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Study of risk factors associated with increased hearing impairment in high-risk infants in a Tertiary Neonatal Care Unit, Detected by oto Acoustic Emission Hearing Test

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Abstract

Aims and objectives: early detection of hearing impairment and intervention will largely help in the speech and language development. This study was done to identify the high-risk neonates who require early evaluation so that early intervention can be done.

Study design: prospective study

Materials and methods: high risk neonates which had one or more risk factors like family history of permanent hearing loss, prenatal infections affecting fetus, birth weight < 1500gm, premature neonates < 32 weeks, neonatal jaundice requiring phototherapy or exchange transfusion, meningitis, HIE (hypoxic ischemic encephalopathy) of any degree, treatment with ototoxic drugs, any baby requiring intensive care or high dependency care were evaluated. They were subjected for OAE (otoacoustic emission) testing 1-2 days before discharge from NICU (neonatal intensive care units), babies which required referral were again screened 15-30 days after discharge. Babies which required referral after second screening were subjected to BERA (Brainstem Evoked Response audiometer) within three months of screening to confirm the hearing loss and early intervention was done.

Results: 164 neonates with any of the above risk factors admitted in NICU were included in the study and were subjected for screening with OAE at the time of discharge. Babies which required referral 33(20.2%)

were rescreened with OAE 15-30 days after the discharge. Among these babies 19(11.5%) required further referral. These babies were confirmed with hearing impairment by BERA 19(11.5%). The most common risk factor for hearing loss included meningitis 40%(2/5), prematurity < 32 weeks 16.2%(5/30), HIE of any degree 16.2%(6/37), birth weight<1500gm 12.5%(1/8), neonates receiving high dependency care 9.4%(5/53)jaundice requiring phototherapy/exchange transfusion 0 (0/25), intrauterine infection 0(0/3), neonates treated with ototoxic drugs 0(0/3), babies with >= 3 risk factors 20%(2/20) and babies with 2 risk factors 20.8%(11/53) had higher incidence of hearing impairment that with single risk factor 5.6%(6/101).

Conclusion: Hearing impairment is common in high risk NICU graduates. All high-risk newborns should get screened for hearing with OAE before discharge for early detection of hearing impairment and double screening with OAE is a good screening procedure which reduces the burden to submit all babies to BERA.

Keywords: NICU, OAE, HRR.

Introduction

Hearing impairment in infants should be identified as early as possible to enable interventions to take full advantage of the plasticity of developing sensory system. Hearing integrity in the first 3-4 years of life, the critical period, is essential for acquisition of speech and language. Unfortunately, by the time hearing loss in infancy and early childhood is suspected, audiologically evaluated and appropriately managed two or more of these critical years have elapsed and the child has lost an enormous developmental advantage. The onus lies on modern physicians to innovate culturally acceptable ways of implementing Infant Hearing Screening programs.

Otoacoustic Emissions (OAE) reflects the status of the cochlea (outerhair cells). A probe microphone similar to that used in acoustic immittance measures the inaudible sounds reflected by vibratory motion in cochlea. OAE 's is a byproduct of sensory outer haircell transduction and are reflected as echoes into the external auditory canal. OAE 's is preneural in origin and directly dependent on outer hair cell integrity.

Aims and objectives

In this study we wanted to screen high-risk infants for hearing impairment and study the risk factors (High-Risk Registry(HRR) of JCIH,2007)[1] associated with increased hearing impairment in high-risk infants.

Methods

This was a prospective observational study conducted among 164 high-risk infants admitted in our tertiary care NICU SSIMS&RC, Davangere. Ethical clearance was obtained from the institutional ethics committee.

Inclusion Criteria

Risk infants having one or more of the risk factors like family history of permanent hearing loss, in utero infections (toxoplasmosis, rubella, cytomegalovirus, herpes simplex virus infections and syphilis), birth weight less than 1500 grams, prematurity less than 32weeks jaundice requiring phototherapy and exchange transfusion, meningitis, hypoxic ischaemic encephalopathy of any degree, treatment with ototoxic drugs, blindness or any babies receiving intensive or high dependency care.

Methods of Data Collection

Proper history was taken. Clinical examination including anthropometry, general examination and otoscopy was done. OAE testing of infants was done at 24 to 48 hours prior to the time of discharge, for refer cases repeat OAE

testing was done at 15 to 30 days. The infants who failed the second OAE screen were referred to Otorhinolaryngologist and audiologist for further audiological evaluation by Brainstem Evoked Response audiometry (BERA) Testing within 3 months to confirm the hearing loss and early intervention. OAE testing was done using NEUROSOFT, NEUROAUDIOSCREEN (Model TC9442-057137218158-2010).

Newborn babies at risk admitted in SS Institute of medical sciences and research center (SSIMS&RC) were enrolled into the study with prior informed verbal consent obtained from the parents. The enrolled neonates were grouped into "at risk" group based on the presence of the risk factors included in the High-Risk Registry (HRR) of JCIH,2007.[1]"At risk" group included neonates who had distinct and significant associations with risk factors included in the HRR of JCIH 2007.[1] Study was conducted in a noiseless environment, on a sleeping neonate after ensuring no obstruction in external auditory canal. All subjects underwent the audiological tests as per the Screening-Rescreening Protocol.

Study Procedure

The following information's of the infants were noted: gestational age, sex, maternal history, prenatal and maternal risk factors, and birthweight, APGAR score at 5 and10 minutes and postnatal complications.

APGAR score was recorded using colour, heartrate, respiration, reflex response and motor response. After otoscopic examination of the ears, screening was done. With the infant lying comfortably on the bed or the mother 's lap, testing was carried out in a sound treated room.

Probe with soft flexible tip was gently inserted into the outer part of the ear canal to obtain adequate seal. Two insert ear speakers with a reasonable flat response property from 0.25 to 10 kHz together with a low noise sensitive microphone system are housed together in a probe which fits into the ear canal. The low amplitude DPOAE are amplified several times and fed, where serial averaging of the response is displayed.

Probes different from that used in adults were used, as the probes are calibrated differently because of the significant difference in ear canal volume. The smaller ear canal results in a higher effective sound pressure level (SPL), thus a different probe was used to correct for the difference.

Multiple responses were averaged. All TOAEs or DPOAEs were analyzed relative to the noise floor. For a quiet and cooperative infant, recording usually required less than a few minutes per ear. For an uncooperative or noisy infant, recordings took significantly longer or had to be postponed till infant slept.

It is screening device that can be used for newborn, children, and adults. The OAE detection scheme is based upon signal statistical analysis which guarantees high specificity and sensitivity, with minimal impact of background noise and recording conditions. It has a clinical sensitivity of more than 99%, without requiring decisions or equipment adjustment by the user. It has a TEOAE testing frequency range from 1.4 to 4kHz. Sound stimulus is by non-linear click sequence with stimulus level 45-60dBHL, self-calibration depending on ear canal volume and click rate is approximate 60Hz. Evaluation of results is by binomial statistics. The instrument does not permit beginning the OAE test until a proper seal of the probe is obtained. A single button pushes initiates OAE screening which last for approximately 3min (maximum time depends on environmental noise conditions).

The display shows statistical wave form, measurement progress, TEOAE detection level and noise level. The

results are given as PASS (PASS is determined by a statistical algorithm, based on binomial statistics) or REFER. PASS indicates that the patient has normal outer hair cell function at the time of testing. A REFER result suggest a possibility of a sensorineural hearing loss or indicates requirement of further diagnostic hearing evaluation. It also shows A '(artifact reject) and S (stimulus stability) values wherein, the A value greater than 20%, indicate a noisy test. The S value less than 80% indicates the ear probe mal position. When test result shows A value >20 % and S value < 80% a repeat test is advocated.

The OAE screening was conducted in a quiet environment with babies comfortably laying on a bed or on their mother lap ideally in sleeping state. Probe tip of sizes varying from 4mm to 12mm were used for different neonates to obtaining an adequate seal. A suitable probe tip was selected and coupled to the OAE probe. The same was inserted sufficiently deep into the ear canal to ensure a good seal in the ear canal. Proper hygiene was maintained by cleaning the probe and changing the ear tip after testing each neonate.

Statistical Analysis

The data was entered into Microsoft Excel and analyzed using S.P.S.S package version 12.0.

Results

A total of 164 neonates were included into the study during the study period, of which 33(20.2%) had REFER in first screening 19(11.5%) with hearing impairment in second screening. Risk factors for hearing impairment as per High-Risk Registry (HRR) of JCIH,2007.

Table1: Distribution of Neonates with Risk factors

Risk factor	No.	%
Receiving intensive or high dependency care	53	32.3
HIE of any degree	37	22.6
Prematurity less than 32 weeks	30	18.3
Jaundice requiring phototherapy	25	15.2
Birth weight less than 1500gms	8	4.9
Meningitis	5	3.0
Suspected intrauterine infections	3	1.8
Treatment with oto-toxic drugs	3	1.8
Total	164	100

The characteristic of the gender distribution out of 164 neonates 62.8% (103) male were male and 37.2%(61) were female. It was seen that of 164 neonates screened, 31 infants had birth weight of <1.5kg, 46 neonates between 1.5-2.0kg and 87 neonates >2.5kg. Out of 164 neonates, 36neonates were of gestation age between 26-32wks, 40 neonates between 33- 36 weeks, 88 neonates were between 37–41weeks of gestation, 98 (59.8%) neonates were born to primigravida mother and 66(40.2%) neonates were born to multigravida mothers.

OAE screen was conducted in 164 risk newborns. Out of 103 male, 14(13.6%) were with hearing impairment and out of 61 females 5(8.2%) were with hearing impairment with p value was 0.29 with no significance.

Out of 164 high-risk newborn screened it was found that, total of 31 were less than 1.5kg, among them 6(19.4%) of them with hearing impairment, 1.5-2Kg total of 46 there were 3(6.5%) were with hearing impairment and remaining 87 more than 2.5kg 10(11.5%) were affected with hearing impairment with p value of 0.22 with no significance.

Among 164 screened it was found that newborns with risk factors between gestational age of 26-32 weeks

were total of 36, 6(16.7%) were with hearing impairment, and 33-36 weeks gestational age total of40, 4(10%) were with hearing impairment, between 37-41weeks 88 were screened 9(10.2%) were with hearing impairment with p value of 0.56 with no significance.

Among 164 high-risks newborns screened the incidence of hearing impairment by oto-aucostic emission screening is 11.6% (19/164).

In the first screening out of 164 of high-risk screened, 33failed the initial OAE screening, accounting to a referral rate of 20.2% and pass rate of 79.9%. Of the 33 who failed, 27(16.5%) had bilateral refer 6(3.7%) had right side pass and left side refer 3.7% (Flow chart2).

In the 2nd screening out of 33 neonates failed the OAE for the1stscreening of which 27(16.5%) belonged to bilateral refer‖ and remaining 6(3.7%) belonged toright side pass and left side refer. Among them though whole group was subjected to OAE screening for 2ndtime 14(8.5%) got pass, 15(9.1%) came out as bilateral refer were found, among the infants who had already belonged to refer in the initial screening and 4 (2.4%) right side pass and left side refer. The referral rate in second screening was 11.5% in the total study cohort. The 19(11.5%) cases were further referred to confirm hearing deficit, using BERA and further evaluation by the audiologist.

Table2: Incidence of Hearing Impaired

Newborns Screened	Incidence in the cohort	Incidence expressed%
Total at risk Screened	19 /164	11.5

Incidence hearing impaired in the total study cohort – 19 newborns among the study cohort of 164 screened, had hearing screening found to be refer and were subjected for further audiological examination for hearing impairment by BERA. The overall incidence of hearing impairment is 11.5% (19/164) screened.

Incidence of hearing impairment in at risk newborns

Among164 infants with risk factors screened, around 19 had hearing impairment, showing an incidence of 11.5% in the risk newborns.

Discussion

Hearing loss affects every aspect of human life irrespective of age and socio-economic condition. The newborn screening programmes are designed for early detection of hearing impairment at birth, with the aim of early intervention and habilitation to improve the prognosis and provide a holistic development of every newborn. The purpose of this study was to determine the incidence of hearing defects in at risk newborns by using TEOAE/DPOAE.

This prospective study was conducted in 164 newborns who were screened with 2-staged TEOAE/DPOAE followed by referral to audiologist for BERA so as to diagnose the hearing impairment as early as 3 months of life. We found of the164 neonates 19 neonates had hearing impairment with an incidence of 11.5%. Incidence was being 11times more in at risk neonates. This high incidence of hearing impairment of 11.5 per 164 newborns careened, warrants an urgent implementation of neonatal hearing screening in India.

The most common risk factors for hearing loss includes meningitis 40.0% (2/5), prematurity less than 32 weeks 16.7% (5/30), HIE of any degree 16.2% (6/37), birth weight less than 1500grams 12.5% (1/8), neonates receiving high dependency care 9.4% (5/53), jaundice requiring phototherapy or exchange transfusion 0%(0/25), intra-uterine infection 0%(0/3), treatment with ototoxic drugs 0%(0/3). High-risk infants with ≥3 risk factors 20% (2/10) and 2 risk factors 20.8 (11/53) had higher incidence of hearing impairment than in infants with single risk factor 5.6% (6/101).

The study has shown that two–stage TEOAE/DPOAE hearing screening can be successfully implemented on a large scale in hospital or community setting. In order to ensure optimal outcome of the screening and intervention programs all stakeholders, including parents, physicians, audiologists, speech pathologists, deaf and hard of hearing individuals, educators, hospital and public healthcare representatives should participate in the development and implementation of national policy systems. Community awareness regarding screening of hearing should be increased. Firm and enthusiastic actions to integrate hearing screening at primary and district health systems, is likely to yield the most cost-effective solutions for prevention and control of the burden of deafness in India.

This study is one of the many steps towards evaluating the need and applicability of universal hearing screening in a developing country like India.

The incidence of hearing impairment in this cohort is 11.5%. There are few surveys showing incidence of hearing impairment in India. In one such study, by P. Naga Poornima et al in 2006, an incidence of hearing impairment of 5.6/1000 was demonstrated.[2] The incidence of hearing impairment in our study 11.5%(19/164) is much higher than the national average of 4/1000.[3] This may be because our hospital being a tertiary care centre has large number of high-risk deliveries leading to larger case load of at risk group. The incidence of hearing impaired 11.5% is very high in relation to other studies in risk infants for which early intervention can be taken,[4] advocating for an early implementation of hearing screening in our nation. In this study a high incidence of hearing impairment of 11.5% is seen in at risk group. This finding is in par with the literature reports of incidence in at risk infants being approximately 10 times greater than the incidence in normal population if one or more risk factors included in High-risk Registry (HRR) of Joint committee for infant hearing are present.[5]

Along with the well-known risk factors of HRR in the infants with hearing loss. But a strong association between these other risk factors and hearing impairment could not be established due to small sample size, warranting a detailed study of these other possible risk factor for congenital hearing impairment. The identification of local risk factors and addition of them into high-risk registry can improve the outcome and efficiency of target screening in resource poor nation like ours.

It is necessary and high time to implement and incorporate universal neonatal screening in our country to secure normal, social and holistic development of the child by detecting hearing loss at birth and providing remedial services at the earliest. National policies in these lines have to be made for neonatal hearing screening in all national health care facilities in India. Universal newborn hearing screening can yield high returns, and the 2-staged hearing screening programme is cost effective and feasible. A child who receives early interventions 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.

Conclusion

Hearing impairment is common in high-risk NICU graduates. All high-risk NICU graduates have some degree of hearing impairment if they had meningitis, prematurity less than 32weeks of gestation, HIE of any degree, weight less than 1500grams, neonates receiving highly intensive care, whereas jaundice requiring phototherapy or exchange transfusion, suspected intra-uterine infections and treatment with ototoxic medication

the hearing impairment was nil. Infants with multiple risk factors found to have more incidence than infants with single risk factors. In the given situation hearing loss should be identified early enough in order to treat and prevent sequelae of speech delay. So atleast all high-risk must be screened for hearing impairment prior to discharge from NICU and followed up during immunization and several times within first year if abnormal responses persist.

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