ORIGINAL RESEARCH PAPER

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KEY WORDS:

OAE IN DETECTING INTRACOCHLEAR INJURY IN ACUTE HEAD TRAUMA

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ABSTRACT

This is a prospective study conducted on patients with acute head injury attending outpatient department and emergency room of Silchar Medical College and Hospital. A total of 11 cases of diagnosed head injury with history of loss of consciousness or reduced GCS score following the injury were selected for this study. Patients with history of ear disease, gross intra cerebral trauma and GCS below 9 were excluded from this study. Transient Evoked Oto-Acoustic Emission test (TEOAE) was performed in the patients along with audiometry. Oto-Acoustic Emissions (OAEs) are sound waves produced by the normal cochlea. They may be spontaneous or evoked OAE. When evoked Oto-Acoustic Emissions are absent, and in the absence of middle ear pathology, it indicates damage to the cochlea. Findings in this study were noted and compared with the hearing status of the patient as well as the GCS score at the time of presentation and mode of injury.

INTRODUCTION

Head trauma is one of the commonest events encountered in high-speed accidents and blast injuries in the emergency room of any hospital. Acute head trauma can cause a range of problems related to the ear, including hearing loss, vestibular effects, and central auditory problems. The most common otological complaints immediately following head trauma are otalgia, tinnitus, aural fullness, dizziness, loudness sensitivity, distorted hearing, and hearing impairment. Because of the sudden and violent nature of the injury, acute head trauma may cause concurrent damage to the auditory pathway. The tympanic membrane, middle ear, and cochlea are the most common sites of peripheral injury as they are often directly in the line of trauma. The hair cells are the most vulnerable elements of the cochlea and, when damaged, can produce sensorineural hearing loss and tinnitus. Animal experiments have shown that the deafness due to injury of the organ of corti is identical with that which results from a shock pulse in the air as a bomb blast or a pistol shot with violent displacement of the basilar membrane and organ of corti.[1]

Schuknecht and Davison estimated hearing loss in cats subjected to head injury. The earliest detectable histological changes consisted of anatomical derangement of outer hair cells and their supporting cells. In mild injuries the outer hair cells which are normally tall and rectangular appeared shorter and wider and the nuclei were smaller and the chromatin was condensed. In severe lesions there was a loss of external hair cells and the beginning of cytological changes in the Dieters cells and the supporting cells, further progressive stages of injury consisted of flattening of the organ of corti and finally its complete disappearance.[2]

Thus, it is very important to assess the extent of outer hair cell damage in all cases of acute head trauma as this can help the ENT clinician in early detection of hearing impairment and better management of the same. This study is carried out with the help of Oto-Acoustic Emissions.

AIMS AND OBJECTIVES

- To establish occurrence of intracochlear injury in cases of acute head trauma.
- To detect cochlear hair cell damage and/or other intracochlear lesion from acute head injury.
- To evaluate the role of Otoacoustic Emissions as a diagnostic tool for detecting intracochlear damage in cases of acute head trauma.

MATERIALS AND METHODS

- Study Design - Prospective Study.
- Study Sample - Patients with acute head injury attending outpatient department and emergency room of Silchar Medical College and Hospital.
- Study Area - Department of Otorhinolaryngology and Head and Neck Surgery, Silchar Medical College and Hospital.
- Sample Size - A total of 11 cases were selected after considering the inclusion and exclusion criteria.
- Study Period – 1st January 2021 to 31st May 2021 (4 months).

Inclusion and Exclusion Criteria:

- **Inclusion criteria:**

1) Patients suffering acute head injury.
2) Patients with normal CT-Scan of brain
3) Patients who are neurologically stable on presentation with GCS 13 and above.
4) Patients with intact tympanic membrane.

EXCLUSION CRITERIA:

1) Patients with past history of ear disease.
2) Patients with past history of hearing problems.
3) Patients with history of chronic metabolic and neurological diseases.
4) Patients with past history of ear surgery.
5) Patients with ear bleed.

Thorough history was taken regarding any ear complaints or procedure undergone prior to the trauma incident. Also history was taken regarding loss of consciousness, altered sensorium, ear bleed or any other ENT complaint following the trauma. Ear canal of all patients were examined and only patients with intact tympanic membrane with visible cone of light were selected for the study. Any ear wax or debris present in ear canal was suctioned thoroughly prior to examining for OAE. Pure Tone Audiometry was performed along with OAE for all patients.

Otoacoustic emissions were measured using Interacoustics Titan Instrument in the frequency range of 1-4 KHz which is the most sensitive speech frequency range for human ears with a decibel range of -20 to 30 dB SPL (where dB SPL stands for sound pressure level measured relative to 20 micro pascals which is the quietest sound pressure level that can be detected by normal ears). Wave reproduction below 50% in

the mentioned frequency range was considered as a no response.

For performing OAE, the patients were examined in a quiet room. Then Transient Evoked OAE recordings were made *via* the probe which was deeply inserted into the ear canal with the cable positioned so as to avoid noise production on movement. Middle ear status affects OAEs and can prevent their detection. Hence, we have excluded patients with known history of ear discharge, tympanic membrane perforation and past history of ear surgery from this study.

RESULTS AND OBSERVATIONS

The current study titled, "OAE in detecting intracochlear injury in acute head trauma" was conducted in the Department of Otorhinolaryngology, Silchar Medical College and Hospital, Silchar, during the period of January 2021 to May 2021.

The results of the study have been analysed and observations made as follows:

Age: The age of the patients in the study sample varied between 19 to 53 years with mean age being 37.8 years. The age distribution is shown in Table 1

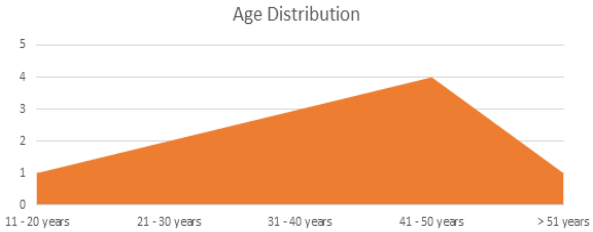

Chart 1: Age Distribution

Table 1: Age Distribution

Age (in years)	
11 – 20 years	1
21 – 30 years	2
31 – 40 years	3
41 – 50 years	4
> 51 years	1
Mean Age	37.8 years

Sex: All participants for this study were of male gender.

Mode of Injury:
Mode of injury in all cases was high velocity trauma due to road traffic accident.

History of Loss Of Consciousness (LOC):
History of loss of consciousness was positive for 63.63% cases while the others did not have any loss of consciousness.

CHART 2: Percentage of patients with LOC

Table 2: Percentage Of Patients With Loss Of Consciou sness

History of Loss of Consciousness		
1)	Positive	7 (63.64%)
2)	Negative	4 (36.37%)

GCS Score: GCS Score of all patients in this study ranged between 11-15 during initial examination. GCS of all patients from 2 weeks of initial examination returned to 15/15. The range of distribution of GCS is shown in Table 3.

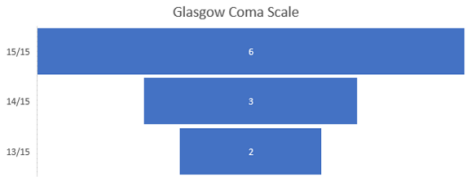

Chart 3: List of Glasgow Coma Scale Scores of patients in the study

Table 3: List of Glasgow Coma Scale Scores of patients in the study

GCS Score	Number of Patients
15/15	6 (54.54%)
14/15	3 (27.27%)
13/15	2 (18.18%)

Ear complaints following trauma:
Only one patient complained of noticeable hearing loss following the trauma incident. Remaining patients could not appreciate any noticeable change in hearing. None of the patients had complaints of newly arising and persistent tinnitus, vertigo or nausea following the trauma.

Pure Tone Audiometry:
Pure tone audiometry was conducted for all the participants of this study and results noted. 6 (54.54%) patients of this study had normal hearing on both ears. Remaining 5(45.45%) patients presented with sensorineural hearing-loss with 3(27.27%) patients with unilateral and 2(18.18%) patients suffered bilateral sensorineural hearing loss. All the cases of sensorineural hearing loss were mild category with only one case with bilateral moderate to severe sensorineural hearing loss. The results are depicted in Chart 4.

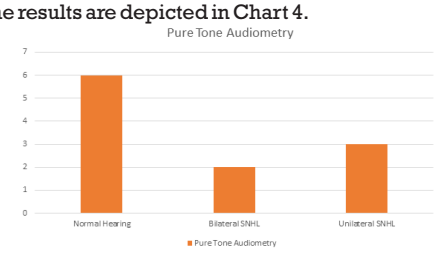

Chart 4: Pure Tone audiometry findings

Table 4: Pure Tone audiometry findings

Pure Tone Audiometry Findings	Number of cases
Normal Hearing	6 (54.54%)
Bilateral SNHL	2 (18.18%)
Unilateral SNHL	3 (27.27%)

Oto Acoustic Emissions:
Transient Evoked Oto Acoustic Emissions were measured in all the patients and it was found that 6(54.54%) patients showed normal response. However, remaining 5 patients (45.45%) showed abnormalities in response with 2 patients (18.18%) showing bilateral no response and 3 patients (27.27%) showing unilateral no response.

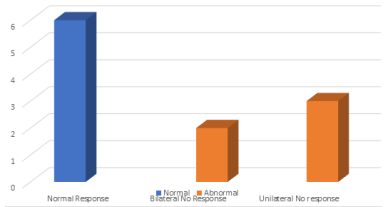

Chart 5: OAE Findings

Table 5: OAE Findings

OAE Finding		Number of cases
1)	Normal response	6
2)	Unilateral No response	3
3)	Bilateral No response	2

DISCUSSION

Otoacoustic emissions (OAEs) are sounds of cochlear origin, which are caused by the motion of the cochlea's sensory hair cells, spontaneously or from their energetic response to auditory stimulation. They can be recorded by a microphone fitted into the ear canal. OAEs provide a simple, efficient and non-invasive objective indicator of healthy cochlear function and OAE screening is widely used in universal new-born hearing screening programmes.3 As a research tool, OAEs provide a non-invasive window on intracochlear processes.4 In this study we have applied the same principle in a different scenario to detect intracochlear injury in cases of acute head trauma.

From the above study it can be seen that most of the cases lie in the above 30 age group (72.72%) with peak at 41-50 age group (36.36%).

All the participants in this study were male. It is notable here that we receive fewer females compared to males in the trauma department. Also, the female cases with acute head injury could not meet our inclusion criteria and hence were not included in this study.

All the cases included in this study suffered high velocity trauma due to road traffic accidents. Road traffic accidents are among the most common causes of acute head injury in our department.

63.53% of the patients included in this study suffered an episode of loss of consciousness following the trauma incident.

GCS Score of majority of the patients in this study (54.54%) remained to be normal of 15/15. The remaining participants had GCS on presentation ranging between 12 to 14. All of these patients however had their GCS returned to normal during the time of the examination for OAE.

Ear complaint of hearing loss following the accident was complained by only one patient in this study. Rest all other patients did not have any ear complaint during the time of examination for OAE.

Pure Tone Audiometry findings revealed sensorineural hearing loss in 45.45% cases with 3(27.27%) patients with unilateral and 2(18.18%) patients suffering bilateral sensorineural hearing loss. It is notable here that all the cases of sensorineural hearing loss were mild with only one case with bilateral moderate to severe sensorineural hearing loss and this was the same patient that complained of hearing loss following the trauma incident.

Transient Evoked OAE findings showed no response in 45.45% cases with 3(27.27%) patients with unilateral and 2(18.18%) patients with bilateral no response. It is worth mentioning here that the cases of deranged OAE were the same patients that suffered sensorineural hearing loss following the trauma incident.

CONCLUSION

From the current study it can be observed that intracochlear damage may be considered in 45.45% of the cases included for this study with deranged OAE.

These are the same patients who also exhibited sensorineural hearing loss in Pure Tone Audiometry. The cases included in this study were all stable patients with GCS 15/15 and only one patient complained of perceivable hearing loss following the trauma incident. Thus, it can be concluded that OAE along with Pure Tone Audiometry has a role to play in detection of occult intracochlear damage which may occur following acute head trauma. Also, OAE can be considered a potential diagnostic tool for detection of intracochlear injury in trauma patients on whom audiometry cannot be performed like patients with poor IQ level or who are unconscious, drowsy or with altered sensorium.

The limitation of this study lies in the fact that the long-term outcome of such patients remains to be seen and that the cases could not be followed up afterwards to assess the progression of the hearing loss and deranged OAE. As no symptoms were noticed by the patients themselves and none of the patients complained of any ear symptoms on subsequent follow-up, it may be assumed that the intracochlear lesion did not progress beyond what was recorded within the first two weeks of the trauma.