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Hearing Impairment Among High Risk Neonates- A Tertiary Care Hospital Based Screening Study

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Abstract:
Background*: Hearing impairment among neonates is an invisible disability that compromises optimal development of a child. Reduced auditory stimulus adversely affects growth of auditory nervous system and also significantly affects their speech development. Early detection of neonatal hearing loss and prompt intervention can facilitate normal speech development. Hence this study focuses on the outcome of screening for hearing loss among neonates admitted in Intensive Care Units to determine prevalence of hearing loss among them and to ascertain the risk factors indicating higher probability of hearing loss.*
Materials and Methods*: In this cross sectional study, 567 high risk neonates were subjected to a two staged hearing screening. All the participants were initially tested with Otoacoustic Emission (OAE) and those who failed the initial test were subjected to subsequent confirmatory test using Brainstem Evoked Response Audiometry (BERA)*
Results*: In this study out of 567participants, 62 newborns were diagnosed with hearing loss (prevalence= 10.9%). 50 % (n=31) newborns had bilateral SNHL, 14.5% (n= 09) newborns had unilateral sensory hearing loss and 35.5% (n=22) newborns had conductive hearing loss. In this study highest frequency of hearing loss has been identified in neonates having family history of congenital hearing loss (37.93%) followed by craniofacial deformities (22.22%).*
Conclusion: *In this study the prevalence of hearing loss among high-risk neonates is 10.9%.*
Key Word*: Neonatal hearing loss, neonatal hearing screening, Otoacoustic Emission, BERA*

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I. Introduction

Hearing loss among neonates constitute a considerable handicap because it is an invisible disability that compromises optimal development of a child.[1]In our country an estimate of 5.82 persons have congenital hearing loss per lakh of population, two deaf babies are born per hour and approximately 18,000 deaf babies are added to our population every year.[2] Detection and rehabilitation of hearing impairment in infants by 6 months of age has a proven advantage over those detected after 6 months to acquire normal language[3]. Hearing impairment may be seen in neonates at risk or not at risk. The prevalence ranges from 0.09 to 2.3 % in low risk neonates[4] and it ranges from 0.3 to 14.1 % in the high-risk population[5]. Hence selective hearing screening based on risk factor identification is not an alternative to universal screening of neonates but this can work as cost-effective measure to reduce the financial and infrastructural burden in developing countries[6].

II. Material And Methods

This is a cross sectional study carried out on neonates admitted in NICU ward of Department of Pediatrics at Regional Institute of medical sciences (RIMS), Imphal from January 2021 to October 2022. A total of 567 neonates admitted in NICU ward during the study duration were included in this study.

Study Design: Cross Sectional Study

Study Location: This is a tertiary care teaching hospital based study done in Department of Otorhinolaryngology and Department of Pediatrics, at Regional Institute of Medical sciences (RIMS), Imphal, Manipur.

Study Duration: January 2021 to October 2022.

Sample size: 567 patients.

Sample size calculation: Based on the formula of cross-sectional study, sample size (N) was calculated as: $N = 4PQ/L^2$ where, P = prevalence of hearing loss among high-risk neonates taken from study conducted by Vashistha et al.[3] which is 15%. Absolute error (L) was taken as 3% and sample size was calculated to be 567.

Subjects & selection method: The study population was drawn from all neonates admitted to NICU ward of Department of Pediatrics of RIMS, Imphal were included in the study consecutively till the required sample size is met.

Inclusion criteria:
All neonates admitted in NICU ward, Department of Pediatrics of RIMS, Imphal during the time period January 2021 to October 2022 were included in the study.

Exclusion criteria:
1. Babies above age of one month at the time of admission
2. Normal healthy babies
3. Those babies who died or were referred to other centers
4. Those who fail to appear for follow up

Procedure methodology:
After written informed consent was obtained from the parents, a well-designed questionnaire was used to collect the data of the recruited patients. The questionnaire included socio-demographic characteristics such as age, gender, religion, nationality, weight at birth and at the time of examination, duration of stay in NICU, detailed obstetric history, family and socio-economic history.

Then the newborns were subjected to a routine ENT examination. Inspection of external ear, auditory canal and tympanic membrane were carried out. Then newborns were initially tested with Otoacoustic emission (OAE). The OAE equipment was calibrated and tested for four frequencies i.e. 500, 1000, 2000 and 4000Hz. The absence of emissions for 2 out of 4 frequencies was taken as "Failed". Those "failed" newborns were subjected to a 2nd stage OAE test after 28 days. Newborns who failed 2nd stage OAE were taken for a confirmatory BERA test after 3 months.

Statistical analysis:
Data was analyzed using SPSS version 21 (SPSS Inc., Chicago, IL). Student's *t*-test and Chi- square test were used for test of significance between variables such as mode of delivery, hyperbilirubinemia, neonatal sepsis etc with outcome variable i.e., hearing loss. The level $P < 0.05$ was considered as the cutoff value or significance.

III. Result

A total of 567 neonates were recruited for the study. Out of which 290 were male and 277 were females. The mean age at the time of examination during first stage of newborn OAE screening was 7.2 ± 1.46 days and the mean birth weight of the participants was 2.6 ± 0.87 kg.

Table no: 1 shows among 567 neonates, 320 neonates were delivered by vaginal delivery of which 228 newborns were delivered by normal vaginal delivery whereas 73 newborns required assisted ventouse delivery and 19 newborns required Forceps delivery. 247 newborns were delivered by cesarean section.

Table no 1: Distribution of patients based on Mode of delivery

Sl. no	Mode of Delivery	Frequency	Percentage (%)
1.	Normal Vaginal Delivery (+/- Episiotomy)	228	40.21
2.	Assisted Ventouse delivery	73	12.87
3.	Forceps delivery	19	3.35
4.	Caesarean Section	247	43.56
	Total	567	100%

First stage OAE screening was conducted at the time of discharge from NICU at mean age of 7.2 ± 1.46 days. Out of which 494 (87%) neonates passed the 1st stage OAE and 73(13%) neonates failed the test. 36 (7%) neonates had failed the test in both ears whereas 19 (3%) students failed the test on right side and 18 (3%) students on the left side. 73 neonates who failed the test were referred for 2nd stage OAE screening subsequently. (Fig no 1)

Figure no 1: Pie diagram showing distribution of newborns according to result of 1st stage OAE

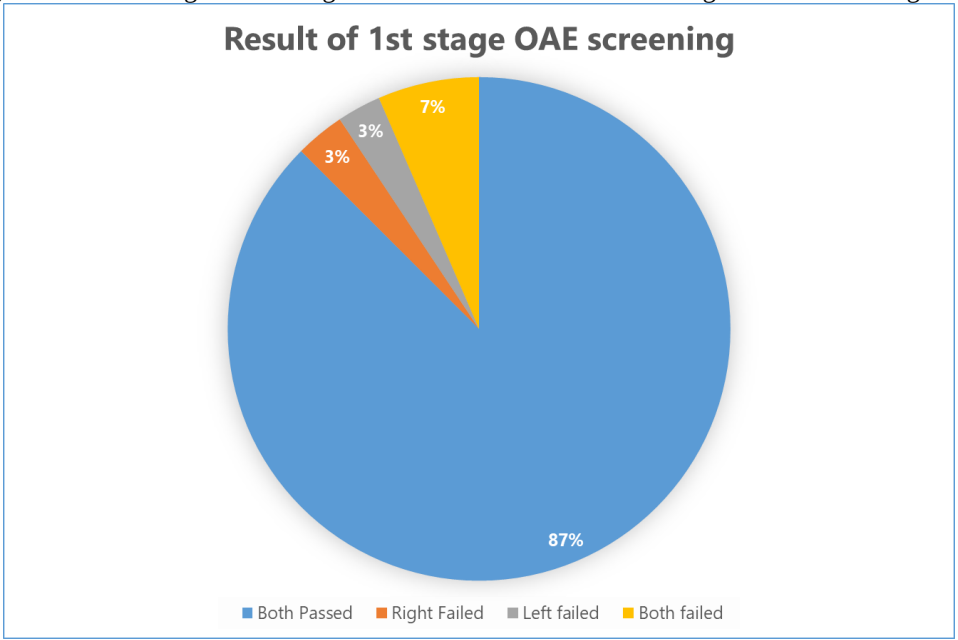

Table no 2: Shows among the 73 newborns undergoing 2nd stage OAE screening, only 5(7%) newborns passed the test and rest of the 68(93%) newborns failed the test. These 68 newborns were subjected to confirmatory BERA test after 3 months.

Table no 2: Shows results of 2nd stage OAE screening

Results of 2nd stage OAE screening	Number of newborns
Passed	5
Failed	68
Total	73

Table no 3 Shows results of 68 newborns undergoing a confirmatory BERA test. Out of 68 newborns 62 newborns failed the test. 38 were male and 24 were female. 50% (n=31) newborns were found to have bilateral SNHL, more than 3 times that of unilateral sensory hearing loss 14.5% (n= 09). 35.5% (n=22) newborns had conductive hearing loss. Out of which 18 newborns had unilateral conductive hearing loss and 4 neonates had bilateral conductive hearing loss. Prevalence of hearing loss in this study was found to be 10.93% among high risk neonates.

Table no 3: Distribution of new born with hearing loss according to type of hearing loss

Sl. no	Type of hearing loss	Frequency (N=62)	Percentage (%)
1	Unilateral Conductive Hearing loss	18	29.1
2	Bilateral Conductive Hearing loss	04	6.4
3	Unilateral Sensorineural Hearing loss	09	14.5
4	Bilateral Sensorineural Hearing loss	31	50
	Total	62	100

Table no: 4 shows out of 62 diseased newborns, 35 were delivered by vaginal delivery. Out of which 5 were instrumental deliveries (ventouse delivery). Cesarean section was carried out for 28 diseased newborns. Association between mode of delivery and neonatal outcome were assessed with P value <0.05 being considered significant. No significant association was found between mode of delivery and outcome of neonatal hearing.

Table no 4: Association between mode of delivery and neonatal hearing outcome

Sl. no	Mode of delivery	Neonates with normal hearing (N= 505)	Neonates with hearing loss (N= 62)	Total (N=567)	P value
1	Normal vaginal delivery (+/- Episiotomy)	198	30	228	0.164

2	Assisted ventouse delivery	68	5	73	0.203
3	Forceps delivery	19	0	19	NA
4	Cesarean section	219	28	247	0.787

Table no 5 shows the risk factors identified among the newborns with hearing loss. These risk factors are compared with their incidence in newborn with normal hearing using chi square test. P value <0.05 was taken as significant. In this study out of all the risk factors, family history of congenital hearing loss (p <0.00001), ototoxic drug use (p = 0.0009), preterm delivery (p = 0.0153), craniofacial abnormalities (p =0.0249) and hyperbilirubinemia (p = 0.047) were the risk factors which showed significant association with hearing loss among neonates.

Table no 6: Table comparing risk factors associated with hearing loss in BERA positive cases and normal population

Sl.no	Risk factors	Neonates with normal hearing (N= 505)	Neonates with hearing loss (N=62)	P value
1	Preterm delivery	166	30	**0.0153**
2	Low Birth weight	202	30	0.2049
3	Craniofacial deformities (including External ear deformities)	28	08	**0.0249**
4	Family history of congenital hearing loss	18	11	**<0.00001**
5	Hyperbilirubinemia	218	35	**0.047**
6	Birth Asphyxia	96	10	0.582
7	Ototoxic drug use	32	11	**0.0009**
8	Meconium-stained amniotic fluid	172	14	0.069
9	Neonatal seizure	78	09	0.848
10	Neonatal sepsis	103	11	0.622
11	APGAR score ≤ 5 at 5min	112	09	0.164

IV. Discussion

Hearing impairment in neonates is a major issue, which hampers developmental milestones if not detected and corrected at the earliest. This study focused at the high-risk group of neonates admitted in NICU of a tertiary care hospital to detect risk factors associated with congenital hearing impairment and its prevalence. In this study 567 neonates were subjected to two staged OAE screening followed by confirmatory BERA test. 62 neonates were found have significant hearing loss in our study.

Among 567 neonates, 320 neonates were delivered by vaginal delivery of which 73 newborns required assisted ventouse delivery and 19 patients required Forceps delivery. 247 newborns were delivered by cesarean section. No significant association was found between mode of delivery and neonatal hearing outcome in this study. Similar conclusion was made from a retrospective study conducted by Güven SG[7], where data of 10,575 neonates from national neonatal hearing screening program were studied for association between their mode of delivery and hearing outcome. He concluded that there is no significant association between mode of delivery and neonatal hearing loss. The finding is consistent with this study.

The mean age in days of the neonates at the time of first examination in our study was 7.2 ± 1.46 days. The examination took place on the day of discharge from the NICU/PICU. The mean birth weight is 2.6 ±0.87 kg and around 29.1% of the neonates were having low birth weight < 2.5kg in this study. But in a study by Jose DJ et al[8], the mean age of the neonate was 2.42 ± 2.25 days at the time of first examination and the mean birth weight was 2.91 ± 0.56 kg. The late examination of first stage screening compared to peer studies is due to declination of ethical clearance to shift sick neonates to audiology dept for hearing tests. Henceforth 1st examination is kept on the day of discharge

In our study, first stage OAE was conducted on 567 high risk neonates, out of which 494 (87%) neonates passed the 1st stage OAE and 73(13%) neonates failed the test. 36 (7%) neonates had failed the test in both ears whereas 19 (3%) students failed the test on right side and 18 (3%) students on the left side. 73 neonates underwent the 2nd stage OAE screening, only 5 newborns passed the test and rest of the 68 newborns failed the test. These 68 newborns were subjected to confirmatory BERA test after 3 months. Among the 68 neonates, 62 neonates failed the confirmatory BERA test. The prevalence of hearing loss among the participants in this study was henceforth found to be 10.93%. In similar studies the prevalence rate varies from 0.3 to 14.1 %. A study conducted by Vashistha et al[9] showed prevalence rate of 15% in the high-risk neonates. Higher prevalence rate can be attributed to a smaller sample size of 100. Panjiyar MM et al[6]conducted a prospective

observational study in 2017 which yielded a similar range of prevalence of 12.19%. Sample size for the study was 478.Nagapoornima et al[3] conducted a prospective study in which 279 at risk neonates where incidence was 10.75 per 1000 screened which is similar to present study.

Highest frequency of hearing loss was seen among neonates who had history of congenital deafness in their family (37.93%). Nagapoornima et al[3] recorded a frequency of 25% of hearing loss in patients with history of congenital deafness in family which was highest among all risk factors. In this study 39 parents gave history of congenital hearing loss in 1st degree or 2nd degree relatives out of which 11 newborns were diagnosed to have congenital deafness.

Risk factor with second highest frequency in this study was found to be use of ototoxic drugs (34.37%). Most implicated drug group being aminoglycosides such as Amikacin, Netilmicin and Gentamicin. Newborns with NICU admission are found to be more prone to exposure to ototoxic drugs.

Vashishtha et al[9] in a similar study identified congenital anomalies (craniofacial abnormalities) ,Birth weight<1500 g, Hyperbilirubinemia at a level exceeding indication for exchange transfusion, prematurity, sepsis, ototoxic drugs (aminoglycosides), NICU stay more than 5 days, birth asphyxia and neonatal seizures as the implicated high risk factors for development of neonatal hearing loss. The study also found higher prevalence of 15 % of congenital hearing loss among newborns belonging to these high risk groups. The findings are consistent with this study.

The limitations of this study include inability to perform first stage OAE at an earlier time period and a comparatively smaller sample size. The strong point of our study includes hundred percent follow up of all the newborns who had abnormal OAE and all these newborns had BERA done. In all the newborns identified with hearing loss, appropriate medical or surgical interventions were taken to ensure proper hearing rehabilitation & speech development. This study is on neonatal hearing screening one of the first of its kind to be conducted among the north eastern states of India and can be useful further as a reference for future policymaking towards newborn screening for hearing loss.

V. Conclusion

In this study the prevalence of hearing loss among high-risk neonates is 10.9% which is considerably higher than that of general population. Screening of these high risk newborns in this study ensured proper intervention at an appropriate time and hence upholds the necessity of newborn screening for hearing loss. In a large developing country like India Universal newborn screening for hearing loss remains a challenge. Thus, risk factor based screening can be a more economical, feasible and practical approach towards early detection of newborn hearing loss as shown in this study

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