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Original Research Article

Outcome of newborn hearing screening a prospective study

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ABSTRACT

Background: Hearing is a very important part of newborn language as well as speech development, hearing loss varies degrees i.e. from hearing impairment to complete hearing loss. It has an effect on person's physical, social, mental, educational, and economic well-being.
Methods: The current study's objective was to use OAE to test newborns for hearing in the department of otorhinolaryngology and study was carried out over a period of 2 years (September 2020 to September 2022) in 2000 neonates born at Rajindra hospital Patiala by DPOAE (distortion product OAE) test. The association between maternal, neonatal, sociodemographic factors and hearing impairment in neonates were evaluated.
Results: In our study 257 out of 2000 newborns had 'Refer' result on OAE. There was a male preponderance (1061 males and 939 females) with 7% males having 'Refer' results as compared to 5.85% of females.153 out of 2000 neonates with 'Refer' result belonged to the lower class and 9.9% newborns with 'Refer' result was from rural area. Perinatal illnesses like Severe anemia (1.17%), Hypertension (0.78%) also have an impact on neonatal hearing impairment. In neonatal risk factors prematurity caused hearing impairment in 7.85% of neonates, low Apgar score at birth and 1 min (8.55% and 8.35%), low birth weight (8.75%), and more than 24-hour NICU admission (3.7%)
Conclusions: The screening of neonates with Otoacoustic emissions is required for early detection of neonatal hearing loss as OAE is an easy,reasonably priced and dependable procedure for infant testing on a wide scale.

Keywords: Otoacoustic emissions, Hearing loss, Screening of newborn for hearing

INTRODUCTION

Total 63 million Indians, or 6.3% of the population, have substantial hearing loss. Severe to profound hearing loss affects four out of every 1000 kids. With approximately 100,000 newborns each year being born without normal hearing. There are 2 percent cases of childhood-onset deafness and 7.6 percent cases of adult-onset deafness in India, according to estimates. Deafness was shown to be the second most common cause of impairment in Indian households and the most important sensory defect in the 58th round of the National Sample Survey, which was performed in 2002. Loss accounted for 10% of all disability in rural areas and 9% in urban areas. There are 291 hearing-impaired persons for every 100,000 people, according to estimates. The quantity of milder degrees of hearing loss and bilateral hearing loss would be more than these estimates for bilateral hearing loss.[1] Hearing loss can be classified into four types: Conductive hearing loss brought on by a medical problem of the middle or outer ear (the pathway for sound to reach the inner ear). Conductive hearing loss often doesn't cause significant hearing loss

and affects all hearing frequencies equally. Typically, those with conductive hearing loss might benefit from hearing aids, medical care, or surgical treatment. Sensorineural hearing loss results from harm to the sensitive sensory hair cells in the inner ear or to the nerves that supply them. This might cause hearing loss that ranges from mild to severe. They often have a greater impact on certain frequencies than others on a person's ability to hear. Because of this, persons with sensorineural hearing loss may still experience distorted sound even when the level is increased, making it difficult for them to effectively use hearing aids. An issue with both the outer or middle ear and the inner ear is indicated as mixed loss of hearing, which is a mixture of conductive and sensorineural hearing loss. Central nervous system (CNS) nerves, brain pathways, or brain nuclei that are damaged or injured lead to central hearing loss. Congenital hearing loss, for instance due to congenital cholesteatoma, conductive hearing loss ,Middle ear fluid, and ossicular discontinuity.[2] Hearing impairment in neonates was measured by OAE test. Otoacoustic emissions are the sounds generated by inner ear outer hair cells in reaction to auditory stimulation and are then recorded by a microphone fitted into the ear canal. OAE is only produced when the outer hair cells of the cochlea and middle ear system are operating normally, hence this test is often performed on newborns and young children. Key points: The significant finding of study is that 257 out of 2000 newborns had 'Refer' result on OAE. There was a male preponderance (1061 males and 939 females) with 7% males having 'Refer' results as compared to 5.85% of females. This study shows association between maternal, neonatal, and sociodemographic factors and hearing impairment in neonates. The further evaluation is required with help of BERA to confirm the final diagnosis of hearing loss.

Aim and objectives

Aim and objevtives were to study the incidence of impaired hearing among neonates using Otoacoustic emissions (OAE), to study the effect of maternal risk factors on neonatal hearing and to study the effects of demographic profile on neonatal hearing.

METHODS

To find out how common hearing loss is in infants and how high-risk variables affect a newborn's hearing, this prospective research was carried out in the ENT department, Government medical college, and Rajindra Hospital, Patiala from 2020 to 2022 (2 years).

Method of data collection

The newborns admitted in Government medical college and Rajindra Hospital, Patiala was selected for this study. Based on detailed maternal and birth history, thorough clinical examination, and audiological examination hearing impairment in newborns was assessed and recorded. The research will choose a minimum of 2000 cases that meet the following inclusion and exclusion criteria.

Inclusion and exclusion criteria

Inclusion criteria were; Neonates are delivered in the Rajindra Hospital and Government Medical College in Patiala, both normal and high-risk neonates and neonates of both sexes. Until they were stable, neonates with serious illnesses were not evaluated for hearing and neonates whose mothers will not give consent take part in the study were excluded.

Sample size

Sample size was calculated by using the formula:

$$n = (Z)2\ pq/(e)\ 2$$

Where n=Sample size; Z=1.96 for 95% CI; p=0.25; e=0.02 & q=1-p, Z^2=3.8416, e^2=0.0004, q=0.75, pq=0.1875. Thus sample size was calculated to be minimum (1800.75), thereby 1801 sample were selected for the study.s

Test procedure

Prior to the test, the moms received education on congenital hearing loss and the need of early diagnosis and care. The moms gave their written, informed consent. The pre-aural, pinna, and post-aural regions of the infants were examined as part of a standard ENT examination. A cotton-tipped swab was used to carefully remove any occluding wax or debris, and a Welch Allyn otoscope equipped with plastic speculums was used to perform the otoscopic examination of the tympanic membrane.

Testing environment

The infants were subsequently evaluated in an audiology department room that had been sound isolation. The infants were evaluated while supine, preferably on the parent's lap, and preferably while the baby was asleep. The sequence of the testing: Otoacoustic emissions were used in the initial test, which included distortion products. A common newborn ear tip kit was attached to the probe. The 3.5mm (yellow) and 4.0mm (pink) tips of the two sizes used for the newborn age group were chosen with the use of the ear tip selection guide. Soft rubber was used to make these probes. By gently pulling the pinna backward and downward, the ear tip was softly put into the right ear. The test was started after the probe tip was in place. A methodical, preloaded computerized procedure tested the probe fit and seal first, then any extrinsic noise levels. The tested frequencies were 2kHz, 3kHz, 4kHz, and 6kHz. The test stopped after the collection of data for these frequencies. Otoacoustic emission test was carried utilizes systems formed by Maico diagnostics Ero-scan Item no.

8106838. All data was compiled and analyzed statically. The outcome is reported as PASS when the infant exhibits responsiveness in 3 frequencies and refer when it exhibits response in only 2 frequencies. A detailed clinical history of each patient was taken and recorded in preformed proforma.

RESULTS

During the study time period, the total 2000 neonates of aged 0-4 day were screened out of 2000, 216 neonates had 'refer' result in one ear and 41 neonates in both ears. Most of the neonates (6.5%) tested on day 1 had 'refer' result on OAE, followed by 6.3% neonates on day 2. Among 2000 neonates 7% males and 5.85% females presented with hearing impairment.

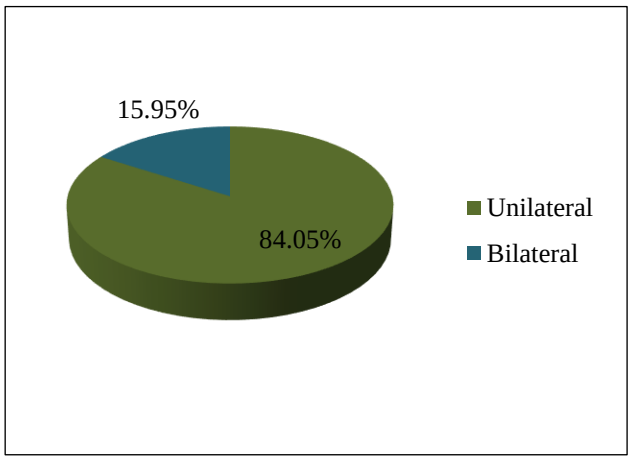

Figure 1: OAE results showing unilateral and bilateral hearing impairment.

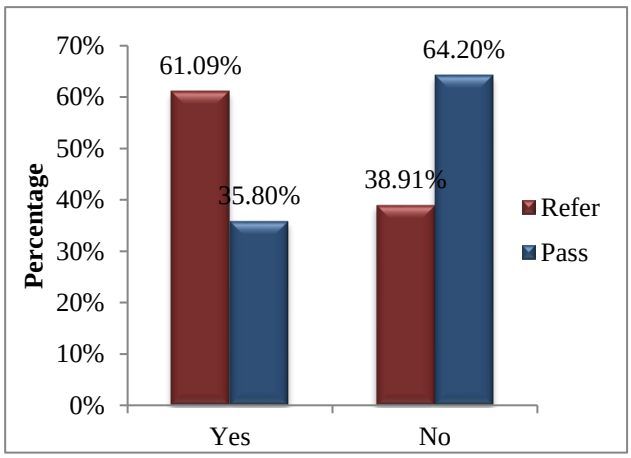

Figure 2: The association of prematurity with hearing loss.

In socioeconomic status 7.65% neonates were from lower class families and minimum 0.05% neonates from upper class family. In our study Mean age of mothers was 25.55±4.41 with age range 18-38 yrs. Maximum neonantes (5.75%) with hearing loss were born to mothers with age group 21-25 years. Neonates born to second gravid mothers were more prone to hearing impairment (4.85%) than first gravida mothers (4.7%). Out of 2000, 186 (9.3%) neonates born to mothers with gestational age between 28-37 weeks had hearing impairment.

Table 1: Correlation between neonatal characteristics and hearing loss.

Neonatal characteristics	P value	Significance
Age/day of testing	0.011	Significant
Gender of baby	0.449	Non-significant
Prematurity	0.001	Highly significant
Apgar score	0.001	Highly significant
Birth weight	0.001	Highly significant
NICU admission	0.001	Highly significant
Congenital abnormality	0.701	Non-significant

P value <0.05 is significant,p value <0.01 is highly significant

Table 2: Correlation between maternal characteristics and neonatal hearing impairment.

Maternal characteristics	P value	Significance
Maternal age	0.604	Non-significant
gravida	0.834	Non significant
Gestational age	0.001	Highly significant
Materanl illness	0.015	Significant
Maternal infection	0.369	Non-significant
Mode of delivery	0.054	Non-significant
Socioeconomic status	0.001	Highly significant
Residential characteristics	0.234	Non-significant

P value <0.05 is significant,p value <0.01 is highly significant

Maternal illnesses like severe anemia (0.15%), uteroplacental insufficiency (0.1%), and RH incompatibility (0.1%) had an impact on neonatal hearing impairment. In our study, 146/2000 newborns delivered with normal vaginal delivery, and 111/2000 newborns delivered with cesarean section had hearing impairment. In neonatal risk factors, 157/2000 (7.85%) premature newborns had hearing impairment, 8.55% of newborns with a low score of APGAR at birth, and 8.35% of newborns with low score of APGAR at 1 min had hearing impairment. Out of 2000 neonates, 175 neonates (8.75%) with low-birth-weight neonates had hearing impairment. Out of 2000 neonates, 74 admitted to NICU (3.7%) had hearing impairment. One neonate had congenital abnormality (cleft palate) but with normal ears had normal hearing.

DISCUSSION

Hearing loss is an important public health problem and newborn hearing screening is an important preventive measure. In most developed countries, neonatal hearing screening programs are present which screen all newborns within 1 month of birth.[3] In India, 1 to 6 out of every 1,000 neonates who are evaluated have hearing loss.[4-6] In India deafness is 1 out of 9 diseases included in Rashtriya Bal Suraksha Karyakram which mandates early screening and early intervention. In this study, we have evaluated 2000 neonates with age 0-4 day old by DPOAE. Refferal among neonates by DPOAE was 12.85%.

Effect sociodemographic risk factors on hearing

Ideal approach to screen neonatal hearing loss is before age of 1 month for complete diagnostic assessment by 3 months and to provide appropriate intervention by 6 months of age. Early identification and intervention during the critical period for the development of the central auditory system are our objectives. It has been reported that the age of neonates also affects OAE results so wait should be done as long as possible before discharge as it will provide time for EAC to clear debris naturally.[7] The present study consisted of 2000 patients between the ages 0 to 4 days. In our study, 6.5% (130/2000) neonates, 6.3% (126/2000), and 0.05% (1 /2000) neonates were diagnosed with hearing impairment on the 1st, 2nd, and 3rd day respectively. Thus, all the neonates in our study were screened within 96 hours of birth. With a p value of 0.011, it was determined that the relationship between newborn hearing loss and neonate age was statistically irrelevant. Gender is also a result of OAE's main factor, with females having normal OAE in comparison to males. The functional asymmetry of the male medial olivocochlear efferent system and prenatal masculinization processes may be to blame for this gender. [8]. In our study group babies had a slight male preponderance (939 females and 1061 males) with hearing impairment in males as 7% (140/2000) and in females at 5.85% (117/2000) with a p-value of 0.449, which is statistically non-significant. In our study incidence of referral rate of OAE was 7.65% (153 neonates) present in lower socioeconomic class, followed by upper lower socioeconomic class with an incidence of 4.65% (93 out of 2000 neonates) and least in upper socioeconomic class 0.05% (1 out of neonate) so there is a direct relationship of socio-economic status of family and hearing loss found in neonates (p=0.001), it may be due to the nutritional deprivations which occurs in the lower socioeconomic classes

Effect of maternal risk factors on hearing

For the purpose of analysis of mothers' age, it had been divided into age-wise categories (16-20 yr, 21-25 yr, 26-30 yr, 31-35 yr, >36 yr). In our study, maximum hearing impairment came in neonates having mothers within the age group 21-25 years with 5.75 % of newborns having hearing impairment followed by 26-30 years (4.05%) and lowest in age groups >36 years (0.2%). The relationship between congenital hearing loss and maternal age was found to be non-significant (p=0.604). Low gestational age at birth is an indicator of prematurity which one of main reason for hearing loss in neonatal hearing screening.[6] In our research mothers of neonates having hearing loss fall in preterm category with gestational age 28 weeks to 37 weeks (9.3%) and least in post-term category with gestational age more than 42 weeks (0%) with a p value 0.001 which is statistically highly significant. Neonates' hearing loss is mostly caused by postnatal infection/inflammation, such as sepsis.[9] In our study maximum hearing impairment was present in newborns born to mothers with severe anemia (1.17%) followed by hypertension (0.78%), RH incompatibility (0.78%), uteroplacental insufficiency (0.78%), gestational diabetes (0.39%), hypothyroidism (0.39%), placenta praevia (0.39%). These maternal illnesses seem to be significantly relevant (p=0.015). Maternal infections were seem to be statistically non-significant to neonatal hearing loss (p=0.369). In our research, hearing loss present in newborns delivered with caesarean section (111 neonates) was 5.55%, and with normal vaginal delivery was 7.3% (146 neonates). Therefore, we came to the conclusion that the delivery technique has little bearing on infant hearing impairment (p=0.054).

Effect of neonatal risk factors on hearing

The most common aetiology for congenital hearing loss is prematurity (born between 22 and 28 weeks of gestation), including other causes very low weight at the time of birth (680-1500g), asphyxia, hyperbilirubinemia, and hydrocephalus.[10] overall. In our study, 781 prematures out of 2000 neonates were screened and the incidence of hearing loss found to be 7.85% (157 out of 2000 had hearing loss) with p value=0.001 which is statistically significant. The APGAR scoring method is a descriptive evaluation of the clinical condition of the newborn after delivery. Its five assessment criteria comprise three signals (reflex irritability, muscle tone, and respiratory effort) that demonstrate the baby's developmental maturity and physiological health. Apgar score classification is 0-3 depressed severely, 4-6 depressed moderately, and 7-10 condition is excellent.[11] In our study, 171 newborns were having at birth Apgar score of less than 9 (leading to an incidence of loss of hearing in 8.55% risk is high for babies). The incidence of hearing loss at 1 minute is 8.35% (167 neonates) which subsequently decreases to 6.15% at 10 min (123 neonates). Our study confirms low apgar score is a highly significant risk factor to congenital hearing loss (p=0.001). Low birth weight is a major cause for hearing impairment in neonates as described in JCIH 2000 criteria. Low birth weight causes cause cochlear dysfunction in neonates.[12] In our study 8.75% (175) neonates having hearing loss were having a birth weight between 1.5-2.5 kg (birth weight is low) with a p value of 0.001 which is statistically highly significant. Neonates having very low birth and birth weight is extremely low could not be

evaluated in the study because either they were in very critical condition or they died before screening.

In accordance with JCIH 2000 standards, a disease or condition that necessitates hospitalization for 24 hours or longer to the NICU is deemed to be a risk factor for hearing loss. This is so that hearing loss is more likely to occur in the unwell newborns who are exposed to a variety of ototoxic medications or hypoxia. However, healthy neonates without postnatal illness or risk factors might nonetheless have hearing impairments, underlining the need for universal neonatal screening.[13] In our study, 80 neonates out of 2000 were having more than 24 hr admission in NICU of which 74 neonates were having hearing loss with an overall incidence of hearing loss of 3.7% with p value=0.001 which is statistically significant. There are various cranio facial abnormalities present in neonates like goldenhar, treacher-collins, and charge syndrome, pierre robin sequence stickler and velo cardio facial syndrome etc. which may cause congenital hearing loss in neonates. In our study one baby with cleft palate was screened by OAE and he passed the test.

Limitations

However, the limitations of our study was a smaller sample size and lack of serial follow-up of neonates who had refer status on OAE. More studies with large sample sizes and over large geographical area should be done and BERA should be done at 3 months of age for final confirmation of loss of hearing.

CONCLUSION

In our study demographic parameters like age distribution of neonates, socioeconomic status, maternal parameters like gestational age, maternal illness, and neonatal risk factors like prematurity, APGAR score, birth weight, and NICU admission, has a significant association in causing neonatal hearing impairment. Thus, the screening of neonates with Otoacoustic emissions is required for early detection of neonatal loss for hearing as OAE is an easy, reasonably priced and dependable procedure for infant testing on a wide scale. Hence, we conclude that neonates who fail OAE test should be segregated from those who pass the test so that their regular follow-up can be done by healthcare professionals for early detection and treatment of hearing-impaired neonates to reduce the burden of disability due to loss of hearing in society.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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