Outcome of newborn hearing screening - A tertiary care centre experience

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Objective: To assess the prevalence of neonatal hearing loss using a 3-phase newborn hearing screening protocol at a tertiary care hospital in New Delhi. Method: New born hearing screening was carried out at a tertiary hospital in Delhi using a) a field tested questionnaire to assess the risk factors, b) hearing screening using OAE for all newborns and c) advanced audiological testing using BERA for newborns failing OAE twice and those admitted to the neonatal intensive care unit. Result: Of the total 1,412 newborns screened a total of 55 newborns failed the screening tests of which 36 newborns had one or more risk factors. BERA (conducted on both newborns who had failed OAE twice as well as high risk neonates admitted in the NICU) confirms a total of 47 newborn with hearing loss. Conclusion: The target population showed relatively lower level of incidence compared to the published reports from other parts of India.

ARTICLE INFO

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INTRODUCTION

With the estimated evidence of 2-4 infants per 1000 live births, significant hearing loss is considered to be one of the most common congenital disorders. [1] Globally it is also ranked as the third leading type of disability. [2] According to the international guidelines by the Joint Committee on Infant hearing in 1994, diagnosis of hearing loss in infant should occur before the age of 3 months and proper rehabilitation should be given by 6 months of age. [3] As hearing plays an essential role in optimal speech and language development, failure or delay in hearing loss detection can lead to irreversible speech and language impairment in children which can further lead to poor academic and occupational performance. [4,5,6,7,8] In one of the studies, it was revealed that the only significant variable to affect language development was the age at which hearing loss was detected. [6]. Markides reported in his study that children identified with hearing loss between the age of 0-6 months show higher developmental functions than those identified later. [9]

Implementation of Universal newborn hearing screening programme is the only way to diagnose hearing impairment at the earliest and as per the international guidelines, all neonates should undergo hearing screening irrespective of presence of high risk factors [10,11,12]. A study conducted by Connolly et al in 2005 indicated that as a result of the universal hearing screening program in place from 1997-2001, the mean age of diagnosis was 3.9 months, with mean age of intervention at 6.1 months. [13] With the early diagnosis of hearing loss and appropriate rehabilitation, it is possible for a child to develop near normal speech. This in turn will contribute towards decreasing financial burden of the country. [14]

This articles aims to identify incidence of hearing loss in the target population by using Oto-acoustic emission (OAE) and Brainstem evoked response audiometry (BERA) as diagnostic tests for hearing loss. The study also aims to highlight the challenges faced in identification of hearing loss using available hearing assessment modalities.

Material and Methods

Study Participants:

This observational cross sectional study includes a total of 14,123 babies born at Lok Nayak Hospital, Delhi in the period from February 2013 to September 2014.

Majority of the infants born at the hospital were screened for hearing loss in the first 24 hours of their life. Mandatory written consent was obtained from the parents before screening the child.

Specifications of the equipment

OAE screening was carried out using MaicoEro Scan Transient evoked Oto-acoustic emission (TEOAE) with the frequency range from 1.5- 4 kHz. Being lightweight the OAE machine has an integrated mechanically isolated probe tip which enables hand held operation with no degradation in noise specification.

SNSEP010 1-800-IHYSYSTEMS (GSI AUDERA) was used for conduction of BERA with the rate of 34/sec, Intensity of 109.6dB HL down to 0 dB HL and filter of 30-1500 HZ

3 Phase screening protocol:

The screening programme consists of a 3 phase protocol which includes
a) Risk factor assessment using field tested questionnaire
b) Hearing screening using Transient evoked Oto-acoustic emission (TEOAE)
c) Advanced audiological testing using Brainstem evoked response audiometry (BERA)

Initial step involved categorizing neonates into low risk and high risk categories. A set of questions were designed to identify potential risk factors and this questionnaire was administered at the time of hearing screening.

The questionnaire included yes or no based questions to record clinical history of the newborn. This included recording the birth weight, gestation, Apgar score along with presence of birth trauma, craniofacial anomalies, family history of congenital hearing loss, history of fever or rash to the mother in first trimester, maternal history of convulsion, neonatal sepsis, history of ototoxic drugs, neonatal jaundice and ear discharge.

The responses to these questions were recorded. Neonates who had history of one or more risk factors and were admitted to the NICU underwent mandatory BERA testing along with the routine OAE testing. All other newborns underwent a 2-stage screening protocol with the first OAE screening within the first 24 hours of life. Those newborns that did not pass the first OAE (oto-acoustic emission) were retested the next day before they were discharged. Infants who failed to pass the second OAE were referred for more comprehensive audiological assessment using BERA (Brainstem evoked response audiometry). BERA test was conducted within 2-3 months in order to ensure early rehabilitation in case of need.

OAE test, done with a portable machine was performed in a silent room while the infant is either asleep or in a quiet state (for example while feeding). However for conduction of BERA, it was necessary to sedate the child in order to get effective results.

In case of premature and low birth weight neonates, both OAE and BERA tests were conducted regardless of whether the result of the OAE was 'pass' or 'refer'.

In formation brochure on newborn hearing care and newborn hearing milestones was distributed along with the result slip to raise awareness about various hearing milestones in infants.

Results:

A total of 14,123 infants were screened over the 19-month period. The average age of all the newborns at the time of initial screening was 24 hours.

Of the total, 232 failed the first OAE test and were referred for the second OAE testing. It was decided to conduct the second OAE test the day after the first test was conducted in order to get both the tests done before the newborns were discharged from the hospital. Of the 232 newborns screened for the second time, 177 passed the test and 55 failed even the second OAE and were then given a date for the conduct of BERA. (Table 1)

All newborns were also evaluated for presence of risk factors with the help of a questionnaire. Based on this, 465 of the 14,123 revealed presence of one or more risk factors. Of the 55 newborn babies who failed the 2-step OAE testing, 36 had a risk factor for hearing loss while 19 were without any obvious risk factor. List of associated risk factor in the newborns who failed OAE twice is given in Table 2.

BERA

Out of the 55 newborns who failed both first and second OAE tests, 53 underwent BERA test. The reason for the absence of the 2 newborns was mortality, after their discharge from the hospital. Another 64 babies who were admitted to the NICU and had a positive risk factor for hearing loss, also underwent BERA testing, regardless of their OAE status, as per the screening protocol (Table 3). Although the number of neonates identified with one or more risk factors with the help of the questionnaire was more, only a few gave consent for conduction of BERA. The average age at time of BERA was 3 months. Associated risk factors in newborn that underwent BERA are highlighted in Table 4.

Out of the 53 BERA conducted on newborns who had previously failed OAE twice, 44 newborns had either unilateral or bilateral hearing loss and 9 neonates showed normal wave pattern.

Out of the 64 BERA conducted on NICU neonates with high risk factors, 61 Neonates showed no significant hearing loss whereas 3 showed absence of normal wave pattern. Hence total 47 babies had either unilateral or bilateral hearing loss.

Table 5 gives the frequency distribution of different types of hearing loss in the screened populations as concluded after the conduction of BERA.

<table>
<thead>
<tr>
<th>No. of newborns screened</th>
<th>No. of newborns failed 1st OAE</th>
<th>No. of Newborns failed 2nd OAE</th>
</tr>
</thead>
<tbody>
<tr>
<td>14123</td>
<td>232</td>
<td>55</td>
</tr>
</tbody>
</table>

Table 2: Associated risk factors in 55 newborns who failed OAE twice

<table>
<thead>
<tr>
<th>Risk factors</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preterm with low birth weight</td>
<td>20</td>
</tr>
<tr>
<td>Jaundice requiring Phototherapy</td>
<td>5</td>
</tr>
<tr>
<td>Jaundice requiring Exchange Transfusion</td>
<td>3</td>
</tr>
<tr>
<td>History of hearing loss in family</td>
<td>3</td>
</tr>
<tr>
<td>Low Apgar score</td>
<td>2</td>
</tr>
<tr>
<td>Birth asphyxia</td>
<td>1</td>
</tr>
<tr>
<td>Meningitis</td>
<td>1</td>
</tr>
<tr>
<td>Neurological disorder</td>
<td>1</td>
</tr>
</tbody>
</table>
studies have suggested that up to 50% of all children with congenital hearing loss have no risk factors and would be missed in case only risk based screening was conducted, [16,17] therefore universal hearing screening was implemented in order to evaluate the burden of hearing loss among all the babies born at the hospital.

According to the present study, the incidence of hearing loss either unilateral or bilateral in the target population is 0.33%. The value was seen to be slightly lower than those obtained in other studies from other parts of country. A study conducted in a tertiary level hospital of northwest India (Ludhiana) in the year 2013 showed the incidence of 0.4% [18] whereas a cohort study by N. Nagapoornima et al shows prevalence of 5.6 per thousand live births. [19] John M at CMC, Vellore shows the frequency of sensorineural hearing loss in his study to be 0.6% [20] while a study conducted in Gujarat between 2008- 2011, the prevalence of hearing loss was seen to be 1%. However, the lower incidence in the present study could be because this has only focused on the immediate neonatal period, whereas other studies have often included children up to 2 years as part of this study. [21] It is noteworthy that 3 of the NICU babies who passed OAE test revealed hearing loss on BERA test. It is possible that other babies with hearing loss may have been missed as they only underwent a single OAE test. As it is not possible to undertake BERA test on all babies, it may be possible to improve the sensitivity of the screening protocol by including ABR screening in the test protocol. This can help to identify children with auditory neuropathy who would not fail OAE test and improve the overall sensitivity of the screening protocol. [22,23]

Study conducted in Singapore in the year 2005 by W.K Low, shows the incidence of hearing loss in newborns to be 0.4%. [24] OAE was technically easier and faster to perform but showed higher false positive result (nearly 17%). This may be attributed to obstruction of ear canal with debris and amniotic fluid soon after birth. Screening with OAE also required a relatively quiet area which is sometimes a challenge in a fully functional tertiary hospital. Due to this reason, more time was taken to complete the test. Study from CMC Ludhiana [18] and CMC Vellore [20] share the same experience in terms of limitations arising due to noisy surrounding. Jacobson and Jacobson recorded the time of OAE testing to be less than 3 minutes for both the ears however due to noise, myogenic activity and relocation of probe the actual mean time came to be around 16.6 minutes. [25]

Damage to the Oto acoustic emission machine and probe also served as one of the limitation of the project. Since, the probe is a very delicate and essential part of the equipment, its damages caused temporary discontinuation on the screening programme. Shulman et al in his work reported that due to the lack of backup equipment at hospitals when the main screening equipment is in repair, many infants were not screened for hearing loss before discharge. [26]

In the findings of Holte et al, it was seen that often parents showed delay in hearing loss detection and intervention which may be due to the observation of their infant responding to sounds at home. [27] This was similar to the limitation we faced as the parents did not appreciate the importance of early steps taken...
towards diagnosis and showed hesitation. Similar observations were recorded in the report by Onada et al where mothers showed difficulty in understanding the importance of neonatal hearing screening. The report also highlighted that, financial difficulty posed a challenge for the parents to commute to the testing center repeatedly. [28] These findings coincide with the observations made during the course of the present study where it was seen that the distance of the hospital from the place of residence, and financial difficulties served as one of the reasons for their hesitation.

**Conclusion:**

1. The prevalence of hearing disorder for the present study was 0.33%
2. Having a quiet room specially designated for the conduct of OAE would help reduce the limitations arising due to noisy environment.
3. Including ABR screening
4. Backup equipment at standby would reduce the number of missed cases however it would escalate the total cost of conduction of newborn screening.
5. Parental counselling at every screening level would help the parents understand the importance of early steps to be taken for diagnosis and rehabilitation.

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**REFERENCES:**