Screening for Hearing Impairment in High-Risk Neonates in a Tertiary Care Centre in Central Kerala

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ABSTRACT

BACKGROUND

Hearing loss is a chronic condition, and many cases can be detected in the neonatal period. Recognizing it early is of crucial importance as early auditory rehabilitation would help in child's comprehensive development. We wanted to assess the prevalence of hearing impairment among high risk newborns admitted to inborn unit of tertiary care centre in Central Kerala and screen for the associated risk factors in these newborns.

METHODS

Thousand consecutive inborn neonates from Neonatal ICU, Department of Paediatrics, tertiary care centre in Thrissur, Kerala, detected as high risk by Joint Committee on Infant Hearing (JCIH) criteria were enrolled for the study from December 2011 to November 2012 after the approval by Institute's Ethics Review Board. Risk factor assessment was done before enrolment. A qualified audiologist conducted the test on babies in soundproof chamber. DPOAEs (Distortion Product Otoacoustic Emissions) were used for initial testing after checking ears for debris. Those who failed in the first test were asked to come for a retest after 2 weeks. Those who failed in the retest were asked to report for Brainstem Evoked Response Audiometry (BERA). Those who were diagnosed as having hearing impairment were advised auditory rehabilitation as well as auditory verbal therapy.

RESULTS

Of the 1000 eligible neonates born in our hospital during the study period (December 2011 to November 2012) 69 were lost to follow up. Among the remaining 931 babies the frequency of hearing impairment was 0.8 %. Among the 931 neonates, 130 had absent response with the first OAE test contributing to 13.9 %. Twenty-one neonates had absent response to second OAE test out of 130 contributing to 16.1 %. The failure rate for second test is 2.2 % of the total population of 931 newborns. Eight of the 21 neonates who were subjected to BERA had severe hearing loss. The prevalence of hearing impairment was 8 per 1000.

CONCLUSIONS

The prevalence (percentage) of hearing impairment by two staged screening protocol is 0.8 %. Risk factors which were present in these babies were prematurity, low birth weight, low Apgar score, history of exanthematous fever in mother, neonatal jaundice, ototoxic medication history, craniofacial anomalies, and family history of deafness, meningitis and mechanical ventilation.

KEYWORDS

Otoacoustic Emissions, Brain Stem Evoked Response Audiometry, Risk Factors, Hearing Impairment, Neonates

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BACKGROUND

Hearing impairment can occur at any age, but the most severe type appears before or immediately after birth.[1,2,3] Hearing loss is one of the most common congenital disorders, with an estimated incidence of 1 – 3 / 1000 live births.[2-5] Most neonatal hearing loss is sensorineural and a known genetic cause is found in 50 % of children.[6] The Centres for Disease Control found an incidence of 1.09 / 1000 with permanent hearing loss based on data from 44 state screening programs.[7] The minimum levels of 40 dB HL and 35 dB HL were considered as permanent hearing loss under the program for screening new-borns in the UK and the US respectively.[8]

Oto-Acoustic Emissions (OAEs) are sounds which arise in the ear canal when (paradoxically) the tympanum receives vibrations transmitted backwards through the middle ear from the cochlea. OAE are sound measured in the external ear canal that reflects movement of the outer hair cells in the cochlea.

OAE recordings are made via an ear canal probe which is deeply inserted into the ear canal. Commonly used techniques, whose clinical reliability has been approved, are the evoked OAE, Transient Evoked OAE (TEOAE) and Distortion Product OAE – DPOAE. [9]

In time and detailed evaluation is needed for neonates infected with cytomegalovirus,[10-12] progressive neurological disorders, injury,[13-15] culture proven neonatal sepsis [16,17] and clinical syndromes associated with hearing loss; for infants who have received advanced life support viz., extracorporeal membrane oxygenation or chemotherapy;[18] and when concerns are expressed by caretaker or history of hearing loss in the family.

Several studies suggest that the infants performed better by significantly higher centile points up to 40 or so, on measures related to scholastic performance viz., cognition, social and behavioural scale if the hearing loss or impairment are picked up earlier than 6-months and intervened early.[19-22]

Therefore, the current study was done to assess the hearing impairment prevalence among high-risk new-borns admitted to inborn unit of a tertiary care centre in Thrissur, Kerala, using OAE. Follow up of neonates who failed OAE was done using Brainstem Auditory Evoked Responses (BERA).

METHODS

This cross-sectional study was conducted in our Neonatal Intensive Care Unit, under the Paediatric Department, a tertiary care centre in Thrissur, Kerala, between December 2011 to November 2012. Thousand consecutive inborn high-risk neonates, both term and preterm admitted in NICU (Neonatal Intensive Care Unit) who had below mentioned any risk factors as defined by the Joint Committee on Infant Hearing (JCIH) in the year 2007[23] were enrolled for the study. The sick babies requiring intensive management were included only after initial stabilization or just before discharge.

Other factors included in the study were:

1. The family history of hereditary childhood sensorineural hearing loss.
2. Intrauterine infections (TORCH).
3. Craniofacial anomalies.
4. Birth weight < 1500 g.
5. Hyperbilirubinemia at a serum level requiring exchange transfusion.
6. Ototoxic medications, including but not limited to the aminoglycosides.
7. Neonatal meningitis caused by bacteria.
8. Apgar scores of less than 4 and 6 at 1 and 5 minutes respectively.
9. New-borns requiring ventilator care for more than five days.
10. Clinical syndromes associated with hearing impairment.

Written informed consent were obtained from the mothers. The study was approved by Institute's Ethics Review Board. The risk factor assessment was done before enrolment. Neonates expired within four days before doing OAE test and babies born outside the study centre were excluded from the study. The patient details were entered in a pretested questionnaire. Then, a qualified audiologist conducted the test on babies in soundproof chamber. After checking ears for the debris, initial testing was done using DPOAEs. Screening protocols consisting two pass tests out of three were conducted on each ear. Neonates who satisfied this criterion in the first trial were considered to have passed the screening.

This study was a time bound study; those who failed in the first test were asked to come for a retest after 2 weeks. Those who failed in the retest were asked to report for BERA. Those who were diagnosed as having hearing impairment were advised auditory rehabilitation as well as auditory verbal therapy. During the study period the NICU protocol was to test only OAE in all the high-risk neonates. BERA was suggested only to those neonates who failed 2nd OAE test.

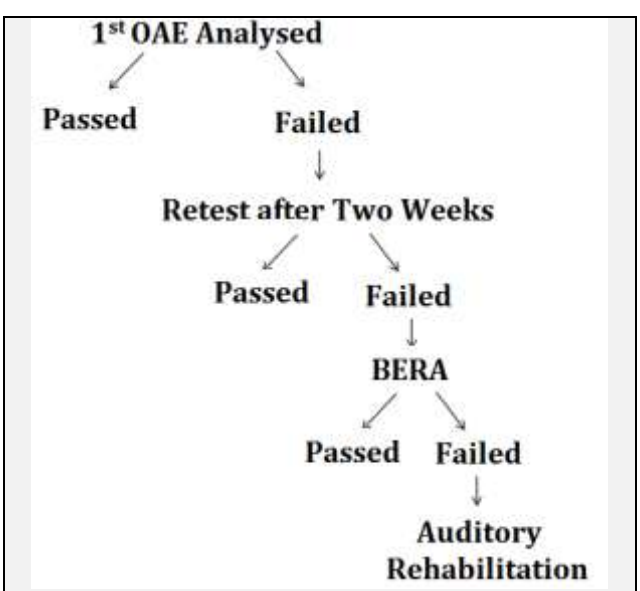

Figure 1. Protocol Followed - Inborn Newborns of NICU Satisfying the High-Risk Criteria.

Statistical Methods

Data was analysed by SPSS statistical package (version 11.5). The data obtained was analysed using appropriate statistical techniques, percentage analysis, Z test and chi square test. For all p values < 0.05, the test statistics is regarded as significant. Inborn new-borns of NICU satisfying the high-risk criteria. 1st OAE analysed.

RESULTS

This study was aimed at assessment of screening of hearing in new-borns based on a two-stage otoacoustic hearing screening protocol. Of the 1000 eligible babies during the study period, (December 2011 to November 2012) 69 were lost to follow up. The remaining 931 babies were included in the study. Of the 931 neonates 51.77 % were males and 48.22 % were female. These babies were tested in a soundproof chamber by a qualified audiologist. Initial testing was done using DPOAEs after checking ears for debris. The first OAE test showed that out of 931 babies 130 babies failed. Second OAE test results showed that out of the 130 babies tested, emissions were absent in both ears in 21 babies. Of these 21 babies, 8 had hearing loss confirmed by BERA. (Fig. 1)

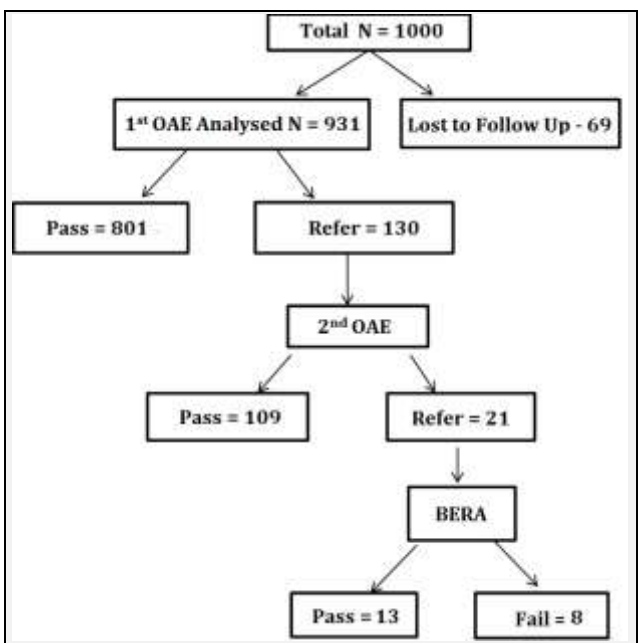

Figure 2. Distribution of Test Results

Of the 931 neonates 0.2 % had family history of deafness. Of this one baby showed absent response to BERA. Thirteen (1.4 %) mothers gave history of exanthematous fever during the present pregnancy and response to OAE was normal in this group. Thirty neonates (3.44 %) were treated with aminoglycosides. Four babies in this group showed absent response to both OAE and 1 baby showed absent response to BERA. Out of total neonates, 158 (16.9 %) neonates were preterm and 773 (85.03 %) were term. Absent response to both OAE was detected in 10 babies delivered preterm. Of this one baby showed absent response to BERA. Sixty-three of the neonates in the study had birth weight below 1.5 kg, in which seven babies showed absent response to both OAE. Out of the seven babies one baby showed absent response to BERA. Low Apgar score was detected in 22 of the neonates admitted in NICU. Two babies in this group had absent response to both OAE. Neonatal jaundice was detected in 22 (2.36 %) of the population. Of these four babies showed absent response to both OAE. Two were ABO incompatible and one was Rh incompatible. Of the 931 babies 19 (2.04 %) had craniofacial anomalies. Of the 931 neonates nine neonates had meningitis and OAE was normal in all these new-borns. Eight (0.86 %) of the neonates had undergone mechanical ventilation. Of this 1 baby showed absent response to both OAE. (Table 1)

Risk Factors	Total Neonates Enrolled (N = 931)	Neonates who Failed 1st OAE (N = 130)	Neonates who Failed 2nd OAE (N = 21)	Neonates who Failed BERA (N = 8)
Preterm	158	87	10	1
Low Birth Weight (< 1.5 kg)	63	43	7	1
Low Apgar score	22	13	2	0
H / O Exanthematous Fever	13	1	0	0
Neonatal Jaundice	22	11	4	2
Ototoxic Medications	30	18	4	1
Craniofacial Anomalies	19	10	3	3
Family H / O Deafness	2	1	1	1
Meningitis	9	4	0	0
Mechanical Ventilation	8	5	1	0

Table 1. Distribution of Risk Factors in Neonates Screened for Hearing Impairment

Variable	OAE Test Pass N (%)	OAE Test Fail N (%)	P Value
Family h / o Deafness	1 (0.12 %)	1 (0.77 %)	0.141
Exanthematous Fever			
No	797 (99.50 %)	129 (99.23 %)	
1st t.m	1 (.012 %)	0 (0 %)	0.753
3rd t.m	3 (0.38 %)	1 (0.77 %)	
Rh incompatibility	29 (3.72 %)	6 (4.72 %)	0.580
Use of Ototoxic medications	12 (1.5 %)	18 (13.85 %)	0.003
Gestation			
Term	730 (91.14 %)	43 (30.08 %)	0.001
Preterm	71 (8.86 %)	87 (69.92 %)	
Birth Weight			
> 1.5	781 (97.5 %)	87 (69.92 %)	0.001
< 1.5	20 (2.5 %)	43 (30.08 %)	
Apgar Score Low	9 (1.2 %)	13 (10.0 %)	0.001
Neonatal Jaundice	11 (1.37 %)	11 (9.47 %)	0.001
Meningitis	5 (1.37 %)	4 (0.62 %)	0.008
Mechanical Ventilation	3 (0.37 %)	5 (3.85 %)	0.001

Table 2. Correlation between Variables and First OAE Test

Of the 130 babies, there was a statistical relation between hearing loss and ototoxic medications, preterm babies, neonates with birth weight < 1.5 kg, babies with low Apgar score, neonatal jaundice, babies with craniofacial abnormalities, meningitis and babies with mechanical ventilation. Of the 130 babies, there was no statistical relation between hearing loss and family history of deafness, mothers who had exanthematous fever in the 1st trimester and Rh incompatibility.

DISCUSSION

Hearing loss is one of the most common abnormalities among high-risk neonates that can be picked up in early life. Timely identification and rehabilitation would help the child's comprehensive development. 1000 inborn neonates satisfying the inclusion criteria born in our hospital during the study period (December 2011 to November 2012) were included in the study. Of these 69 were lost to follow up. Among the 931 inborn neonates 130 had absent response with the first OAE test contributing to 13.9 %. Twenty-one neonates had absent response to second OAE test out of 130 contributing to 16.1 %. The failure rate for second test is 2.2 %.

Those neonates who had absent response to second OAE were subjected to BERA. The frequency of hearing impairment was 0.8 %. Out of the 21 neonates who were subjected to BERA, 8 had severe hearing loss. The risk factors which were present in these babies were preterm, low birth weight, neonatal jaundice, family history of deafness, ototoxic drugs and craniofacial anomalies. In our study use of ototoxic medications and hyperbilirubinemia were the major risk factors in study neonates, which is concordant with the study conducted by Maqbool et.al.[24]

In our study, low birth weight, craniofacial anomalies, preterm babies and mechanical ventilation were independent risk factors for hearing loss. Craniofacial anomalies were significant risk factor in a study conducted by Christine et al too.[25]

In a study by Pereira, Priscila and others, hearing loss had a higher occurrence in preterm infants which was comparable to ours. In their study, lower the gestational age (< 30 weeks) and a birth weight of < 1 kg, higher the chances of failing in the hearing screening test.[26] We found in our study that the prevalence of hearing loss by two staged screening protocol with Distortion Product OAE is 0.8 %. Study done in CMC Vellore found that the frequency of hearing impairment in neonates screening by OAE was 0.6 %, which was almost similar with our study. In a study conducted across eight hospitals in New York State using OAE & BERA, prevalence was found to be 2 in 1000 new-borns.

In a study by Kountakis et al., the associated risk factors were hyperbilirubinemia, Cranio-Facial Anomalies (CFA), length of stay in the intensive care unit, respiratory distress syndrome and retrolental fibroplasias.[27] Our study showed similar findings in risk factors for hyperbilirubinemia and craniofacial anomalies.

Thus, it can be concluded that OAE is a very useful cost-effective hearing screening by which hearing impairment can be detected, further evaluation and treatment can be made at the earliest. Along with providing the valuable information on the hearing loss, OAE tests are also fast, inexpensive and can be conducted easily. By this we can also limit the number of babies subjected to BERA which is a more expensive and cumbersome procedure.

Our method of screening is based on two-stage centralized new-born screening program that was initiated in Cochin in January 2003.[28] In that study all infants were screened with OAE. Infants, who failed OAE, were subjected to BERA. And all NICU babies were subjected to BERA, whereas, in present study only NICU babies who failed 2nd OAE were subjected to BERA.

Limitations

This study was done when OAE screening was just introduced in the study centre and BERA was not done routinely in all high-risk patients. OAE has its limitation especially in identifying and diagnosing infants with Auditory Neuropathy Dyssynchrony Disorders (ANDD). Because a typical child might show OAE pass but BERA will pick up the hearing loss.

CONCLUSIONS

OAE is a very useful cost-effective hearing screening by which hearing impairment can be detected, further evaluation and treatment can be done at the earliest. Along with providing valuable information on the hearing loss, OAE tests are also fast, inexpensive and can be done easily. By this we can also limit the number of babies subjected to BERA which is a more expensive and cumbersome procedure.

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