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THE COMPARATIVE STUDY OF INCIDENCE OF HEARING IMPAIRMENT IN HIGH-RISK AND NON HIGH RISK NEWBORNS USING OTOACOUSTIC EMISSION (OAE) AND BRAINSTEM EVOKED RESPONSE AUDIOMETRY (BERA).

Otorhinolaryngology

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ABSTRACT

Background: Hearing loss occurs at a rate of 10.75 per 1000 high-risk newborns and 4.7 per 1000 low-risk newborns. Neonates with hearing problems must be identified and treated as soon as possible. The goal of the current study is to use OAE and BERA to evaluate the hearing impairment in high risk and low risk newborns, to establish a universal protocol, early diagnosis and intervention for the same. **Methodology:** The present cross-sectional study has been performed on 1508 newborns from March 2021 till Feb 2023 using OAE and BERA available in our Tertiary care center. **Results:** 345 neonates were risk factors, most common being Jaundice in 146 (9.7%). 1163 (77.1%) neonates were non-high-risk infants. On 1st OAE testing 31.88 % high-risk neonates and 30.09 % non-high-risk neonates had bilateral hearing loss. From total 1st OAE referred who underwent 2nd OAE had 59.55% high-risk neonates and 11.32% non-high risk abnormal finding. Brain Evoked Response Auditory (BERA) test was applied on total 94 neonates show that out of 53 high-risk neonates, 3 (5.7%) had Hearing Loss and out of 41 non-high-risk neonates, only 2 (4.9%) had Hearing Loss. **Conclusion:** There are five times as many possibilities of hearing loss in high risk newborns as compared to low-risk newborns. That demonstrates the significance of neonate hearing loss screening. Our research showed that BERA provides a precise representation of hearing sensitivity. As a result, BERA testing to be done routinely in all infants to look for hearing loss.

KEYWORDS

Neonates, High Risk, OAE, BERA, Hearing loss.

INTRODUCTION

Nearly 250 million people worldwide have a hearing impairment, with auditory abnormalities being the most frequent congenital condition, according to World Health Organization (WHO) figures. Hearing impairment observed are 10.75 per 1000 in high-risk newborns and 4.7 per 1000 in low-risk newborns. The crucial years for language and speech development are 0–3 years. There is proof that early hearing deprivation inflicts anatomical and functional changes on the cortical level, impeding the appropriate growth of the central auditory nerve system [1]. Neonates with hearing problems must be identified and treated as soon as possible, according to the Joint Committee on Infants' Hearing (JCIH). Preserving the highest amount of linguistic acquisition abilities is the aim of early hearing loss identification and intervention. JCIH highly advises that all newborns be tested for hearing loss till one month of age, and if hearing loss found in the first testing, the thorough hearing evaluation must be done till three months of age. Therapeutic assistance should be given to infants who have hearing deficits that have been verified up to age 6 months. Researchers have shown that therapeutic assistance given to babies before the age of six months has a much better effect than therapeutic intervention given later, and that neglect in this area may result in a delay in language development [2]. The two tests that are most frequently performed in newborn wards are OAE and BERA, with the BERA test being used in the event that an OAE test results in a false referral. One of the most serious sensory deficits, hearing loss has serious impact on social and mental health. The most frequent problem is significant hearing loss, which affects 1 to 3 babies per 1000 in the general population and 24% to 46% of infants hospitalized to newborn intensive care units. In comparison to a 3-year-old child having adequate hearing, whose vocabulary ranges from 500 to 900 words, a 3-year-old toddler with hearing loss has a vocabulary of 300–700 words at birth, 150–300 words at 6 months, and 0–50 words at 2 years. As a result, it is crucial to screen neonates for hearing loss. Doing so will enable early diagnosis and treatment of hearing impairment [3]. Hearing loss has been a sign of poor socioemotional growth, which might manifest as poor academic performance, underemployment, increased social maladaptation, and psychological discomfort. Correcting hearing loss at the appropriate time can assist to enhance quality of life, lower direct and indirect morbidities associated with the disability, and improve the outcome of those impairments. The goal of the current study is to use OAE and BERA to evaluate the hearing status of neonates with or without a high risk for hearing impairment and to establish a universal protocol for screening of neonates for the same.

MATERIAL AND METHODS

The study was performed at the tertiary care center; 1508 newborns were screened for a period of 2 years.

Study Design: Cross-sectional observational study

Sample Size- 1508

METHODOLOGY:

After obtaining antenatal, Natal and postnatal history and proper ENT examination of neonate our skilled audiologist performed 1st OAE after 24 hours of birth and record as REFER or PASS. REFER neonates underwent 2nd OAE after 2 weeks or before discharging from hospital and document as REFER or PASS.

Those neonates who are documented as REFER in 2nd OAE are examined for Screening BERA within 6 months or early and documented as hearing impaired or normal hearing.

Methods used to perform OAE and BERA:

OTOACOUSTIC EMISSIONS(OAE)

Newborns with parents brought to a sound proof room while neonate is sleeping. Then tiny flexible ear plugs of OAE machine are inserted gently one ear at each time. The results are recorded as 'PASS' or 'REFER' as shown in the machine. Same procedure is conducted in 2nd OAE. For further hearing pathway defect BERA is performed in 2ND OAE REFER newborns.

Brain Evoked Response Audiometry (BERA)

This test is used to detect abnormality in Auditory pathway by using BERA machine. It is performed in a sound proof room after adequately sedating the neonate or while in deep sleep the electrodes are placed. Over right and left mastoid inverting electrodes, non-inverting electrodes over vertex and ground electrode over nasion. Click stimulus of 100msec are given and waveforms are searched starting from 30db then 50db and 90db above threshold limit. In a normal person, 7 waves are produced in the first 10 milliseconds. Waves I, III, and V can be obtained consistently in all age groups shown in (table 1). Waves II and IV appear less consistently. The latency of each wave (time of onset of wave peak after stimulus onset) increases and the amplitude decreases with a reduction in stimulus intensity or loudness [4,5]. No waves are seen till 90db above threshold this is labelled as profound hearing loss. The exact anatomic site of the origin of waves is still disputed but they are thought to arise from the following parts given in Table 1

Table – 1: Site Of Origin Of Waves In Bera Graph.

WAVE I	VIII NERVE
WAVE II	COCHLEAR NUCLEI(PONS)
WAVE III	SUPERIOR OLIVARY COMPLEX(PONS)
WAVE IV	LATERAL LEMNISCUS(PONS)
WAVE V	INFERIOR COLLICULUS(MIDBRAIN)
WAVE VI	MEDIAL GENICULATE BODY(THALAMUS)
WAVE VII	AUDITORY RADIATIONS (THALAMO CORTICAL)

Ethical Approval:
Ethical approval for this study was provided by (DYPMCK/397/2021/IEC) the Institutional Ethics Committee, of tertiary care center, granted approval for the study on 22/03/2021

Instruments Used:
1. OAE machine.
2. BERA machine.

3. Statistical Analysis:
Continuous data may be categorized for statistical purposes, was analyzed using Chi-square test. Continuous data was analyzed using mean standard deviation, standard error of mean, student t test &ANOVA (if more than 2 groups).

Statistical software:
MS Excel, SPSS version 22 (IBM SPSS Statistics, Somers NY, USA) was used to analyse data.

Ethical Concerns:
Written informed valid consent was obtained from the patient's parents in English and the local language, Confidentiality of the patient was assured, no additional expenses were borne by the patient.

RESULTS

In the present study, out of 1508 neonates, 271 (18%) were screened within 48 hours, 1015 (67.3%) were screened within 48 hrs to 7 days and 222 (14.7%) were screened after 7 days. Male to female ratio was almost equal with slight female preponderance (50.6% females and 49.4% males). Male to female ratio was 0.98:1 .345 neonates were having risk factors, the most common being Jaundice in 146 (9.7%) Less common risk factors where Low Birth Weight, Hypothermia, and Bacterial Infection in 32(2.1%),28(1.9%),21 (1.4%) and 19 (1.3%) neonates respectively. 1163 (77.1%) neonates were free from any risk factors, and considered as non-high-risk infants. Based on presence of risk factors, 345 (22.9%) were categorized as High-Risk neonates.

Findings of 1st OAE (Table 2), out of 345 high risk neonates, 3.47% had abnormal finding on right side, 11.59% on left side and 31.88 % on both sides. Out of 1163 non-high-risk neonates, 1.03% had abnormal finding on right side, 4.30% on left side and 30.09 % on both sides. The difference was statistically significant (p value <0.001). Findings of 2nd OAE 59.55% high risk and 11.32% low risk neonates shows bilateral ear abnormalities described in (Table 2). BERA test was applied on total 94 neonates who had abnormal 2nd OAE finding .

Out of total 1508 newborns, 5(0.33%) were found to be deaf and remaining 99.67% had normal hearing (Table 3). Incidence (Table 3) was 5 times higher in high-risk neonates (0.89%) compared to non-high-risk neonates (0.17%) and Odd's ratio is 5.09. BERA test was applied on 53 high risk and 41 non high risk neonates after which 5 neonates showed profound hearing loss. Out of 5 profound hearing loss neonates 2 had Jaundice and one had IUGR showing higher incidence of hearing loss in neonates with hyperbilirubinemia.

Table 2. Findings of 1st and 2nd OAE in high risk and non high risk neonates

1stOAE		Type of Neonate		Total	Chi Square, P value
		High Risk	Non-High Risk		
Refer	Right Ear	12(3.47%)	12 (1.03%)	24(1.59 %)	39.72 0.000
	Left Ear	40(11.59%)	50 (4.30%)	90(5.97 %)	
	Bilateral	110(31.88%)	350 (30.09%)	460(30.50%)	
Pass	183(53.04%)	751 (64.57%)		925 (61.34%)	
Total	345 (100%)	1163 (100%)		1508 (100%)	
2nd OAE					
Refer	Right	0 (0%)	0 (0%)	0 (0%)	43.73, 0.000
	Left	0 (0%)	0 (0%)	0 (0%)	
	Bilateral	53 (59.55%)	41 (11.32%)	94 (18.65%)	
Pass		89 (40.45%)	321 (88.68%)	410 (81.35%)	
Total		142 (100%)	362 (100%)	504 (100%)	

DISCUSSION

Prior to being released from the hospital after delivery, every newborn should ideally have their hearing tested. This is not always feasible in a developing nation with little resources. Correcting hearing loss at the appropriate time can assist to enhance quality of life, lower direct and indirect morbidities associated with the disability, and improve the outcome of those impairments. The goal of the current study is to use OAE and BERA to evaluate the hearing status of neonates delivered in our hospital with and without a high risk for hearing impairment.

345 neonates were having risk factors, most common being Jaundice, in 146 (9.7%) followed by Meconium-stained Liquor in 74 (4.9%) neonates. Findings of 1st Oto-Acoustic Emission testing shows that out of 345 high risk neonates, 3.47% had abnormal finding on right side, 11.59% on left side and 31.88 % on both sides (Table 2). Out of 1163 non-high-risk neonates, 1.03% had abnormal finding on right side, 4.30% on left side and 30.09 % on both sides. The difference was statistically significant (p value <0.001). Findings of 2nd OAE testing (table 2) shows that in non-high-risk 11.32% had abnormal finding. Similar to our study, a study by **Mary James et al [10]** shows 12.1% hearing loss in 2nd OAE. BERA (table 3) shows that 0.89% of high-risk neonates had Hearing Loss whereas in study by **Ur Rehman et al [14]** showed 1.7% **Mary James et al [10]** showed 0.63% hearing loss. Similar to our study **Agrawal el al [8] Martinez-Cruz et al [7]** showed higher incidence of hearing loss in neonates with hyperbilirubinemia.

The limitations-
In our study were that it was conducted only in one institute for time limitation being 2 years. Other shortcoming in our study was that after 1st OAE from 162 high risk 20 failed to follow up and from 412 non-high-risk neonates, 50 failed to follow up.

Table 3. Incidence of Hearing Loss among new born (overall):

Incidence of Hearing Loss	Type of Neonate		Total	Odd's Ratio
	High Risk	Non-High Risk		
Hearing Loss	3(0.89%)	2(0.17%)	5(0.33%)	5.09 (0.85 to 30.59)
Normal	342(99.01%)	1161(99.83%)	1503(99.67%)	
Total	345(100%)	1163(100%)	94(100%)	

CONCLUSION

According to the present study, the incidence of hearing impairment in high risk neonates is 0.89% and in non-high-risk newborns is 0.17%. There are five times as many possibilities of hearing loss in high-risk newborns in comparison to non-high-risk neonates. Amongst the high-risk group, Jaundice was the most common factor followed by IUGR

as a cause for hearing loss in our study. This study demonstrated the significance of newborn hearing screening with OAE followed by BERA (in 2nd OAE Refer cases) not only in high-risk neonates but also in non-high risk once. Our study showed that BERA provides a precise representation of hearing sensitivity in newborns. This suggests that general screening program chosen over targeted screening of high-risk population will help in picking up all candidates with Hearing impairment at the earliest, and proper rehabilitation of such Deaf and hard-of-hearing youngsters will help them in acquiring language abilities during a period of cerebral plasticity that would otherwise be lost, detaching them from social world and causing academic malaise.

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