ORIGINAL ARTICLE

"Catch Them Young" - Neonatal Screening For Hearing Loss, A Hospital Based Study

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Abstract

Background: Neonatal hearing loss is more prevalent than other routinely screened new-born disorders like congenital hypothyroidism. Auditory deprivation during early phase of life causes developmental disorders with poor language, speech& education leading to lack of job opportunities and financial dependence. Early diagnosis is essential for suitable auditory rehabilitation of such children. Any delays in detection of hearing loss ensure an inferior quality of rehabilitation and a handicap for life.**Objectives:** To find the incidence of hearing loss in neonates, compare the incidence of hearing loss in the "at risk" & "not at risk" neonates and to document the risk factors associated with neonatal hearing loss. Methods: A prospective study was carried out where neonates underwent a two-step screening with OAE and BERA as per JCIH guidelines.**Results:** Overall incidence of neonatal hearing loss was 2.85%, incidence being higher in the "at risk" group babies (4.80%). A statistically significant association between the presence of risk factors and hearing loss was observed, $p < 0.05$.**Conclusion:** Universal neonatal screening for hearing loss in all new-borns will ensure the inclusion of apparently normal neonates who form a large chunk of the "invisible burden of hearing impairment".

Keywords

Neonatal Hearing Loss, Neonatal Screening, Otoacoustic Emission, BERA

Introduction

Hearing is one of the most important sense organs in humans which lays the foundation of our language, communication, social integration and cognitive development. Diagnosis of hearing loss in neonates is often delayed since children with hearing loss may have a normal physical appearance and achieve normal milestones. [1] In addition to this invisible handicap which is initially subtle to pick up, a delayed reporting to health care system for remedial intervention occurs as the primary source of information remains "parental suspicion". [2] Prompt diagnosis and early auditory input stimulation have proven to be critical in the maximal rehabilitation of children with hearing handicap as underlined by the Joint Committee on Infant Hearing. [3,4] Since testing only infants considered "at risk" is likely to miss approximately 50% who otherwise are born apparently normal, neonatal screening for hearing loss should be done for all. [5] The present study was carried out to find the incidence of hearing loss in neonates, compare the incidence of hearing loss in the "at risk" and "not at risk" neonates and to document the risk factors commonly associated with neonatal hearing loss.

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Material & Methods:

The study was conducted in the department of Otorhinolaryngology and Head and Neck Surgery with effect from November 2019 to October 2020. It was a hospital based prospective, longitudinal, observational study. Ethical committee approval was sought and a total of 1050 new-born babies born in the hospital during the said period were included in the study. Of these 550 babies did not have any obvious risk factor and 500 babies belonged to the "at risk" group.

The babies with "risk factors" assessed in the study were in accordance with the JCH guidelines.[4] Informed consent was taken from the parents of all neonates. Ear, nose and throat examination was done before doing DPOAE. The new-borns were screened for hearing impairment using the following test protocols:

DPOAE was employed as the first stage of screening by the age of 1-3 days. The result was interpreted as "refer" or "pass". Those with "refer" result underwent repeat DPOAE after 2 weeks. BERA was done for all children with a second time refer at DPOAE at the age of 3 months for confirming hearing loss. OAE was done using Neurosoft Neuro-audio device. If a baby failed on initial screen, it was repeated immediately after an effort to troubleshoot i.e. improve probe fit, clean probe contaminated by dust, decrease ambient noise, calming the baby. ABR/BERA was done using Neurosoft Neuro-audio single channel auditory evoked potentials system. An infant was considered pass the ABR test if a replicable wave V response was present at 30 dB HL in both ears. Incidence of hearing loss was calculated in the "at risk" and "not at risk" neonates.

Statistical analysis

The information collected was entered, coded and analysed using SPSS Version 20.0. For qualitative variables, percentages and proportions were calculated. The strength of association between qualitative variables was calculated using Chi-square test. $P<0.05$ was considered to be statistically significant.

Results:

A total of 1050 cases were included in the study during one year period (2019-2020). 30 (2.85%) cases were detected with hearing loss. Incidence of hearing loss = (No. of cases with hearing loss/ Total no. of cases included in study) x 100 = (30/1050)x 100 = 2.85%

Discussion

Hearing loss is one of the most common problems among the neonates. Diagnosis of hearing loss in neonates is often delayed since children with hearing loss may have a normal physical appearance and achieve normal milestones. Environmental and prenatal factors which prevail in lower socio-economic groups along with a delayed reporting to healthcare facilities contribute to hearing loss in neonates. This is more prevalent in developing nations like ours where the Universal Newborn Screening of Hearing has not been able to reach out to the grass root levels. [6] Any degree of hearing impairment translates into poor language, speech, education, mental development and restricted employment opportunities in the long run. [7-9] The problem is more grim especially if the hearing impairment is congenital or acquired in the immediate peri/ post-natal phase of life, as the central auditory system is highly plastic in early childhood up to 2 years of age. During these periods of maximal cortical plasticity, sensory deprivation due to hearing loss leads to developmental abnormalities. The auditory neuroplasticity being finite makes an early diagnosis of hearing loss and prompt auditory rehabilitation imperative. [10,11] Literature reports that children with neonatal hearing loss due to various reasons, if identified early and managed with appropriate interventions within 6 months of age are at par with their hearing peers in terms of language development by the time they are 5 years old. [12-13] Hence children whose hearing loss is identified at an early stage and receive early intervention with hearing aids, cochlear implants etc have better outcomes than those with late detection and treatment. [14-17] Failure to detect neonatal hearing loss results in lifelong deficits in speech and language acquisition, poor academic performance, personal-social and behaviour problems. Identification and remediation of hearing loss when done before six months of age for newborns enables them to perform significantly better on vocabulary, communication, intelligence, social skills and behaviour in later life. Neonatal hearing screening emphasizes on detection of neonates with hearing loss as early as possible so that intervention can be done at the earliest. [18, 19]

The total number of newborns screened for hearing loss in our study was 1050, of which 623 were males and 427 females. The overall incidence of hearing loss was found to be 2.85% with 3.0 per 1000 babies screened. The incidence of hearing loss in males and females was found to be 3.37% and 2.11% respectively. Neonatal hearing loss has been associated with various risk factors. [4,20,21] In our study, the most common risk factor was ototoxic medications observed in 73.0% neonates followed by low birth weight in 55.6% and NICU stay days>5 in 54.0% neonates. Out of 1050 babies included in the study, 364 babies had "Refer" result on 1st OAE. This high incidence can be attributed to debris or fluid in the external or middle ear which may lead to high referral rates of 5-20%. [22] Contamination by low frequency ambient noise in busy

Table 1, Incidence of Hearing Loss in Neonates Based on the Presence of Risk Factors

Risk factor	Total no. of neonates	No. of neonates with hearing loss	Incidence of hearing loss
Present	500	24	4.80%
Absent	550	6	1.09%
Total	1050	30	2.86%

A statistically significant association between presence or absence of risk factors and hearing loss was observed (= 12.244, p <0.05, p value = 0.0021946)

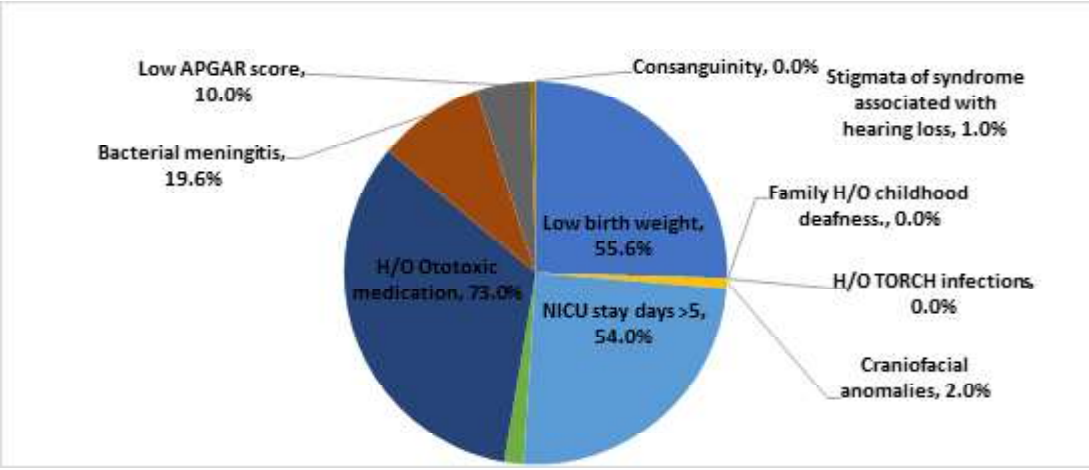


Fig 1. Showing Distribution of at Risk Neonates Based on Presence of Different Risk Factors.

nursery, vernix in the external auditory canal or middle ear pathology may also lead to refer result in OAE.[23] [24] Out of 364 babies with refer result in 1st OAE, [24] (6.59%) belonged to the "not at risk" group and 340(93.4%) belonged to the "at risk" group. Their repeat OAE 2 weeks later showed that 166 again had refer result in second 0AE (45.6%) with 12 (7.22%) belonging to not at risk group and 154 (92.7%) belonging to at risk group. 7 babies did not turn up for repeat OAE.

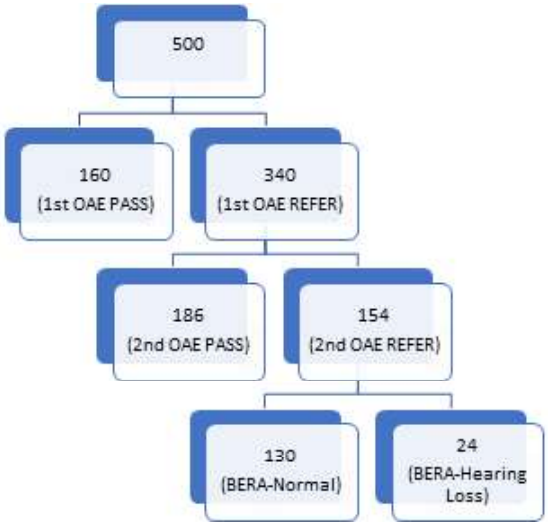
Only babies with refer result on repeat OAE underwent BERA at three months of age. While OAE is a quick and relatively easy means of screening the neonates for hearing loss, a repeat OAE is done to reduce the bulk of neonates requiring to go for BERA in an already overburdened health care system like ours. BERA has the advantage of being independent of the status of external and middle ear due to local conditions e. g presence of any debris or fluid. Two step screening with OAE and BERA also reduces the referral rates. (22) In the present study, 30 neonates were diagnosed with hearing loss that is 2.85% with 24 (80%) belonging to at risk group and 6 (20%) belonging to not at risk group. Of them, 16 neonates had bilateral loss while 14 neonates had unilateral hearing loss. The incidence of hearing loss among at risk neonates was found to be 4.80%. While it was 1.09% in the "not at risk" group which is statistically significant. Many studies on hearing impairment cover high risk infants only, thereby neglecting neonates with no associated risk factor comprising the invisible and unaddressed burden of hearing loss. By this targeted high risk screening, nearly 50% deaf children will be missed. (5)

In our study, the most common risk factor associated with hearing loss was hyperbilirubinemia requiring exchange transfusion seen in 16.7% neonates followed by craniofacial anomalies in 10.0% and bacterial meningitis in 8.2% neonates. The association between presence or absence of risk factors and hearing loss was statistically significant in our study. A statistically significant association between presence or absence of risk factors and hearing loss was observed (= 12.244, p <0.05, p value = 0.0021946)

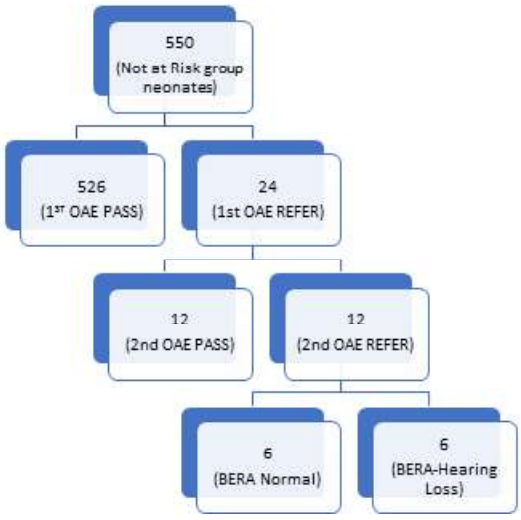
A condition that needs a special mention is "Auditory neuropathy". It is caused by damage to inner hair cells, neurons of eighth nerve fibers and is characterized by a normal OAE and severely abnormal ABR. 10% of children with permanent hearing loss suffer from this condition and is predominantly seen in NICU population. The diagnosis is done by BERA, hence missed on screening by DPOAE alone. Since neonatal hearing screening in our study was done using DPOAE, cases of auditory neuropathy could have been missed; forming a

Table 2 Distribution of at risk neonates with refer result on 1st OAE, 2nd OAE and hearing loss on BERA based on presence of different risk factors.(n=500).

Risk Factors	No. of neonates	%	1st OAE Refer		2nd OAE Refer		Hearing loss on BERA	
			No.	%	No.	%	No.	%
Hyperbilirubinemia requiring exchange transfusion	18	3.6	13	72.2	6	33.3	3	16.7
Craniofacial anomalies	10	2.0	5	50.0	3	30.0	1	10.0
Bacterial meningitis	98	19.6	70	71.4	30	30.6	6	6.1
NICU stay days >5	270	54.0	185	68.5	76	28.1	16	5.9
H/O Ototoxic medication	365	73.0	250	68.5	114	31.2	17	4.7
Low birth weight	278	55.6	193	69.4	86	30.9	13	4.7
Family H/O childhood deafness.	0	0.0	0	0.0	0	0.0	0	0.0
H/O TORCH infections	0	0.0	0	0.0	0	0.0	0	0.0
Low APGAR score	50	10.0	33	66.0	10	20.0	0	0.0
Stigmata of syndrome associated with hearing loss	5	1.0	4	80.0	1	20.0	0	0.0
Consanguinity	0	0.0	0	0.0	0	0.0	0	0.0



Flow Chart showing results of OAE and BERA for "At Risk group babies"



Flow Chart showing results of OAE and BERA for "Not at Risk group babies

limitation. Another limitation was that the equipment (DPOAE and ABR machines) used in our screening was not portable and therefore required the newborn to be brought to the testing room for assessment. The importance of automated ABR along with a separate protocol for babies with a NICU stay exceeding 5 days needs to be emphasized to widen the ease, access and outreach of the screening tools for improving the screening outcomes. [3,4]

Due to COVID -19 pandemic, screening of all the neonates delivered in the hospital could not be done which led to lesser number of babies screened during the period of our study. It is necessary to implement and incorporate a mandatory neonatal hearing screening program in our country to secure normal, social and holistic development of the child by detection of hearing loss at birth and providing remedial services at the earliest. A child who receives early intervention for hearing loss requires less expensive special education in later part of life and has a better chance to have a normal social life and improved quality of life.

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Conflicts of Interest

There are no conflicts of interest.

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