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EVALUATION OF HEARING IMPAIRMENT IN VERY LOW BIRTH WEIGHT NEONATES BY OTOACOUSTIC EMISSIONS AND BRAINSTEM EVOKED RESPONSE AUDIOMETRY

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ABSTRACT

Objective: The study aimed at investigating the diagnostic performance of two sequential otoacoustic emissions and Brainstem evoked response audiometry in detecting hearing impairment in very low birth weight neonates. **Methods:** A total of 102 very low birth weight neonates admitted in Neonatal intensive care unit, Department of Pediatrics were screened by Distortion Product Otoacoustic Emissions (DPOAE) pre-discharge (>34 weeks post-menstrual age). At the follow up visit i.e. at 6 weeks to 3 months corrected age both DPOAE and BERA (Brainstem Evoked Response Audiometry) was done. **Results:** The results showed a Male preponderance was observed in our study (M: F=54:48). For the Left ear Sensitivity, Specificity, Positive Predictive Value and Negative Predictive value of OAE 1 was 100%, 78%, 8.33% and 100% respectively. For the Right ear Sensitivity, Specificity, Positive Predictive Value and Negative Predictive value was OAE 1 100%, 78.22%, 4.35% and 100% respectively. For the Left ear Sensitivity, Specificity, Positive Predictive Value and Negative Predictive value of OAE 2 was 100%, 100%, 100% and 100% respectively. For the Right ear Sensitivity, Specificity, Positive Predictive Value and Negative Predictive value was OAE 2 100%, 100%, and 99% respectively. **Conclusion:** Though OAE cannot replace BERA for detection of sensorineural hearing loss a 2-step sequential OAE has shown to have beneficial diagnostic performance

KEYWORDS

OAE, brainstem, audiometry, hearing, neonates, BERA.

INTRODUCTION

Hearing as a function in human beings plays a substantial role in the growth of intellect & language-related abilities [1]. As time passes the loss of hearing grows slowly and thus the first sign and symptoms ought to be identified as early as possible. So early screening is the best method for the deterrence of progressive hearing disorders [2]. Congenital hearing loss among newborn babies as well as children could cause deficiency and defect in the growth of various abilities, such as speech, leading to emotional distress.

The prevalence of sensorineural loss of hearing is estimated to be roughly one to three per 1,000 newborn babies [3,4]. Among those one to three, 1 out of 1000 children suffer from severe to profound deafness, which may be 70 dB & more. As a result, around 2 to 5 percent of newborns suffer from impaired loss of hearing or deafness.

A significant proportion of congenitally severe or profound hearing loss children show, no risk factors of deafness hence screening is not done in these cases. However, initial hearing screening should be conducted for all newborn babies and children [5]. Both otoacoustic emission (OAE), and auditory brainstem response (ABR) are available to diagnose hearing problems among newborn babies [6].

OAE test evaluates the response of cochlea to noise that is emitted through an external device i.e. microphone in the external auditory canal, reflecting the external auditory function as well as outer hair cells[7] .Whereas, the ABR test makes use of surface electrode for measuring-cochlear neural activity as well as neural activities of auditory nerve and response of brainstem towards an acoustic stimulus that reflects the peripheral auditory system's status as well as the status of the auditory brainstem and vestibulocochlear nerve [8].

The early detection and intervention of hearing impairment in neonates has a beneficial effect on language acquisition and the timely development of speech.

Subjects And Methods

This study is a prospective observational study conducted in very low birth weight neonates (<=1500g) admitted to NICU between October 2020 to August 2022. The study was conducted in NICU in The department of Pediatrics and department of Otorhinolaryngology, KIMS Hospital, Bhubaneswar.

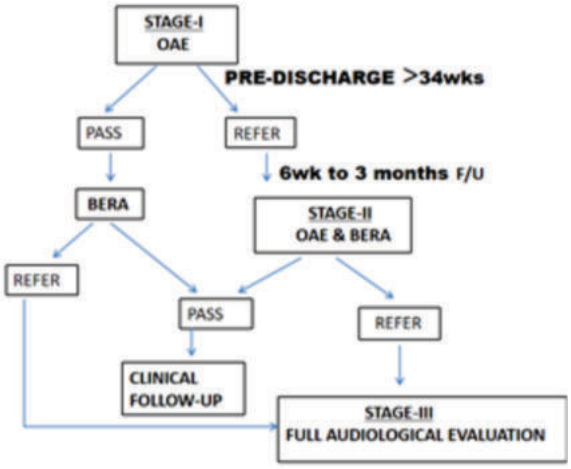
All cases of Very Low Birth Weight neonates (<1500g) discharged from NICU were included in this study. Parents not willing to evaluate for hearing screening and follow-up were excluded from the study.

METHODOLOGY

Very low birth weight neonates were screened after explaining the purpose of the study to the parent. Informed consent was taken for both the tests i.e., OAE and BERA in the 1st visit of screening.

In STAGE I -The infants were tested by OAE at discharge >34 weeks post menstrual age initially and the results were shown as either 'pass' or 'refer'.

In the follow-up i.e., STAGE II- Repeat OAE AND BERA were tested at 6 weeks to 3 months corrected age in Figure 1.



Statistical Analysis

Continuous variables with normal distribution were expressed as mean

(SD) and with skewed distribution were expressed as median (interquartile range). Categorical variables were expressed as n (%). We further assessed the specificity, sensitivity, negative and positive predictive values for the first OAE and second OAE.

RESULT

A total of 102 VLBW neonates were enrolled based on the eligibility criteria. Out of which, 54 were male.

The mean (SD) age of the First OAE was 35.35 (1.65) weeks. Among 23.5% participants, there was some abnormality in left ear. 22.6% participants had abnormality in right ear shown in figure 2.

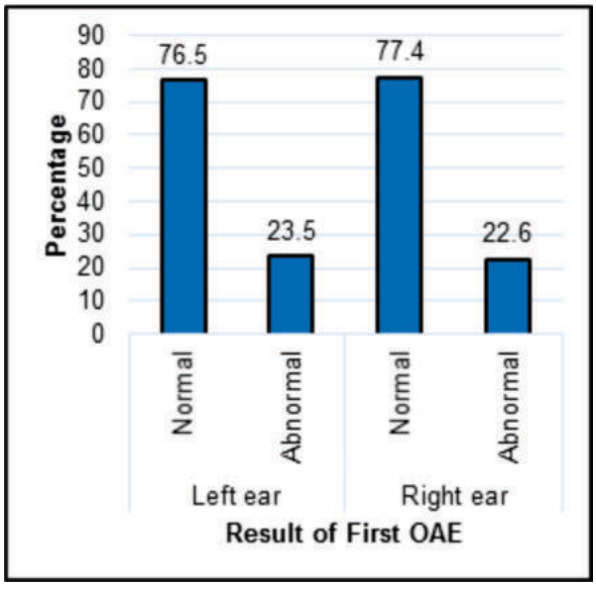


Fig 2: Result Of First OAE

In Figure 3 the mean age of the second OAE was 15.15 (3.80) weeks. Among 2.0% participants, there was some abnormality in left ear. 1.0% participants had abnormality in right ear.

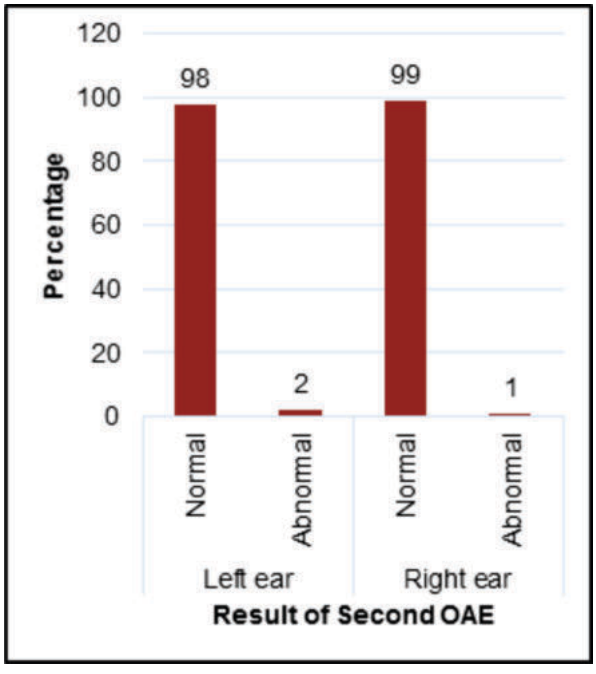


Fig 3: Result Of Second OAE

For the Left ear, the mean (SD) frequency/amplitude of I, III, and V were 1.63 (0.17), 3.41 (0.18), and 5.23 (0.29), respectively. The mean (SD) interval between I & III wave, III & V wave, and I & V wave were 1.80 (0.15), 1.84 (0.15), and 3.69 (0.31), respectively.

For the Right ear, the mean (SD) frequency/amplitude of I, III, and V were 1.7 (0.15), 3.34 (0.19), and 5.32 (0.21) respectively. The mean (SD) interval between I & III wave, III & V wave, and I & V wave were 1.64 (0.23), 1.98 (0.22), and 3.62 (0.23), respectively shown in table 1. Based on BERA, 2% participants had some ear abnormality.

Table 1: BERA Findings

BERA, n(%)	Normal	100 (98.0)
	Abnormal	2 (2.0)
Left ear (n= 101)		
	I wave latency in ms	1.63 (0.17)
	III wave latency in ms	3.41 (0.18)
	V wave latency in ms	5.23 (0.29)
	I & III wave interval	1.80 (0.15)
	III & V wave interval	1.84 (0.15)
	I & V wave interval	3.69 (0.31)
Right ear (n= 101)		
	I wave latency in ms	1.7 (0.15)
	III wave latency in ms	3.34 (0.19)
	V wave latency in ms	5.32 (0.21)
	I & III wave interval	1.64 (0.23)
	III & V wave interval	1.98 (0.22)
	I & V wave interval	3.62 (0.23)

For the Left ear, there was mild and profound hearing loss in 1 and 1 participant, respectively, while 98% participants had normal hearing. For the Right ear, there was profound hearing loss in 1 participant., while 99 % participants had normal hearing show in table 2.

Table 2: Final Diagnosis

Left ear	Normal	100 (98.0)
	Mild	1 (1.0)
	Profound	1 (1.0)
Right ear	Normal	101 (99.0)
	Profound	1 (1.0)

For the Left ear Sensitivity, Specificity, Positive Predictive Value and Negative Predictive value of OAE 1 was 100%, 78%, 8.33% and 100% respectively.

For the Right ear Sensitivity, Specificity, Positive Predictive Value and Negative Predictive value was OAE 1 100%, 78.22%, 4.35% and 100% respectively as calculated from Table 3

Table 3: Accuracy Of First OAE

OAE 1 vs. BERA for Left ear		BERA		Total
		Abnormal	Normal	
OAE 1	Abnormal	2	22	24
	Normal	0	78	78
Total		2	100	102
OAE 1 vs. BERA for Right ear		BERA		Total
		Abnormal	Normal	
OAE 1	Abnormal	1	22	23
	Normal	0	79	79
Total		1	101	102

For the Left ear Sensitivity, Specificity, Positive Predictive Value and Negative Predictive value of OAE 2 was 100%, 100%, 100% and 100% respectively.

For the Right ear Sensitivity, Specificity, Positive Predictive Value and Negative Predictive value was OAE 2 100%, 100%, and 99% respectively as calculated from Table 4.

Table 4: Accuracy Of Second OAE

OAE 2 vs. BERA for left ear		BERA		Total
		Abnormal	Normal	
OAE 2	Abnormal	2	0	2
	Normal	0	100	100
Total		2	100	102
OAE 2 vs. BERA for Right ear		BERA		Total
		Abnormal	Normal	
OAE 2	Abnormal	1	0	1
	Normal	0	100	101
Total		1	100	102

DISCUSSION

Mathur et al [9] in their study found that screening neonates within the first 48 hours of life yielded high false positive result and increased the referral rate to undergo the BERA test. The specificity of transient evoked OAE was lowest at this age. Thus, delaying the transient evoke otoacoustic emission (TEOAE) screening to 3 months of age would substantially lower the false positive outcome.

In a study conducted by Bansal et al [10] infants were screened with TEOAE at ages of 0 to 1 month, 1 to 2 months, and 2 to 3 months. 77.5%, 83.4%, and 92.8% infants, respectively, passed the screening test, making it evident that delayed screening at 3 months of age would considerably decrease the number of false positive cases.

Hyde and associates reported BERA sensitivity of 98% and specificity of 96% if the average target hearing loss is 40dBHL at 2 and 4kHz. If the target degree of hearing loss is 30dBHL, sensitivity and specificity were 100% and 91%, respectively [11].

Norton and co-workers held specificity at 80% and determined sensitivity for TEOAE, and BERA alone and in combination for a target loss of 30dBHL. Sensitivity ranged from 80% to 90%. If those infants with known progressive hearing loss were excluded, sensitivity improved [12].

However, according to the American Academy of Family Physicians studies (2007) the sensitivity of OAE in identification of hearing loss was 84 % and the specificity of it was 90%. As well as, in our study, the sensitivity (70%) and specificity (99.3%) of TEOAE for detecting of hearing loss were high; therefore, it is effective tool for screening of neonates in birth [7].

CONCLUSION

Hearing is not a visible disability. It usually goes undetected until it affects the child's communication in the form of speech and language. This accentuates the need for newborn screening.

As per this study, OAE is also considered a useful tool to screen high-risk patients as OAE has a good sensitivity, requires less expertise, and less time consuming, hence it helps to reduce the number of patients requiring BERA. However, OAE is also has a limitation like inability to calculate hearing threshold and no information is achieved regarding the neural deafness.

BERA is more definitive for detection of sensory as well as neural deafness. OAE gives idea about cochlear portion (sensory part), while BERA gives idea of the entire auditory pathway.

Regular follow-up should be done, and rehabilitative measures should be started as early as possible.

Though OAE cannot replace BERA for detection of sensorineural hearing loss a 2-step sequential OAE has shown to have beneficial diagnostic performance. However, the result cannot be generalized due to low prevalence of hearing loss and a smaller number of study population in this study.

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Conflict Of Interest: There was no conflict of interest before, during or after the completion period of the entire study.

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