ORIGINAL RESEARCH PAPER

ENT

KEY WORDS: AUDIOLOGICAL PROFILE, OAE, NEOATAL HEARING EVALUATION, KASHMIR, TERTIARY CARE CENTRE.

# AUDIOLOGICAL EVALUATION OF NEONATES BORN AT A TERTIARY CARE CENTRE IN KASHMIR

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ABSTRACT

Hearing impairment is the most common form of sensory disorder in humans. Audiological profile of neonates born at a tertiary care centre in Kashmir was conducted to calculate the prevalence of hearing impairment in the study population. Out of 1800 neonates 962 (53.4%) were females rest being males with a sex ratio of 1.15:1.On initial screening 91.2% (n=1642) of subjects had bilaterally present OAE (B/L PASS).First follow up screening was done in all the high risk infants (n=435) and those of not at risk who had absent OAE either bilaterally or unilaterally (n=112).The prevalence of hearing loss in not at risk was 2.97 per 1000 and in high risk was 8.04 per 1000. The combined overall prevalence was found to be 4.07 per 1000.Impedance audiometry showed B/L A type with absent Acoustic reflexes in ipsilateral and contralateral side in infants with impaired hearing on screening. ASSR also documented all these 7 infants to have B/L PSNHL.3 of them underwent cochlear implantation, 3 of them are using hearing aids due to financial constraints while other one was last to follow

**INTRODUCTION;** Hearing empowers us and enriches our lives. Good hearing also helps to keep us safe, warning us of potential danger or alerting us to someone else's distress. A child with subnormal hearing acuity suffers from consequences of hearing loss compounded by impaired speech development. Such a child, if untreated, becomes handicapped physically, intellectually and emotionally.Hearing impairment is classified into three groups.[1,2]

- **Conductive hearing impairment:** This occurs when the sound conducting mechanism of the ear is defective. The lesion could be anywhere from the external auditory canal to the footplate of stapes.
- **Sensorineural hearing impairment:** This type of deafness is due to abnormality in the cochlea, auditory nerve, neural pathway or their central connections with auditory cortex.
- **Mixed hearing impairment:** It denotes that both conductive and sensorineural abnormality is present.

Hearing loss is one of the most common congenital anomalies, occurring in approximately 2-4 infants per 1000. [3,4,5] Hearing impairment can be present at birth (congenital), or become evident later in life (acquired). The distinction between acquired and congenital impairment specifies only the time that the impairment appears. It does not specify whether the cause of the impairment is genetic (inherited).Acquired hearing impairment may or may not be genetic.

**AIMS;** to study audiological profile of neonates born at a tertiary care centre in Kashmir and to calculate the prevalence of hearing impairment in the study population.

**MATERIALS AND METHOD;** This prospective study took place in the Department of Otorhinolaryngology and Head & Neck Surgery at Govt. Medical College, Srinagar, J&K. Subjects included neonates born and admitted in LD hospital Srinagar, tertiary care center. 1800 neonates were recruited for the study with prior informed verbal consent obtained from the parents.All these subjects were assessed clinically. The clinical work-up encompassed the detailed history (which starts from the time of conception) and a meticulous examination.Handheld TEOAE device, "Labat" OAE Screener, Italy, was used in Initial Screening and First Follow-Up Screening. It has a clinical sensitivity of more than 99%, without requiring decisions or equipment adjustment by the user. Sound stimulus is by non-linear click sequence with stimulus level 45-60 dB HL and TEOAE testing frequency range from 1.4 to 4 kHz. Results are displayed as "PASS"- indicating that the patient has normal outer hair cell function, and "REFER"- suggest a possibility of a sensorineural hearing loss or indicates requirement of further diagnostic hearing evaluation. All subjects underwent the audiological tests as per the Screening – Rescreening Protocol and hearing deficit confirmed with ABR. The study protocol was carried out in three steps.

1. **Initial Screening-** All newborns enrolled into study were screened by TEOAE within first 7 days of life.
2. **First follow-up Screening** was done at 4 to 6 weeks of age by TEOAE for-
   i. All babies of **"At risk"** group
   ii. Babies of **"No risk"** group who failed the first test screening ("refer" category)
3. **Second follow-up Screening** was done at 3 months age to confirm the hearing impairment by ABR/ BERA test for-
   i. All babies of **"At risk"** group
   ii. Babies of **"No risk"** group who failed the first follow-up screening ("refer" category) The neonates were documented as 'At Risk' as per guidelines provided by High Risk Register(HRR) of American Joint Committee statement on Infant hearing screening (JCIH), 2007.

1. Family history of permanent childhood hearing loss.
2. Neonatal intensive care of more than 5 days or any of the following regardless of length of stay: Extracorporeal Membrane Oxygenation (ECMO) therapy, assisted ventilation, exposure to ototoxic medications or loop diuretics and hyperbilirubinemia that requires exchange transfusion.
3. In utero infections, such as Cytomegalovirus (CMV), herpes, rubella, syphilis, and toxoplasmosis.
4. Craniofacial anomalies, including those that involve the pinna, ear canal, ear tags, ear pits, and temporal bone anomalies.
5. Physical findings, such as white forelock, that is associated with a syndrome known to include a sensorineural or permanent conductive hearing loss.
6. Culture-positive postnatal infections associated with sensorineural hearing loss, including confirmed bacterial and viral (especially herpes viruses and varicella) meningitis.
7. Head trauma, especially basal skull/temporal bone fracture that requires hospitalization.

"No risk" group included neonates who did not fulfill the criteria mentioned in the HRR of JCIH 2007.The clinical and lab details of the patient were then summarized in a predesigned proforma.

REVIEW OF LITERATURE; Pappas DG, Simpson C, McKenzie RA et al (1990)[2] found that a careful history and physical examination

would establish the cause in many cases of pediatric hearing loss. They suggested the selection of laboratory and radiographic studies based on results of these findings.

Kenneth M Grundfast and Anil K Lalwani (1992)[6] have worked on Audiological Assessment of hearing impaired children. They found that U-shaped or cookie bite audiogram with better hearing in high and low frequencies than in the middle frequencies is highly suggestive of hereditary type of hearing impairment.Lisa Barsky et al (1997)[7] tested 15729 neonates, of which 14,014 were well babies and 1735 NICU graduates. They screened well babies with a single stage ABR for 35dB HL. Those well babies who failed this screening test were evaluated after 6 months for unilateral hearing loss and after 3 months for bilateral hearing loss. NICU graduates were tested with ABR for 40dBHL and 70dBHL. Otoacoustic emissions were reserved for referrals. Out of the 365 well babies who failed the test 29 were identified to have sensorineural hearing loss (2:1000 live births). Out of the 120 NICU graduates, 23 were confirmed to have hearing loss (13:1000). They concluded that conventional ABR was time consuming and expensive.

**RESULTS;** The results from the current study are as below;

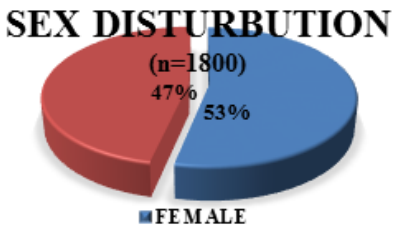


**Figure 1 Majority of the infants in our study were females 53% and males constituted 47% as shown in the above pie chart.**

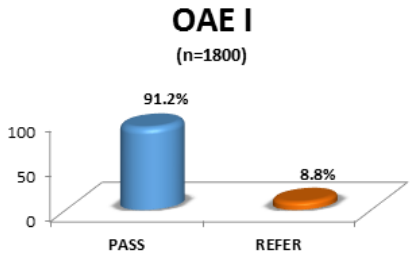


**Figure 2. In the present study 91.2% of the neonates had bilaterally present OAE whereas 8.8% had absent OAE either unilaterally or bilaterally on initial screening**

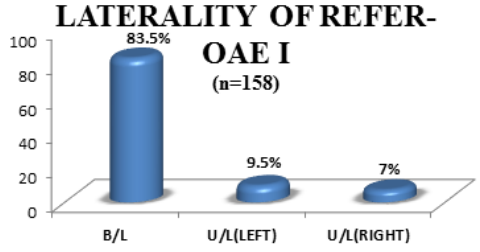


**Figure3 OAE was absent bilaterally in 83.5% of the neonates with REFER. OAE on initial screening and unilaterally absent in the remaining in the present study.**

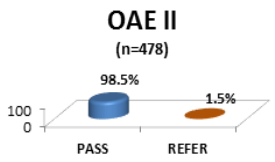


**Figure 4. 98.5% of the infants had bilaterally present OAE whereas 1.5% had absent OAE either unilaterally or bilaterally on first follow up screening.**

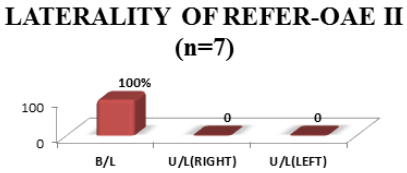


**Figure 5.OAE was absent bilaterally in all of the infants with REFER OAE on first follow up screening in our study.**

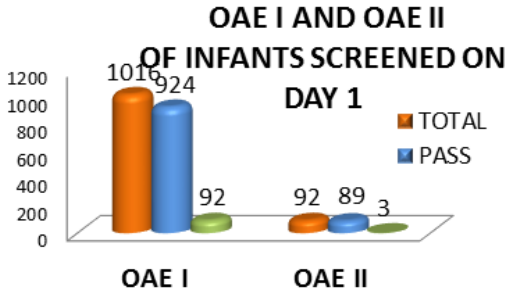


**Figure 6 In our study Sensitivity and specificity of OAE in infants screened on 1st day of birth was found to be 100% & 90.94% respectively.**

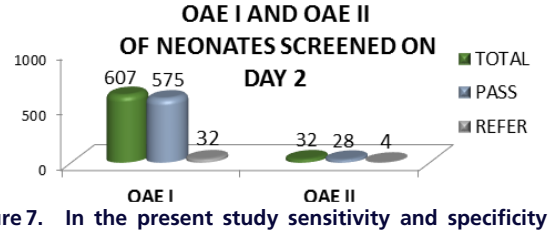


**Figure 7. In the present study sensitivity and specificity of OAE in infants screened on 2nd day of birth was found 100% & 94.73% respectively**

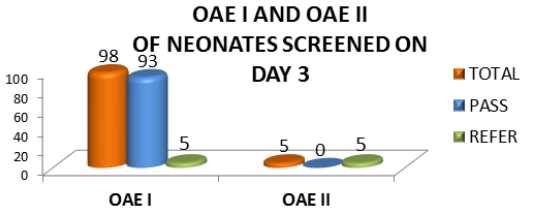


**Figure 8 Sensitivity and specificity of OAE in infants screened on 3rd day of birth was found to be 100% in our study.**

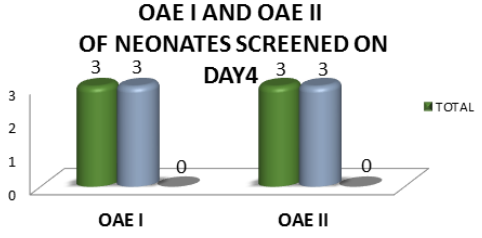


**Figure 9 In our study specificity of OAE in infants screened on 4th day of birth was found 100%.**

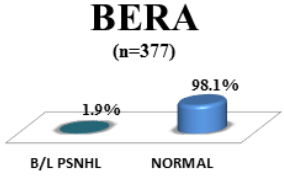

**Figure 10. In the present study 1.9% of the infants who underwent BERA were found to have bilateral hearing impairment.**

**TABLE1: IMPEDENCE AUDIOMETRY**

| | Number Of Babies | Percent |
|---|---|---|
| **B/L A TYPE** | 7 | 100 |
| **Total** | 7 | 100 |

**B/L A type curve was present in all the hearing impaired infants in our study.**

**TABLE2: ACOUSTIC REFLEX**

| | Acoustic Reflex | |
|---|---|---|
| **B/L PSNHL** | **Present** | **Absent** |
| | O | 7 |

**Acoustic reflex was absent bilaterally in all the 7 infants found to have impaired hearing on screening.**

**TABLE4: ASSR**

| | Number Of Babies | Percent |
|---|---|---|
| **B/L PSNHL** | 7 | 100 |
| **Total** | 7 | 100 |

All the hearing impaired infants in the present study had B/L profound sensorineural hearing ASSR testing

**DISCUSSION** The period from birth to 3 years of life is critical for the development of speech and language, therefore, there is need for early identification and assessment of hearing loss and early rehabilitation in infants and children. It was observed that children whose hearing loss was observed and managed before 6 months of age had higher scores of vocabulary, better expressive and comprehensive language skills than those diagnosed and managed after 6 months of age emphasizing the importance of early identification and treatment.[8] .The ultimate goal of early screening and diagnosis is early intervention.

A total of 1800 neonates born and admitted in LD hospital were screened for hearing impairment with prior informed verbal consent obtained from the parents. A two stage OAE protocol was used, wherein neonates were subjected to 2 rounds of otoacoustic emission recording, one of which was performed by first week of birth and the other was conducted in those who had failed the first screening programme or had high risk factors. The further evaluation of these babies who failed the second stage screening or who had high risk features was done by diagnostic 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[9], Finitzo T et al[5], Arehart KH et al[10]

This study comprised of total 1800 neonates with females constituting 53.4% (n=962) and males constituting 46.6% (n=838) which is consistent with the neonatal hearing screening study done by Habib Hs et al[56] on a total number of 11,986 neonates (41.4% male and 58.6% females). 24.2% (n=435) neonates in the present study belonged to high risk group as per guidelines provided by HRR of JCIH 2007 which is consistent with the study conducted by James L Conolly et al[11] who screened 17602 babies of which 18.1% (n=3186) were NICU admitted babies. Among the high risk neonates 48.7% (n=212) were females and 51.3% (n=223) were males which is almost similar to the study conducted by Meyer et al[12] on 777 high risk infants in which 431(55.9%) infants being male and 339(44.1%) female whereas those in not at risk group 54.9% (n=750) were females and 45.1% (n=615) were males.

It is generally agreed that the presence of otoacoustic emissions indicates that the preneural cochlear receptor mechanism together with middle ear systems, responds to sound in a normal way. In other words, otoacoustic emissions are seen as an inevitable by-product of the processes that are essential to hearing but reduce very rapidly as deafness increases and are undetectable when the deafness is above 30-35dB SPL approximately.

On initial screening 91.2% (n=1642) of neonates had bilaterally present OAE (B/L PASS) whereas 8.8% (n=158) of neonates had either unilaterally or bilaterally absent OAE (REFER). OAE was absent bilaterally in 7.3% (n=132), absent on left side in 0.83% (n=15) and absent on right side in 0.61% (n=11) of the subjects. Our pass percentage is similar to other studies conducted by Prieve et al[13](93.3%), Habib et al[14](91.3%).This screening was performed on day 1 of birth in 58.4% (n=1051) of neonates, on day 2 in 35.7% (n=643) of neonates, on days 3 in 5.7% (n=103) of neonates and on day 4 in 0.2% (n=3) of neonates. Dividing subjects into high risk (n=435) and not at risk (n=1365), 10.6% (n=46) of neonates in high risk group had absent OAE either unilaterally or bilaterally. OAE was absent bilaterally in 9.2% (n=40), absent on left side in 0.2% (n=1) and absent on right side in 1.1% (n=5) of these high risk neonates whereas 8.2% (n=112) of neonates in not at risk group had absent OAE either unilaterally or bilaterally. OAE was absent bilaterally in 6.7% (n=92), absent on left side in 1% (n=14) and absent on right side in 0.44% (n=6) of these not at risk neonates. Papadouri et al[15] conducted hearing screening in high risk neonates and found absent OAE in 14.6% of subjects which is similar to our study.

First follow up screening of the appropriate subjects was done between 4 to 6 weeks following initial screening. These subjects included all the high risk neonates (n=435) and those neonates of not at risk who had absent OAE either unilaterally or bilaterally (n=112). Among the high risk group (n=435), 383 subjects had bilaterally present OAE whereas 3 subjects had bilaterally absent OAE. 49 other subjects were lost to follow up (male=14, female=35). 88 subjects of not at risk group had bilaterally present OAE and 4 subjects had bilaterally absent OAE whereas 20 subjects (male=3, females=17) were lost to follow up.

The next parameter calculated in present study was sensitivity and specificity of the screening method used. By comparing the results of initial screening with first follow up screening in the neonates screened on first day of birth,

OAE had
Sensitivity- 100% with a 95% confidence interval of 43.85-100

Specificity- 90.94 % with a 95% confidence interval of 89.02-92.56

Positive predictive value- 3.16 with a 95% confidence interval of 1.08-8.87

Negative predictive value-100% with a 95% confidence interval of 99.59-100

Diagnostic accuracy-90.97% with a 95% confidence interval of 89.05-92.53

| | | OAE II | | |
|---|---|---|---|---|
| | | REFER | PASS | TOTAL |
| OAE I | REFER | 3 | 92 | 95 |
| | PASS | 0 | 924 | 924 |

By comparing the results of initial screening with first follow up screening in the neonates screened on second day of birth,
OAE had

Sensitivity- 100% with a 95% confidence interval of 51.01-100

Specificity- 94.73 % with a 95% confidence interval of 92.65-96.24

Positive predictive value-11.11% with a 95% confidence interval of 4.407-25.32

Negative predictive value-100% with a 95% confidence interval of 99.34-100

Diagnostic accuracy-94.76% with a 95% confidence interval of 92.7-96.27

| | | OAE II | | |
|---|---|---|---|---|
| | | REFER | PASS | TOTAL |
| OAE I | REFER | 4 | 32 | 36 |
| | PASS | 0 | 575 | 575 |

Similarly by comparing the results of initial screening with first follow up screening in the neonates screened on third day of birth,

OAE had

Sensitivity- 100% with a 95% confidence interval of 56.55-100

Specificity- 100% with a 95% confidence interval of 96.03-100

Positive predictive value-100% with a 95% confidence interval of 56.55-100

Negative predictive value-100% with a 95% confidence interval of 96.03-100

Diagnostic accuracy-100% with a 95% confidence interval of 96.23-100

| | | OAE II | | |
|---|---|---|---|---|
| | | REFER | PASS | TOTAL |
| OAE I | REFER | 5 | 0 | 5 |
| | PASS | 0 | 93 | 93 |

By comparing the results of initial screening with first follow up screening in the neonates screened on fourth day after birth,

OAE had

Specificity - 100% with a 95% confidence interval of 43.55-100

Negative predictive value-100% with a 95% confidence interval of 43.85-100

Diagnostic accuracy-100% with a 95% confidence interval of 43.85-100.

| | | OAE II | | |
|---|---|---|---|---|
| | | REFER | PASS | TOTAL |
| OAE I | REFER | 0 | 0 | 0 |
| | PASS | 0 | 3 | 3 |

Sensitivity and specificity of OAE in our study is consistent with the studies conducted by B De Capua et al[16] (sensitivity 100%; specificity 99.7%)and Papadouri et al[15](sensitivity 100% ; specifity 91%).

In neonates who are at risk for neural hearing loss OAE alone are not sufficient screening tool. Therefore such patients should undergo ABR (Auditory brainstem response) screening also so that the presence of auditory neuropathy is not missed. Objective testing with ABR was the next testing tool used for screening of these subjects. These subjects included all the neonates of high risk group and those neonates of not at risk group who failed OAE on first follow up screening. A total of 377 neonates were screened with ABR, of which 7 (male=5, female=2) were labelled as B/L profound sensorineural hearing loss. 4 out of these 7 neonates belonged to not at risk group (n=1341) whereas 3 belonged to the high risk group. One of the high risk neonate was preterm (33 weeks) with very low birth weight (1.4kg) and had history of NICU stay of more than 5 days. Other one had history of hyperbilirubinaemia with exchange transfusion and NICU stay of more than 5 days. Third one had family history of hearing loss.

## SUMMARY:

- Out of 1800 neonates 962 (53.4%) were females rest being males with a sex ratio of 1.15:1.On initial screening 91.2% (n=1642) of subjects had bilaterally present OAE (B/L PASS).First follow up screening was done in all the high risk infants (n=435) and those of not at risk who had absent OAE either bilaterally or unilaterally (n=112).The prevalence of hearing loss in not at risk was 2.97 per 1000 and in high risk was 8.04 per 1000. The combined overall prevalence was found to be 4.07 per 1000.
- Impedance audiometry showed B/L A type with absent Acoustic reflexes in ipsilateral and contralateral side in infants with impaired hearing on screening. ASSR also documented all these 7 infants to have B/L PSNHL.3 of them underwent cochlear implantation, 3 of them are using hearing aids due to financial constraints while other one was last to follow up

## CONCLUSION:

- Hearing is a sense essential to normal communication and consequently a normal life for all individuals. A child with subnormal hearing acuity suffers from consequences of hearing loss compounded by impaired speech development. Many children aren't diagnosed with hearing loss until they are around 2 years old, when delayed speech development becomes obvious and raises concerns.
- Prevalence of hearing loss in not at risk group was found to be 2.97 per 1000 screened and 8.04 per 1000 screened in high risk group.Comparing the prevalences of hearing loss in these two groups the difference is statistically insignificant (p=0.221) and thus applying only high risk strategy for neonatal hearing screening can miss significant number of children with hearing loss among not at risk population.

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