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ORIGINAL ARTICLE

STUDY OF HEARING LOSS IN INFANTS USING TRANSIENT EVOKED OTOACOUSTIC EMISSIONS

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ABSTRACT:

AIM:

The objective of the present study was to screen for hearing loss and to document the importance of using Transient Evoked Otoacoustic Emissions as a screening tool for hearing loss.

MATERIAL AND METHODS:

The descriptive study was conducted during the period August 2012 to July 2014 in a tertiary care health center. A study group consisting of 500 infants were subjected to TEOAE at 24-72 hours after birth. For pass cases no further testing was done. For refer cases repeat TEOAE testing was done at 15-30days, failing which such infant was subjected to Brainstem Evoked Response testing within 3 months to confirm hearing loss.

RESULT:

Five hundred infants were screened by TEOAE's after 24 hours of birth. 29 infants had refer result for 1st TEOAE hearing screen and for these infants repeat TEOAE screen was done at 15-30 days of age. On repeat TEOAE testing, 1 infant gave refer result. Then 19 infants including

18 high risk babies and 1 well baby were subjected to BERA testing within 3 months. On testing with BERA only 5 infants showed hearing loss. Hence the prevalence of hearing loss of 2 per thousand was detected in well babies and 22.2 per hundred in high risk babies. Hence substantiating the need to develop a method for screening infants for hearing loss.

CONCLUSION:

Hence the use of Transient Evoked Otoacoustic Emissions as initial screening test provides as easy, cost effective and quick method to detect infants with hearing loss.

KEYWORDS- Infants, Evoked otoacoustic emissions

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INTRODUCTION:

Communication is the 'Key to Life'. Communication is easily overlooked, but the ability to communicate effectively is necessary to carry out the thoughts and visions of an organization to the people, to convey directions and provide synchronization. Whether it was a small tribe in the Stone Age or a large nation such as the Roman Empire, speech and spoken words have always played a big role in the individual and collective lives of the people. Wars have been won, blood has been shed, men have sacrificed their lives, and peace agreements have been made because of the magical words of a few who knew how to give life to their words.Speech and hearing are interrelated-i.e. a problem with one could mean a problem with the other as speech and language is acquired normally through auditory system.

The prevalence of mild to profound hearing loss is reported to be between 1.1- 6 per 1,000 live-births and with prevalence of hearing loss is estimated to be between 2.5%- 10% among high-

risk infants.[1] In most countries, newborn hearing screening programmes that screen only high-risk infants have been in existence for more than 20 years. However, this group of infants with hearing loss comprises only 50% of newborn population with hearing loss. Therefore, hearing screening programs that screened only high-risk neonates missed out 50% of hearing-impaired newborns, who are from among infants without any risks factors. Also as hearing loss is an invisible disability it cannot be passively identified until the child fails to develop speech and language.

Hearing impairment in infants should be identified as early as possible to enable interventions to take full advantage of the plasticity of developing sensory system. Hearing integrity in the first 3-4 years of life, the 'critical period', is essential for acquisition of speech and language. Unfortunately, by the time hearing loss in infancy and early childhood is suspected, audiologically evaluated and appropriately managed two or more of these critical years have elapsed and the child has lost an enormous developmental advantage. The onus lies on modern physicians to innovate culturally acceptable ways of implementing Infant Hearing Screening programs.

Otoacoustic Emissions (OAE) reflect the status of the cochlea (outer hair cells).A probe microphone similar to that used in acoustic immitance measures the inaudible sounds reflected by vibratory motion in cochlea. OAE's are a byproduct of sensory outer hair cell transduction and are reflected as echoes into the external auditory canal. OAE's are preneural in origin and directly dependant on outer hair cell integrity.

Brainstem Evoked Response Audiometry (BERA) is an objective test of audiological function which measures activity from the auditory nerve up to the level of brainstem on stimulating with acoustic stimulus. It assesses the neural integrity of auditory pathway up to the brainstem. However it is an indirect measure of hearing acuity.

Thus the aim of this study is to show the efficacy of objective physiological screening tests Transient Evoked Otoacoustic Emissions (TEOAE) in screening infants.

OBJECTIVE:

The objective of this study is

- To study the prevalence of hearing loss in infants using transient evoked otoacoustic emissions.

MATERIAL:

This descriptive study was conducted in a tertiary care centre on 500 new born babies.

Inclusion criteria:

1. Newborns referred to the ENT department for transient evoked otoacoustic emissions from the department of obstetrics and gynaecology in the Medical College and tertiary health care centre.
2. Neonates referred to the ENT department for transient evoked otoacoustic emissions from the Neonatal Intensive Care Unit (NICU) in the Medical College and tertiary health care centre.
3. Infants visiting the ENT outpatient department for any ENT complaint at the Medical College and tertiary health care centre.

The babies were tested within one week of birth.

Exclusion criteria:

1. Parents or relatives not willing to give written informed consent.
2. Infants with signs and symptoms of active ear infection.

Procedure of the test:

The mothers were counseled regarding congenital hearing loss and the need for early diagnosis and intervention prior to the test. Written informed consent was obtained from the mothers. The babies underwent a routine ENT examination consisting of inspection of the pre-aural, pinna, and post aural region. Occluding wax or debris was gently cleaned using cotton tipped swab and otoscopic examination of the tympanic membrane was conducted using Heine 3000 series otoscope with plastic speculums.

Testing environment:

The babies were then tested in a sound treated room in the audiology department. The babies were tested in a supine position, preferably on the guardian's lap, and preferably when the child was asleep. The test was conducted with the help of a qualified audiologist.

Sequence of the testing:

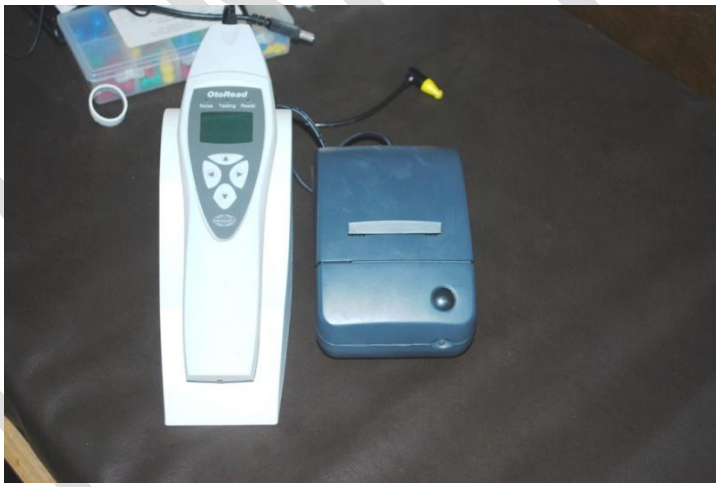
The first test was done using transient evoked otoacoustic emissions. The probe was fitted with a standardized infant ear tip kit. The two sizes used in the newborn age group were selected with the help of the ear tip selector guide and they were of 3.5mm (yellow) and 4.0mm (red) tips. These probes are made of soft rubber.The ear tip was gently inserted into the right ear by a gentle traction on the pinna in a backward and downward direction. Once the probe tip was in

place the test was started. First the probe fit and seal was checked followed by any extrinsic noise levels in a systematic computerized manner preloaded in the software..

Instrumentation:

The newborns will be screened for hearing loss using a OtoRead – screener.

The OtoRead Otoacoustic Emission test instrument is a hand-held device designed to provide an objective measure of outer hair cell function through the measurement of cochlear emissions. It consists of the handheld unit, printer, single-use ear tips and other accessories. This emission is measured by the probe and analyzed by a computer. If the emission is sufficiently robust, "pass" is displayed on the screen. If there is any dysfunction or blockage along that pathway, the equipment will be unable to measure the emission, and the result will be a fail or "refer."



PROTOCOL.

First stage: Neonates born in the tertiary care centre were tested within one week of birth. Neonates admitted in the NICU were tested prior to discharge. They were tested with Transient

Evoked Otoacoustic Emissions. Those babies who passed this test were considered passed. Those babies who failed this test were tested after one to one and a half months.

Second stage: The babies who had failed the first stage screening were rescreened with TEOAE. Babies who failed the second stage test underwent a diagnostic Brainstem evoked response audiometry. Those babies who passed this were not re-screened and were considered pass.

RESULTS:

The study was aimed at assessment of Hearing Screening in newborns based on a two stage otoacoustic hearing screening protocol.

SEX DISTRIBUTION:

The present study was conducted on 500 newborn babies among whom 55 percent (274 babies) were males and 45 percent (226 babies) were females.

BIRTHWEIGHT:

The birth weight of babies in this study group varied from a minimum of 1.15 to 4.4 kg. The mean birth weight of the tested babies was 2.8 kg. Out of the 500 babies, 83 babies weighed less than 2.5 kg and 417 weighed 2.5 kg or more.

PERIOD OF GESTATION

In this study group the mean period of gestation was 38 weeks and 7 days. Out of the 500 babies , period of gestation was less than 37 weeks in 42 babies and was more than or equal to 37 weeks in 458 babies.

The period of gestation in the study group varied from 29 weeks 3 days to 41 weeks and 5 days. The mean was 38.717 weeks. About 22.8% were born with a period of gestation of less than 38 weeks, 22.6 % with a period of gestation of 38-39 weeks, 30.8 % between 39-40 weeks and 23.8% with a period of gestation more than 40 weeks.

DAY OF SCREENING.

The day of screening of the newborns varied between days 2 to day 30, with a mean of day 5.

THE RISK FACTORS ASSESMENT:

The risk factors among the study group of 500 babies were identified according to JCIH 2007 criteria. Eighteen babies were identified to have high risk factors and 482 babies were normal. The sex distribution among the high risk babies was as follows – 63 % (n=12) were female babies and 37% (n =7) were male babies.

The high risk factors identified in this study group included low birth weight in 9 babies (50%), syndromic association (Rubella syndrome and Waardenberg syndrome) in 2 babies (11.3%), craniofacial anomalies in 1 baby (5.5%), Family history of congenital deafness in 1 baby (5.5%), ear anomalies in 3 babies (16.7 %), Mechanical Ventilation in 1 baby (5.5%), and hyperbilirubinemia in one baby (5.5%).

RESULTS OF SCREENING IN WELL BABIES (WITHOUT ANY RISK FACTORS.)

Results of the first stage of screening.

The first stage of screening was conducted for 482 babies with transient evoked otoacoustic emission. These 482 babies were those who did not have any risk factors. During the first OAE testing 94% (453 babies) of the study group (n=482) passed the first test and were considered normal. 1% (6 babies) failed in both the ears, 3% (15 babies) failed in the left ear and 2 % (8 babies) failed in the right ear.

RESULTS OF SCREENING IN WELL BABIES (WITHOUT ANY RISK FACTORS.)

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Results of second stage OAE re screening.

Second stage OAE testing was done for those babies who failed the first testing. (n=29).90% (26 babies) passed the second OAE screening, 7%(2 babies) were lost to follow up and 3% (1 baby) failed the second OAE test. Those babies who failed this test were subjected to Brainstem Response Evoked Audiometry.

SCREENING OF BABIES WITH HIGH RISK FACTORS.

Babies with high risk factors were subjected to both TEOAE and BERA. BERA was done irrespective of the result of TEOAE.

Result of OAE in High risk Babies.

All the 18 high risk babies were subjected to OAE test. Of the 18 babies, 4 babies failed the OAE test and the remaining 14 passed the test.

Brainstem Evoked Response Audiometry

Brainstem Evoked Response audiometry was conducted for the babies who were identified to have risk factors according to Joint Committee of Infant Hearing 2007 guidelines. The babies subjected to BERA were those who were identified to have risk factors (n=18) and one baby who was identified as a part of routine two staged OAE screening. This baby was subjected to BERA after failing both the OAE screening and was not classified under high risk category

Result of BERA

The babies who underwent diagnostic BERA (n=19), were assessed and 14 babies who had high risk factors passed the test. Five babies failed the diagnostic brainstem evoked response audiometry. The sex distribution of those babies who failed the 2 staged protocol and were confirmed to have profound deafness was in terms of 2 male babies (40 %) and 3 female babies (60 %).

When assessing the birthweights of those babies who had failed the two staged protocol, it was noted that 4 babies weighed between 2.1 to 3 kgs and 1 weighed between 3.1 to 4 kgs. No babies were below 2500gms.

DISCUSSION:

Congenital hearing loss is one of the most common congenital anomalies which can be identified early in life. Its early recognition and intervention helps in the overall development of the child. The developed countries are aware of the burden of congenital hearing loss and have taken significant steps by way of government policies for identification and rehabilitation. On the other hand, in developing countries like India there is no estimate of the magnitude of this problem. We undertook this study to evaluate the prevalence of congenital hearing loss and the usefulness of otoacoustic emission in the screening of hearing loss in neonates.

The neonates were assessed by two staged screening using Transient Evoked Otoacoustic Emission (TEOAE). The high risk neonates were screened with TEOAE and Brainstem Evoked Response Audiometry (BERA). Transient Evoked Otoacoustic Emission testing was chosen as the modality of screening for normal babies without any risk factors. TEOAE is the apt test for screening and, certainly, for examination of specific regions of the organ of Corti.[4]Among the babies screened in our study, 55 % were male (n=274) and 45% were female babies (n=226). These findings were similar to that of Christie Ohl et al [7], who found male predominance in their study. The high risk factors identified in 18 babies included Family history of congenital deafness in 1 baby (5.5%) , craniofacial anomalies in 1 baby (5.5%) ,low birth weight in 9 babies (50%), syndromic association (Rubella syndrome and Waardenberg syndrome) in 2 babies (11.3%) , ear anomalies in 3 babies (16.7 %), Mechanical Ventilation in 1 baby

(5.5%), and hyperbilirubinemia in 1 baby (5.5%). Victor Weichbond et al [3] conducted a study of 538 babies with hearing loss.

They found that Family history was present in 11 babies, Craniofacial malformation in two babies, Syndromic association in one baby. No cases of low birth weight <1500gm, Hyperbilirubinemia or Ear anomalies were seen. One baby was subjected to mechanical ventilation, and cardiorespiratory pathology was found in two babies. Since the high risk babies were 18 in number we cannot effectively compare with other large studies.The birth weights of the babies varied from 1.15kg to 4.4kg. No significant correlation was found between occurrence of hearing loss and low birth weight in our study.

The babies were screened within the first one week in normal newborns and after the stabilization of acute phase of illness in those babies needing Neonatal ICU admission. We used a two stage OAE protocol, wherein neonates were subjected to 2 stages of otoacoustic emission screening. One of which was performed by one week of birth and the other was conducted for only those who had failed the first screening programme. Those babies who had failed the second stage and those who had high risk features were subjected top diagnostic Brainstem Evoked Response Audiometry.

This protocol was put forward by the Joint committee of Infant Hearing and was also followed by Jhonson JL et al [2]Finitzo T et al[9], Mason JA et al[10], Arehart KH et al[11], Berg A et al[12], Mehl AL et al [5.]

Screening of well babies:

Otoacoustic emission screening was conducted for 482 normal babies on day 5 after birth in most cases, 453 babies (94%) passed the first screening test. 9 babies (1%) failed in both the ears, 15 babies (3%) failed in the left ear and 8 babies (2%) failed in the right ear. Those babies who failed the first test were screened again within a period of one month. The second OAE testing was conducted for the 34 babies who had failed the first test. 26 babies (90%) passed the second OAE screening, 2 babies (7%) were lost to follow up and 1 baby (3%) failed the second OAE test. Brainstem Evoked Response Audiometery was done for the baby who failed both the OAE tests.

B De Capua [3], De Felice et al screened 532 newborns using OAE. The first test was carried out within 4 days of delivery. Those babies who failed were retested within 15 days, and a diagnostic ABR was done after two consecutive failed OAE within one month. They noted that of the 532 babies screened, 62(11.65%) babies failed the first test. They also noted that 13(11.65%) failed on retesting with OAE. These failure rates were similar to our study.

Screening of high risk babies:

The high risk babies were screened using both TEOAE and BERA.

TEOAE results of high risk babies:

All the 18 high risk babies were subjected to OAE test. Of the 18 babies, four babies failed the OAE test and the remaining fourteen passed the test. BERA was conducted for those babies who had high risk factors and those babies who had failed the two staged

TEOAE screening. So a total of nineteen babies were subjected to BERA. Of the nineteen babies subjected to the confirmatory BERA test, five babies failed. In our study of the five babies who failed the screening programme, one was diagnosed to have hyperbilirubinemia, one baby had Waardenburg syndrome, one baby was diagnosed to have congenital rubella syndrome and one baby had craniofacial anamolies.

Katheleen Billings et al [13] studied 301 children, in whom 68.1% had a definite or probable cause of their SNHL identified 18.9% had 1 or more possible causes; 31.9%, no obvious cause. A family history of SNHL or prematurity and/or complicated perinatal course was found in 28.6% of patients. Named syndromes, multiple congenital anomalies, meningitis, or prenatal maternal factors, including maternal prenatal substance abuse was present in another 38.5%. However, syndromes commonly reported to be associated with SNHL, such as Waardenberg syndrome, were seen in less than 1% of patients. Our study could not be compared to that of Billings et al, because of the relatively small sample size of our study.

B De Capua, De Felice et al [3] noted that two babies (3.8 per1000 live births) were detected to have bilateral hearing loss and one (1.9 per 1000 live births) was detected to have unilateral hearing loss. Prieve et al [2] used a protocol that included Otoacoustic Emission screening at birth. Second stage screening was conducted with OAE, ABR at 4-6 weeks after the first stage scan. They screened 69,766 neonates of which, 4,699 failed the screening test. Diagnostic ABR and OAE were repeated after 4-6 weeks. Thirty three well babies (1 in every 2041) were confirmed to have hearing loss in comparison to fifty two NICU babies (1 in 208).

We found in our study that the prevalence of hearing loss by two staged screening protocol with Transient Evoked Otoacoustic Emission and confirmation by Brainstem Evoked Response audiometry in babies not at risk is 2 per thousand screened. The prevalence of congenital hearing loss in at risk babies is 22.2 per hundred screened. Though the prevalence of hearing loss in normal babies in our study is akin to the studies by Prieve et al [2] and B De Capua, De Felice et al [3], the prevalence of hearing loss in high risk neonates vary. This variability is probably because of the relatively smaller sample size.

The results of this study will be used to initiate universal newborn hearing screening in our hospital. However, because of a relatively small sample size, fallacies in comparison to larger studies are unavoidable

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