was entered on an Excel spread sheet. Statistical analysis was done using SPSS version 27.0 (SPSS Inc., Chicago, Illinois, United States). Regression analysis was done to analyze the data.

Demography: Total 380 patients were recruited in this study with diagnosis of minor head injury. Age range was from 18 to 60 years and mean age was 35.9 years. There were 267 male and 113 female patients (male to female ratio was 2.3:1) (► **Table 1**).

Mode of injury: Two-hundred forty (63%) patients were using two wheelers (148 were drivers and 92 were pillion riders), 7 were using four wheelers, 17 were pedestrian, 34 were having assault injury, and 82 had history of fall. Only 21 (8.7%) out of 240 two wheel riding patients were wearing helmet at the time of injury. Fifty-three (14%) patients were under the influence of alcohol at the time of injury.

Presentation: Most common presenting symptoms were loss of consciousness ($n = 364$, 95.7%) followed by ear bleed ($n = 45$), nose bleeding ($n = 15$), and hearing loss ($n = 8$, 2%).

Imaging: Noncontrast computed tomography head was done in all patients and found normal in 240 (63%) patients and 140 (36.8%) patients had elements of brain injury with variety of lesions such as fractures, brain contusions, and extradural or subdural hematomas.

Management: Three-hundred seventy-nine (99.7%) patients were managed conservatively and only one patient required surgery for extradural hematoma in this study.

Audiological Tests:

PTA (► **Fig. 1**): PTA was done in all patients ($n = 380$) on initial presentation. Two-hundred sixty-nine (70.7%) patients came for second follow-up after 3 months and

Table 1 Clinical profile of the patients ($n = 380$)

Age range (years)	18–60 (mean = 35.9)		
Gender	Male	267	
	Female	113	
Mode of injury	Two wheeler	240	Driver = 148 Pillion rider = 92
	Four wheeler	7	
	Pedestrian	17	
	Assault	34	
	Fall	82	
	Helmet	Using	
Under influence of alcohol	Yes	53	
Presenting complaints	Loss of consciousness	364	
	Hearing loss	8	
	Nose bleeding	15	
	Ear bleeding	45	
NCCT head	Normal	240	
	Abnormal	140	
Management	Conservative	379	
	Surgery	1	

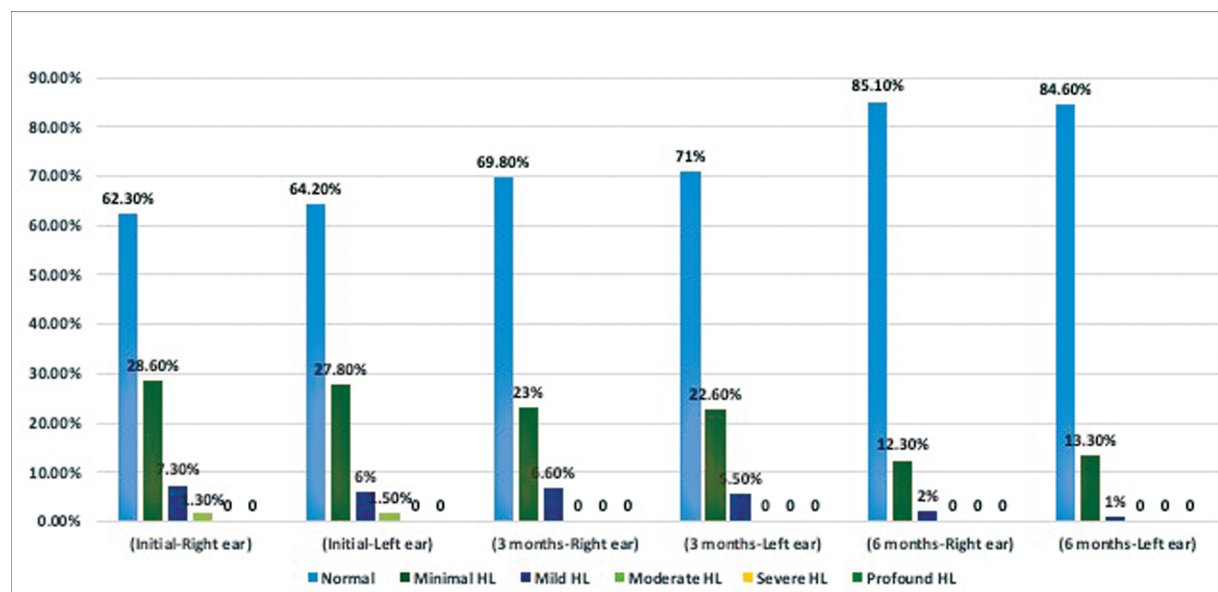
Abbreviation: NCCT, noncontrast computed tomography.

195 (51.3%) patients came for third follow-up after 6 months from injury.

On initial PTA ($n = 380$), normal hearing was present in 237 (62.3%) (right ear) and 244 (64.2%) (left ear) patients, respectively. Minimal hearing loss was present in 109 (28.6%) (right ear) and 106 (27.8%) (left ear) patients, mild hearing loss was present in 28 (7.3%) (right ear) and 23 (6%) (left ear)

patients, moderate hearing loss was present in 5 (1.3%) (right ear) and 6 (1.5%) (left ear) patients, and severe hearing loss was present in 1 each in right and left ear. None of the patients had profound hearing loss on initial presentation.

On second follow-up PTA at 3 months ($n = 269$), normal hearing was present in 188 (69.8%) (right ear) and 191 (71%) (left ear) patients. Minimal hearing loss was present in 62 (23%) (right ear) and 61 (22.6%) (left ear) patients, mild

**Fig. 1** Pure tone audiometry (PTA) of the patients. HL, hearing loss.

hearing loss was present in 18 (6.6%) (right ear) and 15 (5.5%) (left ear) patients, and moderate hearing loss was present in 1 (right ear) and 2 (left ear) patients. None of the patients had severe or profound hearing loss on second follow-up.

On third follow-up PTA at 6 months ($n = 195$), normal hearing was present in 166 (85.1%) (right ear) and 165 (84.6%) (left ear) patients. Minimal hearing loss was present in 24 (12.3%) (right ear) and 26 (13.3%) (left ear) patients, mild hearing loss was present in 4 (2%) (right ear) and 2 (1%) (left ear) patients, and moderate hearing loss was present in 1 (right ear) and 2 (left ear) patients. None of the patients had severe or profound hearing loss on third follow-up.

DpOAE (► **Fig. 2**): DpOAE on initial presentation was done in all 380 patients and found normal in 369 (97%) (right ear) and 362 (95.2%) (left ear) and refer in 11 (2.8%) (right ear) and 18 (4.7%) (left ear) patients.

DpOAE on second follow-up (at 3 months) was done in 269 patients and found normal in 261 (97%) (right ear) and 265 (98.5%) (left ear) and refer in 8 (2.9%) (right ear) and 4 (1.4%) (left ear) patients.

DpOAE on third follow-up (at 6 months) was done in 195 patients and found normal in 194 (99.4%) patients each in right and left ear and refer in 1 each in right and left ear.

In summary, any hearing loss above 50 dB is nonserviceable for the patient and would require rehabilitation. PTA suggests a significant number of patients having minimal and mild degree of hearing loss, which if managed properly improve to preinjury status. However, the patients having moderate or severe loss might have some persistent issues specifically related to higher frequencies, which are not usually monitored in usual scenarios.

DpOAE usually yields a refer result if the hearing loss is more than 30 dB. Our findings suggest that we have identified significant loss more proficiently with OAE than PTA. Major reason is that PTA is a subjective test and OAE an

objective test. The results suggest that DpOAE should be used as screening and follow-up tool as:

- It detects significant hearing loss (> 30 dB), which has a potential for nonimprovement.
- It can be performed even in unco-operative and unconscious patients.
- It can eliminate false-positive and false-negative results.

Discussion

Road traffic accidents were the most common cause of minor head injury as seen in most of the studies. Two-wheeler accidents were found to be the commonest cause of road traffic accident causing minor head injury in our study, whereas Browning et al⁴ reported that assault was the major etiology causing minor head injury. Hearing loss as a presenting complaint was found in only 2% of our patients, which is very less as compared with 10% as reported in other studies.⁹

Fitzgerald¹⁰ proposed various mechanisms for the cochlear hearing loss, namely, disruption of the membranous portion of the cochlea by pressure waves transmitted from the intracranial cerebrospinal fluid, disturbance in the microcirculation of the cochlea, and hemorrhage into the fluids of the cochlea.

Hearing loss can occur for a variety of reasons and etiologies include damage to peripheral ear structures, damage to the brainstem, and injury to the frontal or temporal lobes. Hearing loss can be conductive, sensorineural, or mixed. PTA assesses the type (conductive, sensorineural or mixed) and degree of hearing loss. DpOAE reflect outer hair cell integrity and cochlear function.

The incidence of hearing loss in our study was 38%, which is less as compared with other study by Griffith¹¹ (56%) and males being most affected.

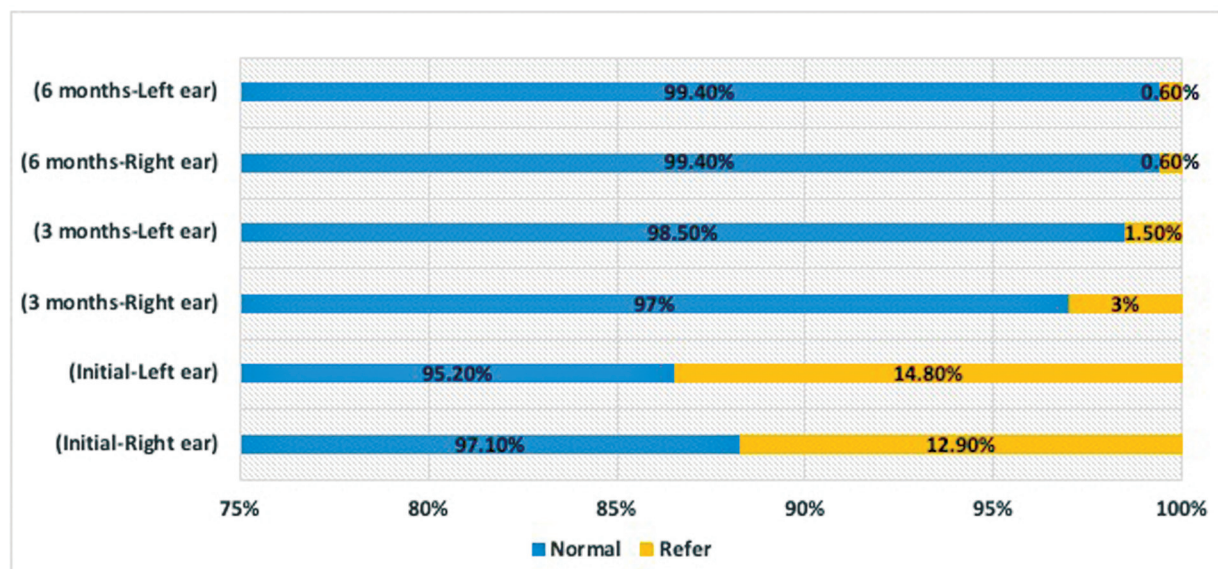


Fig. 2 Distortion product otoacoustic emission (DpOAE) of the patients.

Audiogram is a useful subjective screening tool for suspected hearing loss in head injury patients. Early detection and rehabilitation are possible with the help of audiogram and it proves to be cost-effective.

Severe the hearing loss, poorer was the prognosis. The degree of hearing loss determined the outcome, and it was found in our study that patients who had moderate-to-severe hearing loss at the time of injury had a poorer prognosis.

Conclusion

This study has shown that some form of hearing loss is common after minor head injury and it should be evaluated in all patients to detect subclinical hearing loss. A significant number of patients having minimal and mild degree of hearing loss, which if managed properly, improve to preinjury status. DpOAE testing should be used as screening and follow-up tool. This study highlights the importance of hearing assessment in minor head injury patients and prognosis of recovery as per severity of hearing loss and head injury.

Conflict of Interest

None declared.

References

- Schuknecht HF. Mechanism of inner ear injury from blows to the head. *Ann Otol Rhinol Laryngol* 1969;78(02):253–262
- Emerson LP, Mathew J, Balraj A, Job A, Singh PR. Peripheral auditory assessment in minor head injury: a prospective study in tertiary hospital. *Indian J Otolaryngol Head Neck Surg* 2011;63(01):45–49
- Yetiser S, Hidir Y, Gonul E. Facial nerve problems and hearing loss in patients with temporal bone fractures: demographic data. *J Trauma* 2008;65(06):1314–1320
- Browning GG, Swan IR, Gatehouse S. Hearing loss in minor head injury. *Arch Otolaryngol* 1982;108(08):474–477
- Munjal SK, Panda NK, Pathak A. Audiological deficits after closed head injury. *J Trauma* 2010;68(01):13–18, discussion 18
- Lezak MD. In: Lezak MD, ed. *Neurophysiology for Neurophysiologists*. New York: Oxford University Press, Inc; 1995: 176–193
- Bergemalm PO, Borg E. Long-term objective and subjective audiologic consequences of closed head injury. *Acta Otolaryngol* 2001; 121(06):724–734
- Teasdale G, Jennett B. Assessment of coma and impaired consciousness. A practical scale. *Lancet* 1974;2(7872):81–84
- Makishima K, Snow JB. Pathogenesis of hearing loss in head injury. *Studies in man and experimental animals. Arch Otolaryngol* 1975;101(07):426–432
- Fitzgerald DC. Head trauma: hearing loss and dizziness. *J Trauma* 1996;40(03):488–496
- Griffiths MV. The incidence of auditory and vestibular concussion following minor head injury. *J Laryngol Otol* 1979;93(03): 253–265