

Original Article

ROLE OF OTOACOUSTIC EMISSIONS (OAES) IN SCREENING OF HEARING IMPAIRMENT IN NEONATES & INFANTS

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Abstract

Background: Hearing plays the most important role in communication process. If a child with hearing impairment is not diagnosed and treated at an early stage, this can have a negative impact on a child's personal, social development which can influence the educational and professional opportunities throughout life. For these reasons, even from old times it was searched for an exact method for determining hearing function immediately after birth. **Objective:** the objective of this study is to identify the role that otoacoustic emissions in the screening of hearing impairment at early in infancy. **Methods:** An observational study conducted at the audiology department of Children Hospital, Lahore from 1 November 2015 to 30 January 2016. By using convenient sampling technique, Fifty (n=50) patients of both gender between age neonates to 3 months, who had suspicion of hearing impairment revealed by the international standard of high risk register protocol were included in the study. They were further clinically examined by ear nose and throat physician, audiological examined by audiologist and later on confirmed by comprehensive history, otoscopic examination, and tympanometry and otoacoustic emissions. **Results:** There were 60% (30/50) females and 40% (20/50) males in the study sample. A total of 82% (n=41) were identified to be referred for detailed hearing assessment. It was observed in the study that perinatal risk factors history was more prevalent (30%) in causing hearing impairment in infants. **Conclusion:** A significant percentage of neonates and infants who were born with risk factors either in the prenatal or perinatal period and those who have positive family history of hearing impairment and thus have suspicion of hearing loss were successfully screened via otoacoustic emissions and referred for further comprehensive audiological assessment.

Keywords: hearing impairment, Infant, Neonatal Hearing screening, otoacoustic emission.

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Introduction

Hearing impairment is the global problem so its identification is very necessary for the elimination of burden on the society caused by it.⁽¹⁾ Screening is done in infants for the purpose of eliminating hearing impairment. Hearing impairment can occur at any age, but the most severe one appears before or immediately after birth. Thus, newborn hearing screening has become the expected standard of care internationally. Screening should be done in infants in their early childhood so that all the risk factors affecting hearing can be eliminated in child's early age.⁽²⁾

The Universal Newborn Hearing Screening Program aims to identify newborns with hearing loss early so they can get the help they need as soon as possible to help their language, learning and social development. Since hearing impairment is not just a personal problem for the children but it is for the families as well as of the whole society, nowadays centralized programs for screening of hearing impairment immediately after birth are conducted in order to detect and successfully treat impairment before the clinical symptoms appearance.⁽³⁾

OAE or otoacoustic emission testing is the recording of sounds that the ear produces itself in response to low intensity sound. They appear to be generated in the cochlear outer hair cells. There are 2 types of otoacoustic emissions in clinical use: Transient

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evoked otoacoustic emissions (TEOAEs) - Sounds emitted in response to an acoustic stimulus of very short duration; usually clicks but can be tone-bursts. Distortion product otoacoustic emissions (DPOAEs) - Sounds emitted in response to 2 simultaneous tones of different frequencies.⁽⁴⁾

OAE's is quick and most reliable test for hearing screening in infants and neonates. Standard and clinical recording techniques for universal screening should be less time consuming, requires a little level of audiological skill, simple, quick, and non-invasive so the initial screen recommended by the National Institute for Health (NIH) was the recording of OAEs.⁽⁵⁾

One to two newborns in every 1,000 births have hearing impairment, while in the group with risk factors i.e. low birth weight, late cry and ototoxicity which effect the overall physiological process of hearing mechanism this number is higher and increase to four. Reliability of otoacoustic emissions (OAEs) is estimated from 80% to 98%. Evoked OAE, transient evoked OAE (TEOAE) and distortion product OAE (DPOAE) are commonly used techniques.⁽⁶⁾

OAEs examine the frequency 1000 to 8000 Hz. If the cochlea is normal, OAEs will be recorded. However, in case of cochlear damage partial or complete, cochlea respectively generates either less response or does not generate any response at all.⁷ For testing, a soft probe is used, containing the microphone and micro speaker, which are placed in external auditory meatus. Automatic algorithms for response detection are implemented in the apparatus.⁸ This study signify the importance of OAE's in hearing screening of infants and neonates which can further be referred for detailed audiological evaluation. This will aid the audiologists, pediatricians, health care professionals and health policy maker personals to establish a standard criterion by OAE screener in Pakistan for hearing screening of neonates.

Methods

It was an observational study conducted at the Audiology department of Children Hospital, Lahore. Study was conducted for a period of three months from 1st November 2015 to 30th January 2016. By using non-probability convenient sampling technique, Fifty (n=50) patients of both gender between age, neonates to 3 months who had suspicion of hearing impairment revealed by either one or more than one risk factor as indicated by international standard of high risk register protocol were included in the study. They were further clinically and audiotically examined, comprehensive history proforma filled, otoscopic examination done and later on confirmed by tympanometry and otoacoustic emissions. Comprehensive infant evaluation Performa was filled, Otoscopy, Tympanometry and otoacoustic emission tests were done in audiological room to screen them for pass and refer criteria of hearing status of study participants. Infants having syndrome and multiple disabilities infants were excluded. After taking consent, history and explaining study purpose, audiological tests were performed. Audiological tests measured the status of middle ear and screened the infant population for hearing impairment set by pass/refer criterion as given in following. Handheld OAE Customizable Screener was used to collect the data and pass/refer criterion was established as (Pass=SNR of 5dB at three of four frequencies, Refer= SNR of >20dB at two of four

frequencies). The tested Frequencies included 2000Hz, 3000Hz, 4000Hz and 5000 Hz. Intensity (Sensation Levels called P1, P2 or L1, L2) of Frequencies were 65dB SPL and 55dB SPL and Averaging Time was 2 seconds. All the demographic data and test results noted on the predesigned proforma and statistical analysis of data was performed using SPSS-version 22. Results were stratified for confounding variables like age, gender, status of OAEs according to pass and refer criterion etc.

Results

A total of 50 patients were included in the study. There were 40% (20/50) males and 60% (30/50) females in the study sample. Figure 1 shows that in OAEs testing total of 6 % male and 12% female infants passed the test while 34 % male & 48 % female were referred for further evaluation for hearing impairment. As far as the age of the children at the time of screening was concerned it was observed in the study that the 3(30.0%) neonates, 3(14.0%) 1-month age, 2(16.7%) 2 months age and 1(14.3%) 3 months age infants passed the OAE's screening and did not need further hearing evaluation while 7(70.0%) neonates, 18(85.7%) 1 month, 10(83.3%) 2 months and 6(85.7%) 3months age referred the test indicating the need for detailed audiological evaluation. A total of 82% (n=41) infants were identified to be referred for detailed hearing impairment assessment and 18% (n=9) infants passed the screening (Figure 2). Table 1 indicates the risk factors which attribute to the OAE's results, prenatal factors including ototoxic drugs intake (16.0%) and viral infection history in babies' mothers during pregnancy (12%) were the prevalent one factors for referring the babies on OAE's testing and need for further evaluation for confirmation of hearing loss while perinatal(birth) factors were more prevalent for referring the infants for significant hearing loss such as late cry (30.0%), pre-term (22%) and less birth weight (18%).

All the demographic details, frequency of age and gender of infant population and percentage of significantly passed and referred infants for screening of hearing impairment among this population is presented in table and bar charts.

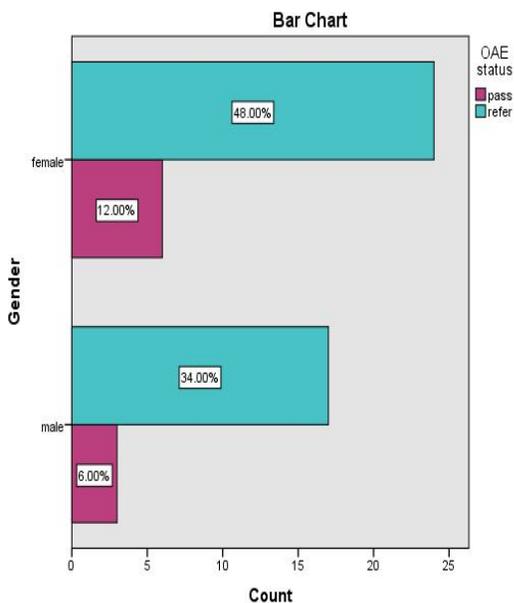


Figure 1: Gender & OAE status

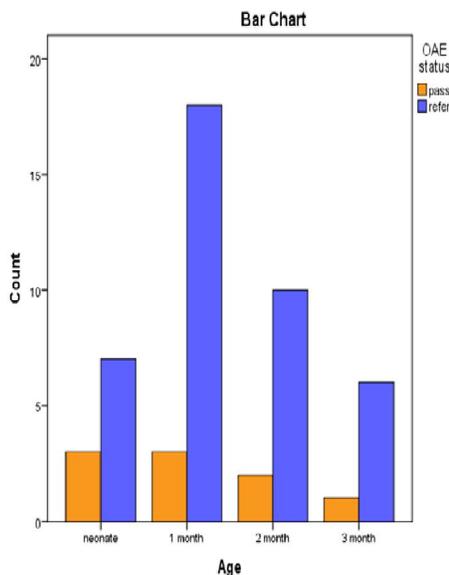


Figure 2: Age & OAE Status

Table 1. NHS screening results in relation to the risk factor indicators data analyzed

Risk factors		OAE status			
		Passed		Referred	
		Frequency	%	Frequency	Percentage
Prenatal History	Miscarriage	1	2.0%	1	2.0%
	Ototoxic	0	0.0%	8	16.0%
	X ray Exposure	1	2.0%	5	10.0%
	Viral infection	0	0.0%	6	12.0%
	Trauma	0	0.0%	1	2.0%
	No history	7	14.0%	20	40.0%
	Total	9	18.0%	41	82.0%
Perinatal (birth) History	Pre-term	1	2.0%	11	22.0%
	Meningitis	2	4.0%	1	2.0%
	Birth injury	1	2.0%	2	4.0%
	Late Cry	0	0.0%	15	30.0%
	Low Weight (<2.5kg)	0	0.0%	9	18.0%
	Jaundice	1	2.0%	2	4.0%
	Low Apgar Score (<3)	1	2.0%	1	2.0%
	No history	3	6.0%	0	0.0%
Total	9	18.0%	41	82.0%	
Family History	Present	4	8.0%	16	32.0%
	Absent	5	10.0%	25	50.0%
	Total	9	18.0%	41	82.0%
Previous ENT Disease History	Present	3	6.0%	13	26.0%
	Absent	6	12.0%	28	56.0%
	Total	9	18.0%	41	82.0%

Discussion

Otoacoustic emission detected is hand-held tool that provides objective test of hearing. Otoacoustic emission (OAE) has many characteristics which makes it suitable for its use as an objective neonatal auditory screener. The most important is its quick application with which it can be performed. This feature alone opens up the possibility of much more general neonatal screening programs. This study will review the important role of OAE in screening applications and discuss the future role of OAE testing in finding hearing impairment. Test failure rate will inevitably far exceed the real incidence of hearing impairment.⁽⁹⁾

A Distortion Product Otoacoustic Emissions (DPOAEs) and Transient Evoked Otoacoustic Emissions (TEOAEs) audiogram can be obtained in a couple of minutes. DPOAE thresholds derived from DPOAE audiograms are closely related to behavior audiometric thresholds and can be used for determining characteristic quantities of the cochlear-impaired ear. DPOAE audiograms provide a tool for a fast and automated frequency-specific and quantitative evaluation of a mild or moderate hearing loss.⁽¹⁰⁾

There is a growing data indicating that evoked OAEs can be used accurately and efficiently to screen for identification of hearing impairment. In our study 82% infants with positive prenatal, perinatal, family history of hearing loss and previous ear nose and throat history were successfully screened and referred by otoacoustic emission testing. The goal of screening is to identify those infants at risk for peripheral hearing loss.⁽¹¹⁾

Several studies have found that in the absence of external and middle ear pathology OAE are robust and broad-band in normally hearing infants and children. In quiet/sleeping neonate OAE screening of both ears can be completed in about 10 minutes or approximately half the time required for ABR screening. OAEs appear to be robust over a broad frequency range in normally hearing infants. When properly implemented, it appears that both TEOAEs and DPOAEs can be accurate and efficient noninvasive hearing screening tools.⁽¹²⁾

The use of this test for hearing screening in newborns was effective, confirming reports from previous Studies and because of relative ease of recording it

should be a method of choice in newborn hearing screening protocols. OAEs reflect outer hair cell integrity and cochlear function. It provides detailed diagnostic information in cases of suspected hearing loss. As in our study 70% newborns were referred for hearing loss. When used appropriately in the audiology clinic, they are an effective diagnostic tool and can detect hearing loss with accuracy.⁽¹³⁾

In the past decade, solid guidelines have been established to select the most effective recording parameters, thereby optimizing the OAE's diagnostic potential. Distortion product otoacoustic emissions which is the important type of OAE's provide the objective measure regarding the hearing information of different frequencies spectrum in the cochlea.⁽¹⁴⁾

OAEs can be detected in persons with normal inner ear function. They originate from the cochlea and are interpreted as an energy leakage of cochlear processes, perhaps resulting from active outer hair cell movements. OAEs travel from the cochlea through the middle ear to the external auditory canal where they can be detected using sensitive miniature microphones.⁽¹⁵⁾ In the neonatal period, registration of OAEs can be accomplished during natural sleep.⁽¹⁶⁾

OAEs are constant over long periods of time and they are reduced or absent due to various adverse influences in the inner ear i.e. developmental abnormalities.¹⁷ When used by an experienced examiner who is aware of the possibilities as well as of the limitations of this method, registration of OAEs is a promising new tool which complements our current-arsenal to diagnose hearing disorders in children.⁽¹⁸⁾

The widespread implementation and interest in neonatal hearing screening stems from recent research showing that identification of hearing loss prior to 6 months of age provides a child an excellent chance to acquire normal language.⁽¹⁹⁾

Conclusion

A significant percentage of infants with suspicion of hearing loss and who were born with risk factors for hearing loss and who had a strong family history of hearing impairment were referred by the criterion established and sent for further diagnostic audiological evaluation. This study concludes that Perinatal risk factors had higher rates of occurrence

of hearing impairment in both genders. The factors concluded in this study associated with screening failure and referral for audiological evaluation for hearing impairment were similar to the ones illustrated in the literature. It is recommended to use OAE's as the screening tool in Pakistan where audiology field is yet not developed on large scale because it require little man-power, not as much trained professional for its application and it is less time taking procedure.

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Authors' contributions:

Hina Sultana: Analysis and interpretation of data, revising article critically for important intellectual content for final approval.

Tayyaba Dawood: Conception and design of the work, the acquisition, analysis, drafting and revising article for final approval. Responsible for data integrity.