Original Article-

Study of Otoacoustic Emissions and Brainstem Evoked Response Audiometry in Infants

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Abstract

Aim and objective: To evaluate the usefulness of otoacoustic emissions and brainstem evoked response audiometry for assessment of hearing loss in newborn.

Materials and Method: Total of 370 healthy newborns were subjected to ENT examination, otoacoustic emissions (OAE) within 3 days to 30 days of birth. All newborn with normal hearing at OAE were not studied further, and for refer cases OAE testing was carried out again at 3rd month of age. The infants who failed the second OAE were subjected to brainstem evoked response audiometry (BERA). All newborn with abnormal BERA were subjected to repeat BERA at 6th month of age.

Results: All 370 healthy enrolled babies underwent OAE testing. Of which 200 (54.05%) passed the test and 170 (45.95 %) were referred. All 170 referred babies underwent repeat OAE at age of 3 months. Of which 50 passed the test and 120 were referred again. All these 120 referred cases were subjected to further testing using BERA between the ages 3-4 months. 2 were found to be having profound hearing loss during BERA testing at 3-4 months as well as at 6 months.

Conclusion: Profound hearing loss was found in 2 out of 370 enrolled normal newborn. This also means that if only 'at risk' babies were screened there is likely chance of missing impaired hearing in newborn without any risk factor. Hence, during hearing assessment it is mandatory to include all newborns irrespective of their status normal or 'at risk'.

Keywords: *Hearing loss, Hearing tests, Newborn*

Introduction

Hearing impairment is one of the most critical impairments with significant social and psychological consequences. Delay in detecting children with congenital or acquired hearing loss may result in lifelong deficits in speech and language acquisition, poor academic performance and personal-social and behavior problems [1,2]. Significant hearing loss is the most common disorder, occurring in 1 to 2 newborns per 1000 in the general population [3,4]. As compared to vocabulary of a 3-year-old child without any hearing impairment is 500-900 words. Similarly with hearing impairment if remediated at birth is 300-700 words; at 6 months is 150-300 words and at 2 years is 0-50 words. The hearing loss can be conductive or sensorineural and mixed. Sensorineural further can be either cochlear, retrocochlear or central. Many risk factors for congenital hearing loss are well known[5]. Critical period for identification and remediation of hearing loss is before

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the age of 6 months. It has been observed that practice of neonatal screening has dramatically lowered the age of diagnosis of deafness from 1½ - 3 years to less than 6 months of age. In view of the above, standard guidelines for early diagnosis of hearing loss are very much needed. We undertake this study about usefulness of otoacoustic emissions (OAE) and brainstem evoked response audiometry (BERA) as a part of two-stage screening protocol in early assessment of hearing in newborn. In this two tier screening program, the second tier BERA being relatively more expensive was used only for select a few, making the program more practical and viable. OAE are quicker methods unlike BERA for assessing hearing in newborns. OAE are sounds of cochlear origin recorded in the auditory meatus, produced by the action of healthy outer hair cells. In organ of Corti there are three rows of outer hair cells (OHCs) and one row of inner hair cells that sit on the basilar membrane and by the tectorial membrane on top. OAE test is performed by keeping a small probe in the child's external acoustic meatus, click sound is delivered and response is detected by the probe and its graphical output in the form of display as well as print is obtained. In BERA test the clicking sound is presented in each ear separately by the earphone placed in external auditory canal, resultant action potential generated by the cochlea in auditory nerve is picked up by the skin electrodes placed strategically. This is further processed to generate graphical output. OAE and BERA are useful tools in determining the type and the site of lesion causing hearing loss. The timely intervention by stimulation of hearing is most important part in management of hearing loss in newborn. This study was made to evaluate the usefulness of OAE and BERA for early diagnosis of impaired hearing in newborn with no risk factor.

Material and Method

The study was carried out at Otorhinolaryngology department, in tertiary care teaching hospital. Total of 370 healthy newborn referred from the department of Obstetrics without any risk factors during period between October 2017 and April 2019 were included in the study. All newborn requiring active life support therapy, newborn with acute illness, congenital anomalies of ear such as atresia or stenosis of

external auditory canal, any head and neck deformities and newborns whose parents did not consent for the procedure were excluded from the study. All enrolled cases were subjected to OAE using distortion product otoacoustic emission (DPOAE) screening after ENT examination. OAE testing was done as per referral at 3 days to 30 days of birth. All babies with normal hearing at OAE were eliminated from further study, and for refer cases OAE testing was repeated at 3-4 months of age. The infants who failed the OAE at 3-4 months of age were subjected to BERA for confirmation of hearing loss or without any deafness. All babies with abnormal BERA were considered as a probable candidate requiring stimulation of hearing either by way of hearing aid (HA) or cochlear implant (CI) after reconfirmation by BERA again at 6th month of age. All procedures performed on human participants were in agreement with ethical standards of the Institutional Ethics Committee.

Informed Consent: Informed consent was obtained from all the cases in the study.

Statistical Method

Using statistical analysis the frequency distribution of collected data was obtained with the help of IBM SPSS (Statistical Packaging for Social Sciences) IBM, INDIA, version 20.0 software.

Observation and Results

The present study was conducted on 370 newborn among whom 183 (49.5%) were males and 187 (50.5 %) were females. 247 were in age group of 1-10 days, out of which 183 were male and 84 female. 93 were in age group of 11-20 days, out of which 48 were male and 45 female. 30 were in age group of 21-30 days out of which 17 were male and 13 female. Out of 370 neonates screened initially, 200 (54.1%) did not require further assessment as they passed first OAE between 3 days to 30th day. Remaining 170 (45.9 %) were referred cases requiring further testing (Refer Table 1). Out of 170 cases, 50 (29.4%) cases passed the second OAE at 3-4 months and did not require further assessment (Refer Table 1). Remaining 120 (70.6%) referred cases were advised further testing by BERA (Refer Table 2). At 3-4 months of age out of remaining 120 cases BERA was normal in 118 (98.33%) requiring no further testing and in 2 (1.67%) it was profound hearing loss, which was reconfirmed at 6 months. (Refer Table 2)

Summary

All 370 healthy enrolled newborn underwent OAE testing. Of which 200 (54.05%) passed the test and 170 (45.95 %) were referred. All 170 referred underwent

repeat OAE at age of 3 months. Of which 50 passed the test and 120 were referred again. All these 120 referred cases were subjected to further testing using BERA between the ages 3-4 months. 2 out of these 120 were found to be having profound hearing loss during BERA testing at 3-4 months as well as at 6 months. (Refer Table 3)

Table 1: 1st OAE and 2nd OAE Screening.

	1st OAE Screening		2nd OAE Screening	
Result	**Frequency n=370**	**Percent**	**Frequency n=170**	**Percent**
B/L Pass	200	54.1	50	29.4
B/L Refer	140	37.8	115	67.6
Right pass, left refer (R-p, L-r)	17	4.6	4	2.4
left pass, right refer (L-p, R-r)	13	3.5	1	0.6
Total	370	100	170	100

Table 2: BERA at 3rd and 6th months.

	BERA at 3rd months		BERA at 6th months	
	Frequency n=120	**Percent**	**Frequency n=2**	**Percent**
Normal	118	98.33	--	--
Hearing Loss	2	1.67	2	100
Total	120	100	2	100

Table 3: Summary

Screening	**No. of Cases**	**%**
Total Number Screened	370	100
Pass in 1st OAE	200	44.05
Refer in 1st Screening	170	45.95
Pass in 2nd OAE	50	29.41
Refer in 2nd Screening	120	70.59
Hearing Impairment	2	0.54

Discussion

The hearing loss is often overlooked because of its silent nature preventing the detection through routine clinical evaluation. The definition of early identification and intervention has evolved over the years. Early identification is considered to be as early as 3 months for diagnosis and 6 months for intervention. There are few surveys about finding incidence of congenital hearing loss in India. In this study the incidence of impaired hearing was 5.4 per 1000. Whereas, P.Nagapoornima, et al in 2006 found it to be 5.6 per 1000 [6], and similarly Bhatt in 2015 found 5% in high risk newborns and 0.5% in normal newborns.[7] In this study there were 2 cases having impaired hearing amongst 370 newborn without any risk factor. Out of remaining 368 cases 200 were eliminated from the study as they passed OAE at first visit and 168 failed became normal during further study. Johnson et al reviewed the results of 1317 ears of patients who initially failed the OAE test and then passed the BERA test.8 Therefore even though OAE is useful initially for early screening about hearing loss, BERA is for diagnosis as well as confirmation as in this study. Hence universal screening remains the ideal strategy for diagnosis of hearing impaired in newborn. This study has shown that the strategy of two–stage OAE screening and subsequent confirmation by BERA helped in picking up 2 newborn from not 'at risk' group which otherwise would have gone unnoticed if only 'at risk' were screened. These 2 newborn having profound hearing loss would otherwise be refrained from the benefits of early stimulation of their hearing either by way of hearing aid (HA) or cochlear implant (CI) for speech rehabilitation. The incidence of hearing impairment and other findings of this study are in accordance with previous studies.[6,7,8]

Conclusion

Amongst 370 enrolled newborn 170 were referred in first OAE, 120 were referred in second OAE. Profound hearing loss was found in 2 by BERA during 3-4 months of age which further was confirmed by BERA again at 6 month. If only 'at risk' babies were screened initially there was likely chance of missing above 2 cases of profound hearing loss amongst 370 enrolled newborn without any risk factor. Hence, it becomes mandatory to include all newborns irrespective of their status normal or 'at risk' during hearing assessment for the benefits of early stimulation by way of hearing aid (HA) or cochlear implant (CI) and speech rehabilitation.

Ethical approval: All procedures performed on human participants were in agreement with ethical standards of the Institutional and/or National Ethics Committee.

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Conflict of Interest: None.

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