

IDENTIFICATION OF HEARING LOSS USING OTOACOUSTIC EMISSION (OAE) IN ASPHYXIATED NEWBORNS- A PROSPECTIVE STUDY

Sandeepjith P¹, V Srinivasa², A.R. Glannie³

¹Assistant Professor, Department of ENT, Azeezia Medical College Hospital, Kollam, Kerala, India

²Professor & Hod, Department of ENT, Vinayaka Missions Medical College, Karaikal, India

³Assistant Professor, Department of Community Medicine, SRM Medical College Hospital and Research Centre, Chengalpattu, Tamil Nadu, India

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Corresponding Author:

Dr. Glannie. A R,

Email: glannia@srmist.edu.in

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Abstract

Background: Otoacoustic emissions (OAE) test is generally appropriate for screening neonates' hearing. Babies, who are diagnosed and rehabilitated sooner, demonstrate better language and behavioural skills. Consequently, exorbitant costs of treatment would be prevented. The objective is to assess the utility of OAE as a screening tool for hearing loss in asphyxiated new borns and to evaluate the association of birth asphyxia and hearing in new borns. **Materials and Methods:** A prospective study among 50 asphyxiated newborns in Tamil Nadu, was conducted. Categorical variables were reported using percentages. The relationship between the dependent and independent variables was investigated using the Chi-square test with <0.01 P-value. **Result:** Among the participants 62% were female and 38% were male and majority were born by Caesarean Section (72%) and of normal weight (68%). Among the newborns that underwent OAE in 1st session, 28% and 30% had right and left ear abnormality respectively. In 2nd session among 11 study subjects who had undergone OAE, 66.6% and 72.7% had right and left ear abnormality respectively and 20% were screened to have hearing abnormality in 3rd session and referred to do confirmatory BERA test. A significant association was found between birth weight and OAE and also between APGAR and OAE. **Conclusion:** Screening for hearing impairment is essential in all high risk infants. In this study it shows that OAE is an excellent tool as an initial screening method for high risk new borns.

INTRODUCTION

Hearing loss is a highly prevalent congenital condition occurring in about 2 to 3 per 1000 live births.^[1,2] It is considered to be the most common birth defect, much more common than diseases like congenital hypothyroidism (30 per 100 000), phenylketonuria (10 per 100 000) and galactosemia (2 per 100 000 live births).^[3] WHO estimates that globally the number of children with hearing loss, defined, has more than doubled from 120 million in 1995 to at least 278 million in 2005, thus making this condition the most prevalent sensory deficit in the population. Permanent hearing loss can occur at any age but about 25% of the current burden is of childhood onset. Annually, up to 6 per 1000 live-born infants, or 7,98,000 babies worldwide, suffer permanent hearing loss at birth or within the neonatal period.^[4] Based on high incidence of hearing impairment, the joint committee in 2000 recommended performance of hearing screening test, especially for high-risk babies.^[5] Children with impaired hearing, present delays in language learning

and general development. This problem can only be prevented by early diagnosis and management. Some methods are available for screening of hearing: otoacoustic emission (OAE) and auditory brainstem response (ABR) are two methods of choice for detecting hearing impairment, because they are fast, non-invasive, sensitive, and easy to use at neonates, although ABR is more expensive.^[6] OAE test is generally appropriate for screening neonates' hearing. Babies, who are diagnosed and rehabilitated sooner, demonstrate better language and behavioural skills. Consequently, exorbitant costs of treatment would be prevented. There are contrasting views regarding relationship between hearing loss and high-risk babies such as asphyxiated newborns. Some are of the opinion that there are substantiating evidences for positive correlation. Nevertheless others hold the opposite viewpoint. Considering the "for" and "against" arguments in the literature review it has become inevitable to conclude at either of the above mentioned, owing to the clinical importance of both the conditions from a humanitarian perspective. Although both OAE and ABR are used for hearing

loss assessment, only OAE is used in this study pertaining to its easiness in using, less time-consuming nature and cost effectiveness. The purpose of this study is to assess the effectiveness of OAE as a rapid hearing screening test in asphyxiated neonates in order to detect hearing problems in children as early as possible which would help in early interventions.

Objective

- To assess the utility of OAE as a screening tool for hearing loss in asphyxiated new borns
- To evaluate the association of birth asphyxia using APGAR score with hearing loss in the study participants.

MATERIALS AND METHODS

Study setting and population

A prospective study among 50 asphyxiated newborns in Tamil Nadu, South India, between 2016 January to 2017 August was conducted following STROBE guidelines. Participants in the study comprised of asphyxiated newborns with 5th minute APGAR score <7. The information was gathered using the convenience sampling method. Parents of the participants were informed about all major components of the study and were given the option to refuse to participate or withdraw their consent at any time. The parents' understanding of the instructions and consent to participate in the study were validated. Newborns with congenital anomalies of external ear were excluded from the study. The Institutional Human Ethics Committee gave its approval to the project.

Procedure

A detailed history were taken from the parents and otological examination are done on all the 50 new borns. Patient's parents were counselled and informed about the importance of early detection of hearing problems.

Prerequisite required for conducting DPOAE screening include:

1. **Unobstructed outer ear canal-** The transmission of DPOAE's in the reverse direction of the primaries from the cochlea back to external canal depends upon the integrity of ossicles and tympanic membrane. Seal of the ear canal with the probe-proper probe fit is critical in the usage of OAE instruments, without which, background noise levels of 45dB SPL can prevent obtaining a response via OAE device.
2. **Optimal positioning of the probe-** Manipulation of the pinna can allow for the opening of collapsed ear canals found in newborns.
3. **Absence of middle ear pathology.**
4. **Functioning cochlear outer hair cells.**
5. **A quiescent patient:** Excessive movement or vocalization may preclude recording.
6. **Relatively quiet recording environment.**

7. **Screener training-** allowing for the proper handling of instrumentation as well as minimizing other problems.^[7]

Interpretation

Pass result- This means that the infants' outer hair cell functioning in each ear was normal at the time of testing.

Passed but at risk: Some infants pass the initial screen but were known to be at risk for developing a hearing impairment in childhood. These babies had screening at a later date.

Refer: Though a refer result was suggestive of outer hair cell dysfunction, other causes for refer result included debris in external ear, fluid in middle ear, noisy environment or if the infant is very restless. Such infants required reassessment and a retest with OAE. If retest also indicated refer, confirmation by Brain stem Evoked Response Auditory (BERA) was required.^[8]

According to Centres of Disease Control and prevention, screening of hearing loss of newborns is best done prior to being discharged from hospital after birth, no later than 1 month of age and if a newborn does not pass the hearing screening, then a comprehensive hearing test, no later than 3 months of age. Hence in the current study, Screening test was performed between the 3rd and 5th days of birth. Babies with a normal OAE were discharged, but in case with abnormal OAE (unilateral or bilateral), second OAE were performed after 2 weeks. If the baby had abnormal OAE on the second session, final OAE was performed in the 3rd month. Once a suspected impairment have been identified on screening by OAE, further testing was done to confirm the suspected diagnosis so early intervention can be carried out for speech and language development of children.

Statistical Analyses

The study parameters were entered using Microsoft Office Excel 2016. All statistical analyses were performed using the SPSS 18. Categorical variables were reported using percentages. The relationship between the dependent and independent variables was investigated using the Chi-square test with <0.01 P-value.

RESULTS

The study consisted of 50 participants among which 62%(31) were female babies and 38%(19) constituted of male babies. As per the mode of delivery, majority of the babies were born by Lower Segment Caesarean Section (LSCS) 72%(36) compared to Normal Vaginal Delivery (NVD). Most of the study participants were of normal weight 68%(34). The characteristics of the study participants by the above variables [Table 1].

In this study among 50 newborns that underwent the OAE in 1st session, 28% had right ear abnormality and 30% had left ear abnormality. In 2nd session among 11 study subjects who had undergone OAE,

66.6% had right ear abnormality and 72.7% had left ear abnormality. The same subjects were confirmed to be having hearing abnormality in 3rd OAE session and referred for BERA confirmation test, from 50 newborns tested with OAE 20%(10) were screened to have hearing abnormality from OAE results and referred to do confirmatory BERA test.

The ear abnormalities identified by all the sessions of OAE had statistically significant ($p < 0.05$)

associations with Apgar score (P value= 0.001 in Right 1st and left 1st, 2nd session, 0.002 in Right 2nd session, 0.048 in Right 3rd session, 0.007 in Left 3rd session) which shows newborns with birth asphyxia have more chance of developing hearing impairment than newborn without birth asphyxia. [Table 2]

A significant association was found between birth weight and OAE was noted as an additional outcome as shown in [Table 3].

Table 1: Distribution of specified characteristics among study participants (n=50)

Characteristics		Frequency (n)	Percentage (%)
Gender	Male	19	38
	Female	31	62
Mode of delivery	LSCS	36	72
	NVD	14	28
Birth weight	≤ 2	8	16%
	2.1 – 3	34	68%
	> 3	8	16%

Table 2: Association between birth asphyxia (APGAR score) and hearing (OAE) in the study participants.

APGAR	Left			χ^2 value	P-Value	Right			χ^2 value	P-Value
OAE 1 st session	P (%)	PF (%)	R (%)			P (%)	PF (%)	R (%)		
≤ 4	0 (0)	6 (12)	3 (6)	29.927	0.001*	0 (0)	6 (12)	3 (6)	28.818	0.001*
4 – 6	33 (66)	6 (12)	0 (0)			34 (68)	4 (8)	1 (2)		
> 6	2 (4)	0 (0)	0 (0)			2 (4)	0 (0)	0 (0)		
TOTAL	35 (70)	12 (24)	3 (6)			36 (72)	10 (20)	4 (8)		
OAE 2nd SESSION										
≤ 4	2 (4)	2 (4)	3 (6)	24.657	0.001*	3 (6)	2 (4)	2 (4)	20.896	0.002
4 – 6	1 (2)	3 (6)	0 (0)			1 (2)	2 (4)	1 (2)		
> 6	0 (0)	0 (0)	0 (0)			0 (0)	0 (0)	0 (2)		
TOTAL	3 (6)	5 (10)	3 (6)			4 (8)	4 (8)	3 (6)		
OAE 3rd SESSION										
≤ 4	0 (0)	2 (4)	3 (6)	17.613	0.001*	1 (2)	3 (6)	1 (2)	12.713	0.048
4 – 6	1 (2)	3 (6)	0 (0)			1 (2)	1 (2)	2 (4)		
> 6	0 (0)	0 (0)	0 (0)			0 (0)	0 (0)	0 (0)		
Total	1 (2)	5 (10)	3 (6)			2 (4)	4 (8)	3 (6)		

OAE- Oto Acoustic Emission; *Significant

Table 3: Association between birth weight and hearing loss (OAE) in the study participants.

Birth weight (kg)	LEFT				RIGHT					
	OAE (R)1 st SESSION			χ^2 value	P-Value	OAE (R)2 nd SESSION			χ^2 value	P-Value
P (%)	PF (%)	R (%)	P (%)			PF (%)	R (%)			
≤ 2	0(0)	7(14)	1 (2)	24.687	0.001*	0 (0)	5 (10)	3 (6)	26.869	0.001*
2.1 – 3	27(54)	5(10)	2 (4)			28(56)	5 (10)	1 (2)		
> 3	8(16)	0(0)	0(0)			8 (16)	0 (0)	0 (0)		
Total	35(70)	12(24)	6 (12)			36 (72)	10 (20)	4 (8)		
OAE (R) 2nd SESSION										
≤ 2	1 (2)	4 (8)	2 (4)	27.515	0.001*	2 (4)	3 (6)	2 (4)	25.328	0.001*
2.1 – 3	2 (4)	1 (2)	1 (2)			2 (4)	1 (2)	1 (2)		
> 3	0 (0)	0 (0)	0 (0)			0 (0)	0 (0)	0 (0)		
TOTAL	3 (6)	5 (10)	3 (6)			4 (8)	4 (8)	3 (6)		
OAE (R) 3rd SESSION										
≤ 2	0 (0)	4 (8)	2 (4)	25.423	0.001*	1 (2)	3 (6)	2 (4)	21.949	0.001*
2.1 – 3	1 (2)	1 (2)	1 (2)			1 (2)	1 (2)	1 (2)		
> 3	0 (0)	0 (0)	0 (0)			0 (0)	0 (0)	0 (0)		
Total	1 (2)	5 (10)	3 (6)			2 (4)	4 (8)	3 (6)		

OAE- Oto Acoustic Emission; *Significant

DISCUSSION

In a study done by Elaheh Amini et al,^[9] in 2014, among the 149 asphyxiated neonates, 3(2%) had abnormal OAEs. No statistical correlation was found between the 5th minute apgar score and abnormal OAE (P value = 0.391). However, a significant

relationship between the mean birth weight and abnormal OAE (P value = 0.0406) was found similar to the current study. In a study by Zia Ul Haq Gouri et al,^[10] in 2015, 22 neonates showed abnormal OAE examination among 415 babies. Out of these 22 neonates, hearing loss was confirmed in 18 (82 %) subjects by ABR. Apgar score less than five at 5 min

showed statistically significant association with hearing loss.^[11]

Study conducted by Mishra et al,^[12] in which 43% of newborns with birth asphyxia were found to have Hearing impairment. In the study they included newborns with moderate to severe birth asphyxia and in the study conducted by Sayed et al,^[13] included only severely asphyxiated newborns with an incidence of Hearing impairment of 100%. So it can be said that the more severe the hypoxic insult the more is Hearing impairment.

In the study done by Thomson et al,^[14] of 39 (1.2%) babies of apgar ≤ 5 were found to cause failure of hearing screening. In the study by Gisel et al,^[15] following observations were made: family history of congenital hearing loss (OR = 5.192; p = 0.016), craniofacial deformity (OR = 5.530; p < 0.001), genetic syndromes associated with hearing loss (OR = 4.212; p < 0.001), weight below 1,000 g (OR = 3.230; p < 0.001), asphyxia (OR = 3.532; p < 0.001), hyperbilirubinemia (OR = 4.099; p = 0.002) and use of mechanical ventilation (OR = 1.826; p < 0.031) were the indicators that best characterized the group at risk for hearing impairment. D.Suchitra et al,^[16] found that severe birth asphyxia is significantly associated with hearing loss, however moderate birth asphyxia did not show any correlation with hearing loss. Further, any degree of asphyxia is not an independent risk factor for permanent hearing loss. Guo and Yao et al,^[17] conducted OAE and ABR screening tests on 132 infants. The results showed that percentage of infants passing OAE was 88.3% and 92 % passed ABR. The sensitivity and specificity of OAE in comparison to ABR were 90.5% and 95% respectively. The mean test time was 3 min for OAE and 30 min for ABR. They concluded that OAE is a highly sensitive, reliable and convenient method for infant screening. Kennedy et al,^[18] suggest that the OAE test is non-invasive, less expensive, quicker and simpler to perform than the ABR test. Bilateral failure rates (and upper 95% confidence limits) with a stimulus 35-36 db above normal hearing threshold level) were 3.0% with automated OAE, 3.2% with ABR and 2.7% with automated ABR. Hence automated OAE was the most sensitive for subsequently confirming hearing impairment. Heinemann & Bohnert,^[19] have published a paper quoting the comparative studies and cost analysis with different instruments in screening for hearing impairment in children. They have suggested that a cost effective way for hearing analysis is to do oto acoustic emission testing universally for all children and then in those who fail the test, Auditory Brain Stem evoked response audiometry can be done. Sun JH et al,^[20] from Shanghai medical university have published a report stating that critically ill neonates with some specific high-risk factors had a significantly high incidence of hearing impairment and therefore early hearing screening is necessary for neonates who are discharged from neonatal intensive care unit.

CONCLUSION

Late identification of hearing loss presents a significant public health concern. However, without screening, children with hearing loss are usually not identified until 2 years of age, which results in significant delays in voice communication, language communication, social, cognitive, and emotional development. In contrast, early recognition, and intervention prior to 6months of historic period has a significant positive impact on development. In this study it shows that Birth Asphyxia can cause hearing impairment in infants. Screening for hearing impairment is essential in all high risk infants. In this study it shows the importance of developing a hearing screen with OAE that when repeated appropriately and when required combined with BERA for cases that fail serves as effective screening test. Programs should guarantee close cooperation between maternity units and audiological centers in order to decrease time between exams, eliminate unnecessary tests, and assure proper interventions.

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