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Original Research Article

Predicting sensor neural hearing loss in chronic suppurative otitis media with and without cholesteatoma: a comparative study using pure tone audiometry and brainstem evoked response audiometry

Varun Singh[1], Sandip M. Parmar [2], Rahul Kumar Shailat[3], Bibhu Prasad Hota[4], Meenu Chaudhary[5], Himanshu Kumar[6]

[1]P.G. JR-III, [2]Associate Professor & Head, [3]Audiologist, [5]Senior Resident, Department of ENT, Muzaffarnagar Medical College, Muzaffarnagar, (U.P.), India
[4, 6]Lecturer (Speech & Hearing), AYJNIHH, ERC, Kolkata, India

***Corresponding author**
Dr. Varun Singh
Email: drvarun1988@gmail.com

Abstract: Chronic Suppurative Otitis Media (CSOM) is the major cause of hearing impairment, mainly conductive type of hearing loss. The occurrence of Sensori neural Hearing Loss (SNHL) in Chronic Suppurative Otitis Media (CSOM) is controversial. This study aims to investigate the pattern of Sensori neural Hearing Loss (SNHL) in patients diagnosed with Chronic Suppurative Otitis Media (CSOM) with & without cholesteatoma & to estimate the correlation between various degree of sensori neural hearing impartment and the auditory evoked potential wave characteristics, computed using pure tone audiometry & brainstem evoked response audiometry in patients with chronic suppurative otitis media with & without cholesteatome. In Method 100 patients with unilateral Chronic Suppurative Otitis Media (CSOM) with normal contralateral ear were included in the study. The affected ears formed the Chronic Suppurative Otitis Media (CSOM) group & the normal ears formed the control group. Detailed audiometric and Brainstem Evoked Response Audiometry (BERA) findings were recorded and analysed. In Results No significant difference was observed across the wave I - III, III - V and I - V interwave latency values of normal ears and ears with Chronic Suppurative Otitis Media (CSOM) with or without cholesteatoma. Significant difference was observed across the pure tone average values of air conduction and bone conduction pure tone of normal ears and ears with Chronic Suppurative Otitis Media (CSOM) with or without cholesteatome. Good correlation was obtained across the waves I – III, III - V & I - V interwave latency values of normal ears and ears with Chronic Suppurative Otitis Media (CSOM) with or without cholesteatoma. Poor correlation was obtained across the air conduction pure tone average thresholds of normal ears and ears with Chronic Suppurative Otitis Media (CSOM) with or without cholesteatoma. Conclusion was Sensori neural hearing loss exists concurrently with chronic suppurative otitis media with and without cholesteatoma. The correlation of pure tone audiometry with inter peak wave latencies of ABR was debatable.

Keywords: Chronic suppurative otitis media, Conductive hearing loss, Sensori neural hearing loss, pure tone audiometry, Brainstem evoked response audiometry

INTRODUCTION:

Chronic Suppurative Otitis Media (CSOM) has been defined as a chronic inflammation of the middle ear or mastoid cavity, which presents with recurrent or persistent ear discharges or otorrhoea through a tympanic membrane perforation [1]. Conductive hearing loss has been commonly associated with chronic suppurative otitis media with the tubotympanic variety presenting with more degree of conductive hearing loss than the attico-antral type. A spate of research however has outlined strong connection regarding incidence of sensori neural hearing loss in chronic suppurative otitis media with tubotympanic variety of CSOM being documented to be the greater precursor [2]. However, the association between safe mucosal CSOM and sensori neural hearing loss has remained a controversial topic till date [3]. With conductive hearing losses accounting for shift of mass reactance and stiffness reactance in the middle ear, a pseudo increase of bone conduction thresholds in the affected ear is often seen during pure tone audiometry. As greater air bone gap causes greater increase or better bone conduction thresholds, it becomes imperative on part of the otorhino laryngologist to determine sensori neural hearing loss in the audiogram prior to planning for surgical management.

With advent of objective electrophysiological test protocols such as brainstem evoked response audiometry, the diagnosis of degree of hearing impairment and idea about the integrity of auditory system has increased manifold. The comparison of air conduction and bone conduction BERA findings give an objective estimation of the extent of conductive hearing loss. Of late assessment of the magnitude of conductive hearing loss and presence of sensori neural hearing loss particularly in children using Brainstem Evoked Response Audiometry (BERA) test has become the choice of practice for many otorhino laryngologists around the globe.

With dearth of research regarding prevalence of sensori neural hearing loss and its pathogenesis in chronic suppurative otitis media in the Indian subcontinent as well as unequivocal advocacy regarding presence of sensori neural deafness in chronic suppurative hearing loss, it is important to study the efficacy of audio logic and electrophysiological tests in detecting the presence of sensori neural hearing loss in persons diagnosed with chronic supurative otitis media with and without cholesteatoma. This study was an effort in the same direction and intended to find the relationship between pure tone audiometry and brainstem evoked response audiometry parameters in patients diagnosed with unilateral CSOM.

METHODOLOGY:

The study group included from patients those were attending outdoor patient department of ENT in hospital from CSOM. The patient has to need the following criteria to become eligible from the study.

The patient had to be suffering from unilateral CSOM with normal contralateral ear. The normal ear was used as a control to cancel out the confounding factors such as prebycusis; noise induced as congenital hearing losses etc. A total of 100 patients within the age range of 10-50 years (mean age of 24.2 years) were included in this study. The children below 10 years were excluded as they were expected to be uncooperative for accurate testing. Also above 50 years. There is possibility of an element of pres bycusis subjects with a history suggestive of systemic disease like diabetes, meningoencephalitis, head injury, familial hearing loss, prolonged noise exposure, previous otologic surgeries were excluded from the study.

Detailed otolaryngologic history including hearing impairment, ear discharge, vertigo, tinnitus etc. was taken. Extensive ENT examination was done in all subjects to look for status of otorrhea, site & size of perforation, ossicular disruption & presence of cholesteatoma.

The examination further included the tuning fork tests that are weber's, rinne's & absolute bone conduction test. By using an ALPS AD 2100 two channel diagnostic audiometers with telephonic TDH-49 supra annual headphones & radio ear B-71 bone vibrator, pure tone audiometry was performed in all patients in a semi sound attenuated chamber. By using interacoustics ECLLIPSE audiometry evoked potential system with telephonic TDH-49 supra annual headphones.

STATISTICAL ANALYSIS:

Test of significance any reasons correlation co-efficient & comparison of performance scores using fisher paired't' test. Data was analysed using SPSS version 17.0 software. A p value of < 0.05 was considered statistically significant. All these findings were documented as per the study performa.

RESULTS:

The data obtained was analysed using SPSS version 17.0 software. The performance scores of the patients across the pure tone audiometry tests and the brainstem evoked response audiometry tests has been shown in table 1 and 2.

No significant difference ($p>0.05$) was observed across the waves I – III, III – V, and I – V interwave latency values of normal ears and ears with CSOM with or without cholesteatoma.

Significant difference ($p<0.05$) was observed across the pure tone average values of air conduction and bone conduction pure tone audiometry of normal ears and ears with CSOM with or without cholesteatoma.

Good correlation ($r = .631$) was obtained across the waves I – III interwave latency values of normal ears and ears with CSOM with or without cholesteatoma.

Good correlation ($r = .759$) was obtained across the waves III – V interwave latency values of normal ears and ears with CSOM with or without cholesteatoma.

Good correlation ($r =.781$) was obtained across the waves I – V interwave latency values of normal ears and ears with CSOM with or without cholesteatoma.

Poor correlation ($r =.428$) was obtained across the air conduction pure tone average thresholds of normal ears and ears with CSOM with or without cholesteatoma.

Poor correlation (r =.409) was obtained across the bone conduction pure tone average thresholds of normal ears and ears with CSOM with or without cholesteatoma.

Table 1: Mean values of pure tone thresholds of normal and CSOM ears

Values	n	Minimum	Maximum	Mean	SD
Pure tone average of air conduction thresholds of normal ears	100	13.33	46.67	17.9260	6.19270
Pure tone average of air conduction thresholds of CSOM ears	100	15.00	58.33	37.2317	10.42857
Pure tone average of bone conduction thresholds of normal ears	100	6.67	15.00	10.6849	2.24849
Pure tone average of bone conduction thresholds of CSOM ears	100	3.33	46.67	14.3772	8.84715

Table 2: Mean values of interwave peak latencies of normal and CSOM ears

Values	n	Minimum	Maximum	Mean	SD
Wave 1-3 ABR interwave latencies of normal ears	100	1.37	3.07	2.1100	.31269
Wave 3 - 5 ABR interwave latencies of normal ears	100	1.10	2.57	1.8115	.31708
Wave 1 - 5 ABR interwave latencies of normal ears	100	2.77	4.50	3.9147	.398100
Wave 1 - 3 ABR interwave latencies of CSOM ears	100	1.30	2.93	2.0696	.33069
Wave 3 - 5 ABR interwave latencies of CSOM ears	100	1.27	2.50	1.8272	.30550
Wave 1 - 5 ABR interwave latencies of CSOM ears	100	2.63	4.50	3.8906	.35519

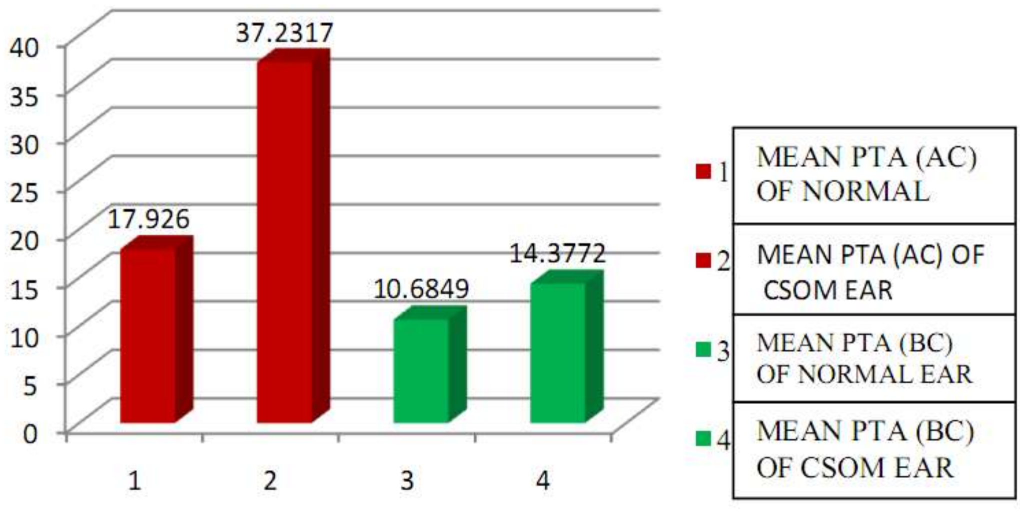

Fig 1: Graph showing mean AC & BC PTA values of normal and CSOM ears

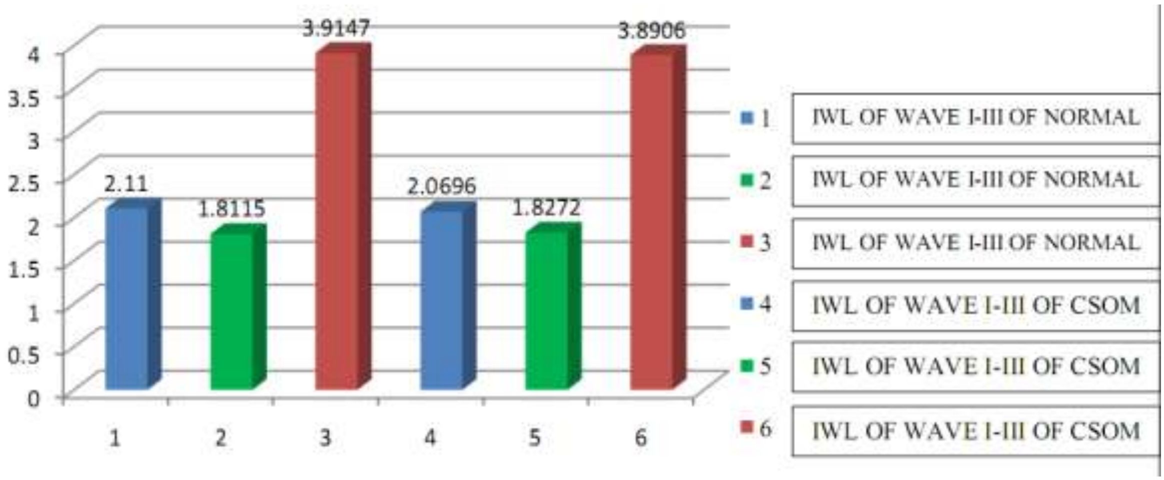

Fig 2: Graph showing mean ABR interwave latencies of normal and CSOM ears

Table 3: Test of significance using Pearson's Correlation Co-efficient

		Correlation	sig.
Pair 1	Wave 1-3 ABR interwave latencies of normal ears & Wave 1 - 3 ABR interwave latencies of CSOM ears	.631	.000
Pair 2	Wave 3 - 5 ABR interwave latencies of normal ears & Wave 3 - 5 ABR interwave latencies of CSOM ears	.759	.000
Pair 3	Wave 1 - 5 ABR interwave latencies of normal ears & Wave 1 - 5 ABR interwave latencies of CSOM ears	.781	.000
Pair 4	Pure tone average of air conduction thresholds of normal ears & pure tone average of air conduction thresholds of CSOM ears	.428	.001
Pair 5	Pure tone average of bone conduction thresholds of normal ears & pure tone average of bone conduction thresholds of CSOM ears	.409	.002

Table 4: Comparison of performance scores using Fisher Paired "t" test

Pair		Significance
Pair 1	Wave 1-3 ABR interwave latencies of normal ears Wave 1 - 3 ABR interwave latencies of CSOM ears	.293
pair 2	Wave 3 - 5 ABR interwave latencies of normal ears - wave 3 - 5 ABR interwave latencies of CSOM ears	.601
pair 3	Wave 1 - 5 ABR interwave latencies of normal ears - wave 1 - 5 ABR interwave latencies of CSOM ears	.490
pair 4	Pure tone average of air conduction thresholds of normal ears Pure tone average of air conduction thresholds of CSOM ears	.000
pair 5	Pure tone average of bone conduction thresholds of normal ears - Pure tone average of bone conduction thresholds of CSOM ears	.002

DISCUSSION:

Advocacy for presence of sensori neural hearing loss in patients with chronic suppurative otitis media has received mixed support in the otological fraternity. Adam Politzer **(**1887) was the first to show the alteration in the hearing in chronic suppurative otitis media confirmed that "when the illness continues from infancy or in advanced age or when adhesive phenomena occur in tympanic cavity, the perception of sound through the bone conduction is diminished or abolished". In due course of time, research citingsSharma [4], Azevedo [5], Papastavros [6], Paparella [7], MacAndie [8], Redaelli [9], Handa [10], Papp [11], Feng [12], have advocated the presence of sensori neural hearing loss in chronic suppurative otitis media. However, studies (Ologe [13], Miura [14], Mostafa [15], Mills [16] have also refuted the prevailing notion. Hence, it is itinerant to evaluate the presence of sensori neural hearing loss in chronic suppurative otitis media using a combination of objective tests such as brainstem evoked response audiometry and subjective tests such as pure tone audiometry.

The current study aimed to compare the inter peak wave latencies of brainstem evoked response audiometry with the air conduction and bone conduction pure tone thresholds of patients with chronic suppurative otitis media.

No significant difference ($p>0.05$) was observed across the waves I – III, III – V, and I – V interwave latency values of normal ears and ears with CSOM with or without cholesteatoma.

For the majority of patients with hearing loss, the pattern of ABR findings (eg: the minimum response level or the shape of the wave V latency-intensity function) provides some information on the type and degree of the hearing loss. For individual patients, however, there may be very marked discrepancies between the ABR and the findings for pure tone audiometry. For example, patients with severe-to-profound sensory hearing loss in high frequencies (greater than about 80 dB nHL for frequencies above 1000 Hz) typically do not yield an ABR, even if hearing sensitivity is normal throughout the region for lower frequencies. Conversely patients with severe low-frequency sensory hearing loss that may have a serious impact on communication capability will have normal ABR findings if hearing sensitivity is good for the higher frequencies.

Balfour *et al.;* [17] 1998 cited major discrepancies between hearing sensitivity and ABR findings. The authors recorded distortion product oto-acoustic emissions (DPOAEs) from 5 children with "normal auditory sensitivity for at least one frequency in the 250 to 8000 Hz region" described as "islands of normal sensitivity" using a protocol with six $f2/f_l$ ratios per octave (frequency resolution of 1/6 octave). None of the 5 patients had normal DPOAEs at each test frequency. Audiogram configurations were highly variable among the 5 subjects. For each child, an ABR was evoked with click stimuli and with tone bursts of 500, 1000, 2000, and 4000 Hz. Following analysis of their data the authors stated "Click-evoked ABR thresholds were ascertained at normal intensity levels for three out of five pediatric ears when a significant communicatively handicapping hearing loss was present.

In majority of patients with chronic suppurative otitis media the appearance of low frequency conductive hearing loss is more commonly seen. Low-frequency hearing impairment involves audiometric frequencies below approximately 1000 Hz. Most low-frequency audiogram patterns reflect conductive hearing loss secondary to middle-ear pathology, or mixed hearing loss due to a disease that may involve both the middle and inner ears.

Reliance on pure-tone audiometry alone can sometimes lead to errors in interpretation. Invalid high-intensity bone-conduction thresholds, resulting from harmonic bone-conduction distortion or "vibrotactile stimulation" (feeling rather than hearing the sound vibrations), may produce apparent but false and misleading "air-bone gaps" and misinterpretation of the type of hearing loss.

With click stimuli, normal-appearing ABR waveforms and latency-intensity functions are typically recorded in low-frequency hearing impairment [18]. The ABR to clicks reflects cochlear activation in the basal turn and is thus largely dependent on hearing status in the 2000 Hz frequency region and above.

However a normal ABR is not necessarily recorded for low-frequency conductive hearing deficits. A study of audiogram configuration and ABR patterns, Keith and Greville [19] 1987 showed wave V latencies that were shorter than normal at low intensity levels (below 60 dB HL) for patients with low-frequency sensory hearing loss. Wave I latency, in contrast, was unchanged. The result was a slight decrease in the wave I-V latency interval in comparison to normal hearers or hearing-impaired persons with other audiometric configurations. In light of the above evidence, the occurrence of no significant difference ($p>0.05$) across the waves I – III, III – V, and I – V interwave latency values of normal ears and ears with CSOM with or without cholesteatoma is truly justified.

Significant difference ($p<0.05$) was observed across the pure tone average values of air conduction and bone conduction pure tone audiometry of normal ears and ears with CSOM with or without cholesteatoma.

As chronic suppurative otitis media with and without cholesteatoma may result in perforation of tympanic membrane, tympano malleolar joint ankylosis, as well as erosion of ossicles, the loss of hearing acuity is also correspondingly present.

Fair correlation ($r = .631$) was obtained across the waves I – III interwave latency values of normal ears and ears with CSOM with or without cholesteatoma.

The wave I-III interwave latency values are more sensitive to either cochlear or conductive pathologies as compared to wave III-V or wave I-V inter peak latencies as the latency-intensity function observed in cochlear hearing loss is often steeper than that seen in persons with normal hearing or conductive or retro cochlear hearing loss [20]. This occurs because Wave V latency increases at faster than normal rates at moderate intensities. Hence, the wave I-V or wave III-V inter peak latencies have good correlation between normal and CSOM ears.

Good correlation ($r = .759$) was obtained across the waves III – V interwave latency values of normal ears and ears with CSOM with or without cholesteatoma.

Good correlation (r =.781) was obtained across the waves I – V interwave latency values of normal ears and ears with CSOM with or without cholesteatoma.

The I-V interval is often referred to as a reflection of 'brainstem transmission time' or "central conduction time" [21] implying that it, unlike absolute latency measures is not subject to influences of middle ear and cochlear pathology. Certainly, the wave I-V interval is less affected by these disorders and more consistently related to brainstem function than is the absolute latency for wave V. In particular, an interaural comparison of the wave I-V latency value can reduce the likelihood of false-positive interpretation error[22]. However, wave I-V inter peak latency interval is not a pure measure of brainstem transmission time as alterations in the wave I-V latency value clearly can be associated with conductive or cochlear auditory dysfunction. In the present study, the good correlation between the normal and CSOM ears could have been due to the presence of minimal conductive loss at high frequencies or good cochlear functioning within the frequency range of 2 – 4 KHz.

Poor correlation (r =.428) was obtained across the air conduction pure tone average thresholds of normal ears and ears with CSOM with or without cholesteatoma.

Poor correlation (r =.409) was obtained across the bone conduction pure tone average thresholds of normal ears and ears with CSOM with or without cholesteatoma.

Several research studies (Sharma [4], Azevedo [5], Papastavros [6], Paparella [7], MacAndie [8], Redaelli [9], Handa [10], Papp [11], Feng [12], have investigated and cited the concurrent occurrence of sensori neural hearing loss in chronic suppurative otitis media. The results of the present study also purport similar findings. The poor correlation between bone conduction thresholds of normal and CSOM ears could be due to the significant sensori neural component present particularly at and beyond 2 KHz. The pseudo increase in bone conduction thresholds which occur in conductive hearing losses could also have affected the threshold values of bone conduction.

SUMMARY AND CONCLUSIONS:

The results of this study show that sensori neural hearing loss exists concurrently with chronic suppurative otitis media with and without cholesteatoma. The correlation of pure tone audiometry with inter peak wave latencies of ABR was debatable. However, significant differences and fair correlation was obtained between the air conduction and bone conduction thresholds of normal and CSOM ears and across wave I-III ABR inter peak wave latencies of normal and CSOM ears. Consistent with findings this strongly suggests utilization of ABR in the test protocol in determining the presence of sensori neural component in CSOM. The exact bone conduction thresholds could have been computed using tests such as sensori neural acuity level (SAL) or conductive SISI. The present study if would have taken measures for computing true and exact bone conduction thresholds would have better clinical correlation. However, the processes are very time consuming and require a high amount of patient co-operation. It is hoped that research in this area will help in better post op hearing restoration and efficacy of surgical management of chronic suppurative otitis media with and without cholesteatoma.

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