Pediatric Oncall Journal
https://doi.org/10.7199/ped.oncall.2023.22

PEDIATRIC ONCALL
CHILD HEALTH CARE

ORIGINAL ARTICLE

THE SENSITIVITY AND SPECIFICITY OF DPOAE (DISTORTION PRODUCT OTOACOUSTIC EMISSION) COMPARED WITH ABR (AUDITORY BRAIN STEM RESPONSE AUDIOMETRY) IN NEONATAL HEARING SCREENING

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ABSTRACT

Background: Both auditory brainstem response audiometry (ABR) and otoacoustic emission (OAE) are two widely used tests for a neonatal hearing screening. The OAE is easier to perform, faster, and cost-effective. However, ABR is precise with few false-positive results. We intended to know the sensitivity and specificity of OAE compared to ABR.

Methods: This cross-sectional study was conducted on 282 neonates in a neonatal intensive care unit (NICU) at Dhaka. All the neonates had one or more risk factors for hearing impairment (as defined by The Joint Committee of Infant Hearing). All the study subjects were screened by an expert team with a proper environment and machine (GSI AUDIOscreener, Denmark). Initial DPOAE was done within 30 days of age and then ABR, at three months. The results were expressed as "Pass" (probably no hearing impairment) or "Refer" (further evaluation is needed).

Results: Among the 282 neonates, 44(15.6%) neonates were referred at the initial screening. However, at ABR it was found that 27 (9.5%) had a hearing impairment. Among these 27, twenty-four were also referred at DPOAE (true positive). But 3 were not detected by DPOAE (false-negative). Other 20 neonates who were referred at DPOAE, were normal at ABR (false-positive). So it was estimated that the sensitivity of DPOAE for identifying hearing loss was 88.9% and the specificity was 92.2%.

Conclusion: The DPOAE is a good screening test for neonatal hearing screening with high sensitivity and specificity.

ARTICLE HISTORY

Received 17 August 2022

Accepted 23 September 2022

KEYWORDS

Neonatal hearing screening, DPOAE, ABR, Sensitivity, Specificity.

Introduction

It is observed that about 80% of hearing impairment in children is congenital or occurs during 1st year of life.[1] Early identification and proper intervention of hearing impairment result in significantly better language, speech development and so as in communication. So neonatal hearing screening is a must-do work.[2,3] Different behavioral and electrophysiological screening methods are used for this purpose. About all the behavioral methods are difficult to perform. Moreover, a high number of false-negative results are found in this procedure.[4,5] On the other hand electrophysiologic methods have a greater sensitivity and specificity to detect hearing impairment in this age group. The JCIH (Joint Committee of Infant Hearing) also recommended ABR (Auditory Brainstem Response audiometry) and the OAE (Otoacoustic Emission) for a neonatal hearing screening.[6] Both ABR and OAE record physiologic activities of the auditory system. They are non-invasive and require minimal patient cooperation. Although ABR can check the integrity of the entire auditory pathway, OAE only assesses the peripheral part.[6] But the OAE is easier to perform and faster. The average time required to perform ABR ranges from 8 to 15 min. On the other hand, OAE takes only about 2 to 13 min.[7,8] However, ABR is precise with few false-positive results.[7,9] But it is not so cost-effective. We intended to know the sensitivity and specificity of OAE by comparing the results of the DPOAE (Distortion Product Otoacoustic Emission) with ABR.

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Methods & Materials

This cross-sectional study was carried out in the Department of neonatology, BIRDEM General Hospital-2, Dhaka from January to December 2020. The institutional review board approved us to do the study. The neonates having one or more high-risk factors for hearing impairment (as defined by JCIH) were included in this study.6 The risk factors are mentioned below.

1. The family history of childhood hearing loss
2. Diagnosed TORCH infections
3. Any craniofacial anomalies
4. Baby with birth weight less than 1500 gm
5. Hyperbilirubinemia at such a level that requires exchange transfusion
6. Use of ototoxic medications for more than 5 days
7. Acute pyogenic (bacterial) meningitis
8. Neonates with an APGAR score less than 4 at 1 min and less than 6 at 5 min

9. Requiring mechanical ventilation for more than 5 days
10. The syndromic baby who may have a hearing impairment.

Normal healthy babies without any risk factors, age above 1 month, had an active ear infection or congenital anomalies that are incompatible with life, and parents who refused to screen were excluded from the study.

First of all, neonates with high-risk factors were separated with meticulous history, thorough examination, and close followed-up. The parents of those neonates were counseled and written informed consent was taken. A routine ENT and otoscopic (with Heine 3000 series Otoscope) examination of the auditory canal and the tympanic membrane was done. Anything in the canal (vernix or fluid) was removed.

All the babies were gone through a two-step of hearing screening. The first screening was done by DPOAE within 30 days of age and the second by ABR at the age of three months. Both the procedures were performed by a qualified audiologist along with a skilled neonatologist, and an audiology technician. The hearing screening was applied in a quiet room separated for this purpose and preferably when the baby was in natural sleep.

The machine used for the screening was a GSI AUDIOscreener, Part Number 2205-0100 Rev A, made in Denmark. The machine and all the probes are calibrated daily before initiating screening to ensure that the babies were screened appropriately with the functioning probe. The results were expressed as "Pass" or "Refer". Pass means probably no hearing impairment is present. Refer means further evaluation is needed.

Neonates who result "pass" in both the tests were declared as having no hearing impairment and no further evaluation is needed at this time. However, those results "refer" in ABR, in one or both ears, were referred to an ENT specialist for further evaluation and proper intervention.

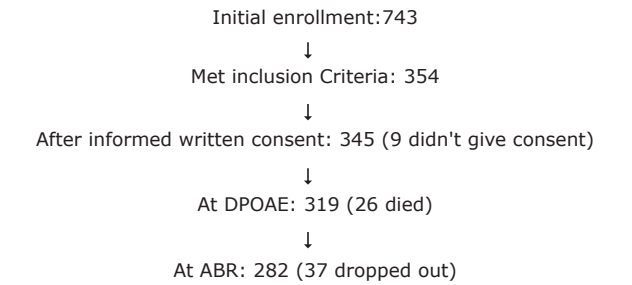
Statistical analysis

Statistical analyses were done with the help of SPSS version 23 for Windows. The results of both DPOAE and ABR were presented as numbers and percentages. Sensitivity, specificity, and other validity test was calculated for DPOAE and expressed as a percentage.

Results

Among 743 admitted neonates, 354 met inclusion criteria of which 282 neonates completed the DPOAE and ABR test (flow chart).

Flow chart 1. Distribution of population and selection of study subjects.



The median age of the neonates going through the initial screening was 13 days. Among the 282 neonates, 44(15.6%) neonates were referred at the initial screening and tested by DPOAE. But at ABR, which was done at 3 months of age, it was found that 27 (9.5%) had a hearing impairment. Among these 27, twenty-four were also referred at DPOAE (true positive). But 3 were not detected by DPOAE (false-negative). Other 20 neonates who were referred at DPOAE, were normal at ABR (false-positive). So, it is estimated that the false-positive rate of DPOAE was 7.1%. The summary of the DPOAE and ABR has been shown in Table 1. The sensitivity and specificity of DPOAE compared to ABR were calculated. The sensitivity was 88.9% and the specificity was 92.2% (Table 2).

Table 1. The summary of the DPOAE and ABR results (N=282)

Results of tests	n	%
Referred at DPOAE	44	15.6
Hearing impairment found at ABR	27	9.5
Impairment detected by both DPOAE and ABR (True positive detected by DPOAE)	24	8.5
False positive detected by DPOAE	20	7.1
False negative detected by DPOAE	3	1.1

Table 2. Validity of the DPOAE in comparison to ABR for prediction of hearing impairment.

Validity test	DATE
Sensitivity	88.9%
Specificity	92.2%
Accuracy	91.8%
Positive predictive value	54.5%
Negative predictive value	97.9%

Discussion

Any screening method is considered highly valid as well as sensitive if it can detect a high number of cases for which it was done. The method will be more specific if it can exclude most of the people who have not had the disorder. Hearing screening by Otoacoustic emission (OAE) and auditory brain stem response audiometry (ABR) has now been used in many centers worldwide.[10] American academy of family Physicians detected OAE as a sensitive and highly specific test (sensitivity 84%; specificity 90%).[11] However, in one other observation, it was shown low sensitivity but high specificity (66.7% and 98.8% consecutively).[9] In our current study, both the sensitivity (88.9%) and specificity (92.2%) were much higher than those of the studies.

In many studies, OAE was done twice; initially soon after birth and then 2-3 weeks later.[3,9,10,12] We have done it once within 30 days of age. In such a two-step OAE screening, the referral rate was observed at about 7.7%[4] which was almost half of our values (15.6%). Referral rate after two-stage screening by DPOAE was reduced to 1.2% in this study which is similar to one other study also (1.8%).[4,9] This was probably due to the sampling technique. Their studies included all the neonates whereas our study included only high-risk neonates who are more prone to be referred. The JCIH recommended hearing screening of all neonates with or

without risk factors for hearing impairment. It is also recommended to do a standard test at 3 months of age who failed the initial screening test.[6,8] But screening of all infants is not cost-effective due to false positivity and large population.[13] Furthermore due to a large population, the age of detection of hearing impairment is often exceeded by 2 years. Ultimately these groups of children will fall lacking their hearing peers to learn the language and verbal communication.[6] So it is more convenient to test only high-risk neonates for any hearing impairment.[14,15,16] On this basis, for developing countries and resource-poor nations, hearing screening of high-risk neonates instead of universal screening is recommended.[17]

The high sensitivity and specificity of DPOAE, as per our study findings, make it an effective hearing screening tool in the neonatal period. The hearing screening was performed with an audiologist, a skilled SCABU doctor, and a trained technician with a single measurement tool that could prevent measurement errors and observer biases. Both DPOAE and ABR tests were done to avoid false positivity. However, the study was conducted upon a small population of high-risk neonates in a very limited area (only one center) that did not represent the whole country.

Conclusion

The sensitivity of DPOAE was 88.9% and specificity was 92.2% for detecting hearing impairment in neonates. So DPOAE is a good screening test. However, its impaired results must be confirmed with ABR.

Compliance with Ethical Standards

Funding: None

Conflict of Interest: None

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