

Prevalence of hearing impairment among high risk neonates- A hospital based screening study

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Abstract

Background and objectives: Hearing loss present at birth is one of the major disabilities in childhood, the early detection of which can prevent further disability in speech, language and cognition. The prevalence of congenital hearing loss has been estimated to be 1.2 – 5.7 per thousand live births and is more among high risk neonates. In this context the present study was conducted as an attempt to find the prevalence of hearing loss among high risk neonates and the associated risk factors.

Methodology: The present study was a hospital based cross sectional study conducted at a tertiary care centre in Trivandrum, Kerala during the period of November 2012 to October 2014. A total of 231 high risk babies were assessed by 2 staged DPOAE screening and those who failed the second stage DPOAE screening were subjected to diagnostic Brainstem Evoked Response Audiometry.

Results: 0.9% of the high risk babies had hearing loss. Both the neonates who had sensorineural hearing loss were males and had identifiable risk factors, such as hyperbilirubinemia, ototoxicity, neurological deficits and congenital malformation.

Conclusion: The two staged screening protocol with Distortion Product Otoacoustic Emission and confirmation by Brainstem Evoked Response Audiometry was found to be a useful tool in detecting hearing loss in newborn. Hence the results of this study will be used to initiate universal newborn hearing screening in our hospital. Moreover our study highlights the relevance of neonatal hearing screening in our country where this screening is not performed routinely in all hospitals.

Keywords: DPOAE, high risk neonates, hearing loss.

1. Introduction

Hearing is essential for speech and language development, communication and learning. Children with hearing loss continue to be under identified and underserved population and their life is affected both quantitatively and qualitatively. Hearing loss in children constitutes a considerable handicap because it is an invisible disability that can compromise their optimal development and personal achievement. The prevalence of congenital hearing loss has been estimated to be 1.2 – 5.7 per thousand live births.[1,2]

Early detection and appropriate treatment provides the best choice maximizing the critical period of hearing and thereby availing the resources to improve hearing and oral communication skills. On the other hand late detection and treatment leaves the children with poor speech development and school achievement. Programmes that focus on detecting hearing disabilities at an early part of life help in improving the overall development of the child in cognitive, motor and social domain. However diagnosis of these children at an early stage can be a difficult task even for the experienced

clinician. Choosing the appropriate method and instrument in establishing the clinical diagnosis at an early stage is also practically difficult.

In this context, the present study was conducted to identify the prevalence and associated risk factors of hearing impairment among high risk newborns, in an attempt to initiate early interventions in affected children.

2. Materials and methods

2.1 Study type

Hospital based cross-sectional study in a tertiary care hospital at Trivandrum done from November 2012 – October 2014

2.2 Inclusion criteria

All neonates born in the above tertiary care hospital during the specified period, having any of the following risk factors: Prematurity; Meconium aspiration; Multiple pregnancies; Hyperbilirubinemia; Low birth weight; Low APGAR score; Sepsis; Seizure; Mechanical ventilation for more than 24hrs; Shock; Major morbidities such as

intraventricular haemorrhage and periventricular leucomalacia; Rh haemolytic disease; Major malformations; Abnormal neurological examination at the time of discharge; Obstructed/prolonged labour; Assisted labour; Babies born to diabetic mother.

2.3 Exclusion criteria

- Babies above the age of 1 month
- Normal healthy babies without any risk factors
- Parents refusing screening

2.4 Procedure of the test

The parents of the newborn were counselled regarding the chances of hearing loss in high risk neonates and the need for early diagnosis and appropriate interventions. Following this, written informed consent was obtained from the parents along with a detailed questionnaire being filled. The babies underwent a routine ENT examination involving inspection of the pre-aural, pinna, and post auricular regions followed by otoscopic examination of the external auditory canal and tympanic membrane using Heine 3000 series otoscope.

2.5 Testing environment

The babies were then tested with the help of a qualified audiologist, in a sound treated room in the audiology department along with a caretaker, preferably when the child was asleep.

2.6 Sequence of the testing

The neonates who were at risk were initially tested using Distortion Product Otoacoustic Emissions (DPOAE) during the first 1 week after birth or after stabilising their general condition. The test was conducted in a two staged protocol using DPOAE and confirmatory test with Brainstem Evoked Response Audiometry.

For DPOAE testing, soft rubber probes with a standardized infant ear tip kit was gently inserted into the right ear by a gentle traction on the pinna in a backward and downward direction. First the probe was fit and seal was checked followed by any extrinsic noise levels in a systematic computerized manner preloaded in the software. The frequencies tested ranged from 2 kHz, 3 kHz, 4 kHz and 6 kHz. The same procedure was repeated in the other ear also. The graph was plotted simultaneously along with the acquisition of data.

2.7 Instrumentation

The machine used for data collection and analysis was the Intelligent Hearing System Smart DPOAE Ver. 4.00 PC software. The calibration of system was done using the calibration mode in the software and was done daily to ensure the neonates were screened with a functioning probe. Two pure tone stimuli (f_1 and f_2) were presented, where f_2 was higher than f_1 and f_1/f_2 ratio at approximately 1.22 (range 1.21 to 1.23) to obtain a robust DPOAE response in human's ears. The f_2 frequencies were tested in a 2 point per octave manner, from 2 kHz to 6 kHz. Two stimuli were presented at

an asymmetrical intensity level of $L_1 = 65$ dB SPL and the second intensity, $L_2 = 55$ dB SPL (such that $L_1 > L_2$)

DPOAEs were initiated after the probe tip was in place and the check fit procedure passed. The DPOAE amplitude and noise floor adjacent frequency regions of distortion product $2f_1 - f_2$ were recorded. After assessing hearing with DPOAE, with a pass or fail criterion, a neonate, who has failed the first screening procedure by OAE, will undergo a second screening OAE. The infants who failed the second screening are further evaluated by Brainstem Evoked Response Audiometry, for the confirmation of hearing loss.

2.8 Data analysis

The collected data was entered in Microsoft Excel and analysis was done using SPSS software. The factors related to hearing impairment which were analysed include age, sex, antenatal & perinatal medical history, family history of hearing impairment and various ear examination findings.

3. Results

In the present hospital based cross sectional study conducted at a tertiary care centre in Trivandrum, Kerala, a total of 231 high risk babies were assessed by 2 staged DPOAE screening. The gender distribution of the study sample is shown in Figure 1 and the descriptive statistics of birth weight, gestational age and age at screening are depicted in Table 1. The distribution of antenatal and perinatal risk factors is shown in Table 3 and 4 respectively.

3.1 Results of the first screening

The first stage screening was conducted for 231 neonates With Distortion Product Otoacoustic Emission, of which 38 neonates (6.1%) failed the first screening test. Details are shown in Figure 2.

3.2 Results of the second screening

Second stage OAE testing was done for those neonates who failed the first testing, of which 89.5% passed the test and 10.5% failed it (Figure 3). The 4 infants who failed it were subjected to Brain Stem Evoked Response Audiometry.

3.3 Results of BERA

The neonates who failed the second screening OAE underwent BERA. Out of the 4 neonates, BERA was positive for 2 neonates, thereby identifying 0.9% prevalence of hearing loss (Figure 4). Both the neonates who were detected to have sensorineural hearing loss were males and had identifiable risk factors, such as hyperbilirubinemia (1 of the 2 neonates), ototoxicity (1 of the 2 neonates), neurological deficits (1 of the 2 neonates) and congenital malformation (1 of the 2 neonates). However, sensorineural hearing loss was present in 1 out of 2 neonates with congenital malformations and neurological deficits, 1 out of 35 neonates with prior exposure to ototoxic drugs and 1 out of 19 neonates with hyperbilirubinemia.

Figure 1: Gender distribution among the high risk neonates

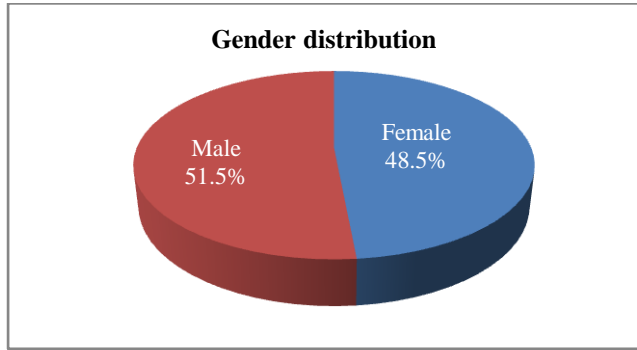


Fig.3: Results of second OAE screening

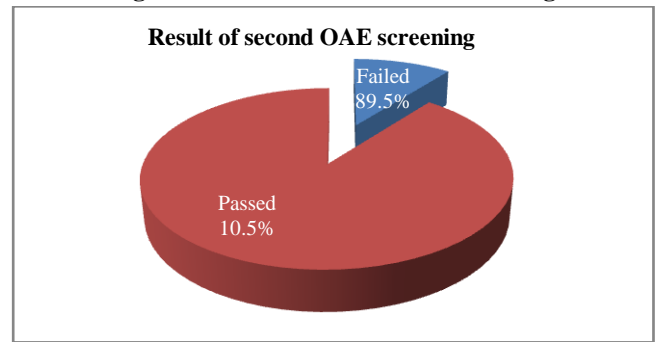


Table 1: Descriptive statistics of birth weight, gestational age and age at screening

Descriptive statistics				
	Minimum	Maximum	Mean	SD
Weight (kg)	1.3	4.3	2.91	0.56
Gestational age (weeks)	30	41	38.05	1.60
Age at screening (days)	1	23	2.42	2.25

Fig.4: Result of BERA

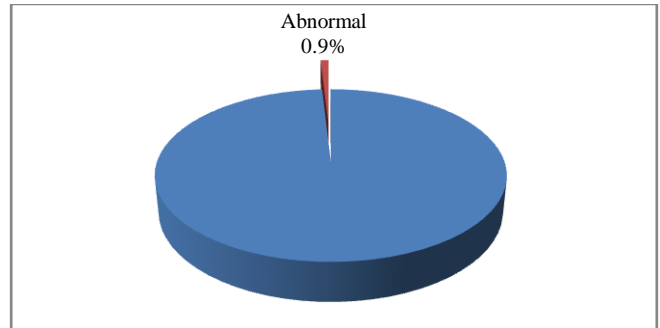


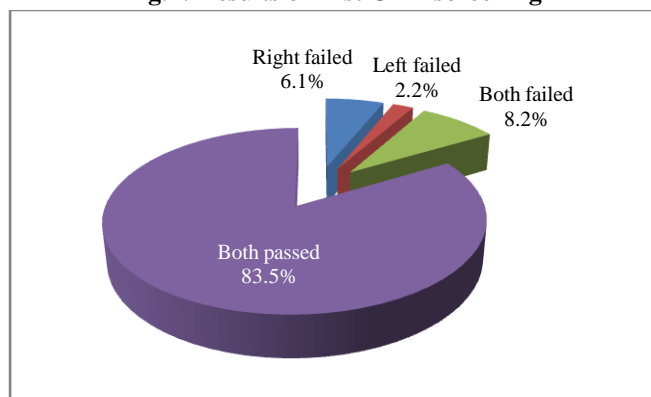
Table 2: Distribution of antenatal risk factors

Distribution of risk factors (n=231)		
Risk factor	Number of cases	%
Maternal fever with rash (1 st trimester)	2	0.9
Maternal urinary tract infection	6	2.6
Gestational diabetes mellitus	53	22.9
Gestational hypertension	40	17.3
Gestational hypothyroidism	15	6.5

Table 3: Distribution of perinatal risk factors

Distribution of risk factors (n=231)		
Risk factor	No. of cases	%
Low (< 7) Apgar score	6	2.6%
Gestational age < 35 weeks	7	3.0
Low birth weight (<2.5kg)	54	23.4
Neonatal asphyxia	5	2.2
Meconium aspiration	27	11.7
Neonatal respiratory distress	26	11.3
Prolonged NICU admission	40	17.3
Hyperbilirubinemia	19	8.2
Ototoxic drug intake	35	15.2
Mechanical ventilation	1	0.4
Shock	1	0.4
Metabolic errors, mainly hypoglycemia	51	22.1
Neurological deficit	2	0.9
Congenital malformations	2	0.9
Neonatal seizures	2	0.9
Neonatal sepsis	11	4.8

Fig.2: Results of first OAE screening



4. Discussion

Congenital hearing loss often is an invisible disorder at birth which may be recognised only when an infant does not achieve expected communicative milestones. However early detection and management of hearing loss is crucial in the developmental period for auditory, speech, and language acquisition. In light of the studies conducted in the past, the WHO has come up with the ‘Universal screening programme for hearing’ for all hospital born neonates.

The concept of early identification and intervention though not new, is yet to gain a foothold in India. Numerous studies demonstrate that early diagnosis and intervention (before 6 months of age) of hearing impairment is effective in allowing children with congenital hearing loss to acquire age appropriate speech and language development, social, emotional and cognitive growth, and academic achievement in the child.[3] This also helps in taking the advantage of the plasticity of developing the sensory system (critical period is 0-3 years). In addition, identifying hearing loss before it is clinically apparent provides a baseline on which subsequent evaluation can be made and compared. Timely information also provides acceptance of hearing impairment and improves the parents' readiness to initiate a family centred rehabilitation program. Moreover, early identification and intervention is guaranteed by the People with Disabilities Act Government of India.[4] The Joint Committee on Infant Hearing (JCIH) endorses early detection of and intervention for infants with hearing loss (early hearing detection and intervention, EHDI) through integrated, interdisciplinary state and national systems of universal newborn hearing screening, evaluation, and family-centred intervention. Thus, all infants' hearing should be screened using objective, physiologic

measures in order to identify those with congenital or neonatal onset hearing loss. In recent years, the technology and expertise has developed to allow screening to detect hearing loss in newborn babies.

Otoacoustic Emissions (OAE) is the currently acceptable methodology for physiological screening, as it is non-invasive, quick and easy to perform. Distortion Product Otoacoustic Emission (DPOAE) contains information about cochlear place (frequency), is sensitive to low frequency hearing losses and therefore is the apt test for screening and examination of specific regions of the organ of Corti. DPOAEs have no normative due to differences in probe design, noise floor, electrical noise, testing environment. Pass criteria and normative have to be derived for a particular population and machine.

The pure tones which stimulate the cochlea are called primaries and they are assigned as Frequency 1 (f1) and Frequency 2 (f2) and their corresponding amplitudes are assigned as L1 and L2. The DPOAE amplitude and noise floor adjacent frequency regions of distortion product 2f1-f2 were recorded.

It is generally accepted that the primary generation site for the 2f1 – f2 DP is at or close to the f2 place. This frequency is about 1/2 octave lower in frequency than f2 when an f2/f1 ratio of 1.22 is used. It is also known that similar DPOAE measurements in neonates and infants result in robust responses in the vast majority of ears for f2 frequencies of at least 2.0, 3.0 and 4.0 kHz. Sound to Noise Ratio (SNR) decreases as frequency decreases, making the measurements less reliable at 1.0 kHz.

In our study we used a two stage OAE protocol, wherein neonates were subjected to 2 stages of screening using otoacoustic emission followed by confirmation using Brainstem Evoked Response Audiometry. This protocol was put forward by the Joint committee of Infant Hearing and was also followed by Jhonson JL et al and Arehart KH et al.[5,6]

In our study, the prevalence of hearing loss among high risk babies by two staged screening protocol with DPOAE and confirmation by BERA was 0.9%. In another study conducted in Cochin, Kerala [7] the incidence of hearing loss in the high risk group was 1.03%. Other studies [8] have revealed the incidence of severe hearing loss among survivors of neonatal intensive care ranges from 1% to 28%. Studies done in India using different screening protocols for neonatal hearing loss have estimated the prevalence to vary between 1 and 8 per 1000 babies screened.[9,10] However, both normal as well as high risk neonates were included in these studies. Among the babies screened in our study, 51.5 % were male and 48.5% were female babies. These findings were similar to that of other studies who also found male predominance of hearing impairment.

Both the neonates who were detected to have sensorineural hearing loss were males and had identifiable risk factors such as hyperbilirubinemia, ototoxicity,

neurological deficits, congenital malformation etc. As only 2 neonates out of the 231 high risk neonates were detected to have sensorineural hearing loss, we were unable to statistically analyse the correlation between hearing loss and associated risk factors.

5. Conclusion

The two staged screening protocol with Distortion Product Otoacoustic Emission and confirmation by Brainstem Evoked Response Audiometry was found to be a useful tool in detecting hearing loss in newborn, which is vital in preventing further disability in speech, language and cognition. Hence the results of this study will be used to initiate universal newborn hearing screening in our hospital. Moreover our study highlights the relevance of neonatal hearing screening in our country where this screening is not performed routinely in all hospitals. Fallacies in comparison to larger studies are unavoidable because of a relatively small sample size.

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