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Hearing screening using OAE and ABR.

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Abstract
Objective:
This study included screening of hearing assessment of neonates and children using combined automated auditory brainstem response audiometry and otoacoustic emission testing in a tertiary care set-up, to assess the prevalence of neonatal hearing loss and also to manage the children with profuse SNHL.
Methods:
A retrospective study was conducted between September 2016- September 2018 in Pacific Medical College and Hospital, Udaipur .First, all of neonates were evaluated by OAE within 24th to 48th hours of birth. If responses of OAE were failing, they were retested in 1 month and 3 month after birth by OAE. Also, Neonates failing on above were assessed by ABR at the age of 6 months. A total of 1518 newborns were assessed by OAE, failing in it again after 3 months were asked for ABR testing. A bunch of 236 children were tested for ABR, among those 147 patient were confirmed of profound sensory neural hearing loss. Children who were confirmed of sensorineural hearing loss considered for rehabilitation either by prescribing hearing aids or cochlear implantation if fulfilled the criteria for the above.
Results*:*
Neonatal hearing screening using OAE and BERA is a feasible service. The estimated prevalence of confirmed hearing loss was comparable to that in literature. In our study 9.6 % children presented to our health care system within 2 years were found to have profound SNHL. Rehabilitation by either using hearing aids and surgically implanted stimulating device were enormously helpful to children who were in regular follow up.
Keywords: *OAE , ABR, Neonatal Screening.*

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I. Introduction

Early identification and intervention for hearing loss by 6 months of age provides better prognosis in language development, academic success, social integration and successful participation in the society [1].Congenital, bilateral hearing impairment occurs in approximately 1 to 5 per 1000 live births and when permanent unilateral hearing loss is included, the incidence increases to 8 per 1000 live births [2]. Studies done in other parts of India using different hearing screening protocols have estimated the prevalence of neonatal hearing loss to vary between 1 and 8 per 1000 babies screened [3-5].

Tests used for screening newborns for hearing loss include Otoacoustic emissions (OAE) and automated Auditory Brainstem Response audiometry (aABR). Otoacoustic emissions are clinically important because they are the basis of a simple, non-invasive test for hearing defects in newborn babies and in children who are too young to cooperate in conventional hearing tests. The development of automated ABR technology was a major factor contributing to the emergence of universal newborn hearing screening (Hall et al, 1987; Stewart et al, 2000). Similarly, beginning with the earliest published reports over 20 years ago, transient evoked otoacoustic emissions (OAE) (Bray and Kemp, 1987;Johnsen et al, 1988; Vohr et al, 1998; Norton, Gorga, Widen, Vohr et al, 2000), and then distortion product OAEs (Lafreniere et al,1991; Bonfils et al, 1992; Smurzynski et al, 1993; Gorga et al, 2000; Hall, 2000), have assumed an important role in newborn hearing screening. While OAE is cheap, quick, simple and reliable with a sensitivity of 100% and specificity of 99 % [6], aABR has the additional advantage of identifying neonates with auditory neuropathy unlike testing for OAE. The other advantages of aABR include rapidity, easy-to-use and high sensitivity (0.99) and specificity (0.87) [7].

This study was undertaken with the primary objective of exploring the inicidence af hearing loss in new born children by screening them using OAE and BERA testing in a tertiary health care institute (handling an average of 2500 deliveries/year). With the use of combined OAE and ABR screening, one type of testing can be used to evaluate or crosscheck the other type of testing. The secondary objectives included rehabilitation of children with congenital sensory neural hearing loss who fits in the criteria for cochlear implantation. .

II. Methods

This descriptive study was conducted from September 2016 to September 2018 at our tertiary care center located in hilly areas of Rajasthan, India. All normal newborn babies delivered in our hospital were screened by the trained audiologist using OAE between 24 hours and 72 hours after birth. Patient who came out as refered on testing were called again after 1 month and 3 month for repeat assessment, failed to pass again were then underwent ABR Testing. Mothers of all babies born in the tertiary care hospital were counseled regarding the benefits of hearing screening, procedure of the screening test, need for follow-up and further tests if the neonate failed the screening test, and the interventions available if hearing loss was confirmed. Parents of babies who failed ('refer') the screening test were counseled and asked to return after 1 week for second screening. These babies underwent a second testing in a quiet room. Those who passed on the second screening were discharged from the study while those who failed a second time were referred for further evaluation in the BERA clinic at the same centre, where the babies were examined thoroughly, parents were counseled and diagnostic testing using ABR was done. Repeated phone calls and letters were used to contact parents of babies who failed to return for follow-up.

We used a combined approach including OAE and BERA to assess and label the hearing status of the patients both neonates and hearing disabled children who presented directly of our specialized run deafness clinic. Combined automated OAE and ABR screening offers a variety of other potential advantages. Integrated OAE and ABR technology allows for an individual patient's in-ear calibration of signal levels for ABR, as well as for OAE test signals. Screening efficiency is enhanced by a combined OAE and ABR screening capability that allows immediate application of many different protocols that account for differences in hearing loss prevalence and etiology (Gorga et al, 2001).

For recording OAE, Signals were presented, and tPOAEs detected, with a probe assembly that contained a microphone and two miniature loudspeakers. response is detected the test produces a 'Pass' result while failure to detect a response within 180 seconds produces a 'Refer' result. For each subject, a complete probe fit was determined and signal levels were verified and adjusted with real ear measures immediately before data collection The ABRs were recorded from the scalp using disposable electrodes placed at Fz (noninverting) and the ipsilateral mastoid process (Mi, with the contralateral mastoid process used as ground) in response to click stimulus signals (100 μsec).

The babies who were referred after screening twice with BERA and whose parents consented for blood tests also underwent serological tests for known infective causes of hearing loss (Toxo plasma, Rubella, Cytomegalovirus and Herpes simplex virus) were calculated. Radiological scans were done to rule out any anatomical abnormalities responsible for their hearing problem after which the patient is prepared for rehabilitation program. Hearing aid trial proposed to them for 6 to 12 months meanwhile their parents were counseled for cochlear implant surgery, after their consent for active participation in post operative rehabilitation, their children were considered for cochlear implant surgery. A sum of 55 such children already underwent surgery and many of them are undergoing audio verbal therapy.

III. Discussion

The hearing screening program required intense supervisory input from the primary investigator as well as an audiologist. Frequent evaluation of test procedures, entry of data and supervision of the technicians is required. Maintenance of OAE and ABR hardware as well as record keeping played an important role for an easy and quick assessment. Under ideal conditions (sound proof room and a quiet sleeping child) the BERA phone screening test takes five minutes to complete. On an average, screening took 5 to 10 minutes to complete in our setup. .However, the equipment required frequent servicing by the company and the software required frequent reinstallation. High usage was the reason attributed. The laptop required constant recharging of batteries which added to delays and disruption in work and consequently limited the number of children who could be screened on a given day.

Follow-up (after failing the test the first time) was intended at 6 weeks after birth also the IgM testing for infective causes (TORCH) required an early sample. In practice, it was found that the follow up was poor at 6 weeks, so parents were given a 6 weeks window period for repeat OAE testing. Parents were more likely to come earlier in a week or two after discharge from the hospital for a checkup hence decreasing the dropouts. This also had the advantage that those children who failed the test the second time could be referred for the diagnostic test earlier.

The waiting time for confirmatory testing was between3 to 6months. This was because of the availability of only one testing facility for both the routine diagnostic testing of patients attending tertiary care and the neonates identified during the study. Often babies required multiple attempts to obtain a satisfactory result because of artifacts produced by upper respiratory tract infections and failure of the baby to achieve deep sleep. Frequently, patients did not keep appointments and so had to be rescheduled for another date. Babies with

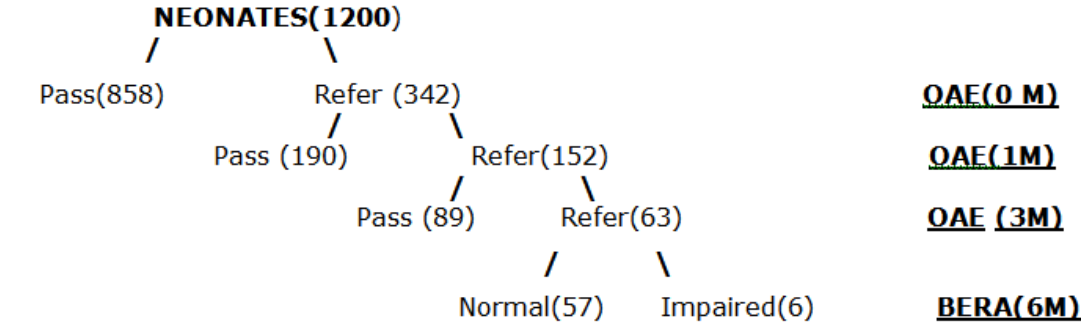
confirmed hearing loss could be fitted with appropriate hearing aids by 6 months of age and started on auditory verbal therapy thereby initiating the process of early rehabilitation.

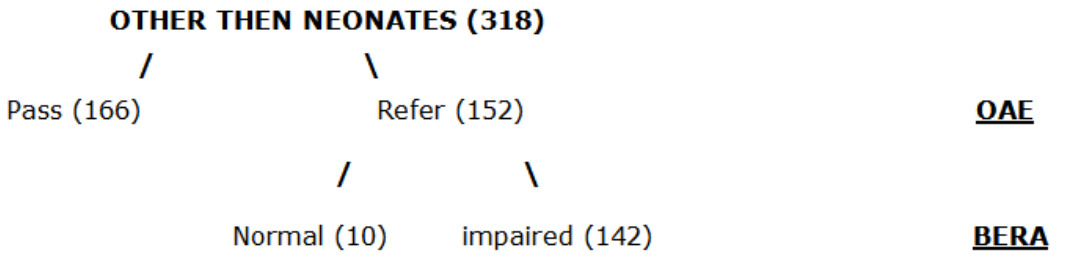
The estimated prevalence of hearing loss among neonates in this study was 5 per 1000 babies screened. Although this value is similar to that obtained in other studies done in India, it is still an underestimation considering a significant number of babies who were lost to follow-up. Nearly 20% of neonates who attended the AVC after failing the screening test twice had one or more risk factors for hearing loss. However, babies with risk factors are more likely to be brought back for follow-up as these children require frequent hospital visits for various other reasons.

The problem of a huge loss to follow-up is a reality even in developed countries which have established universal neonatal hearing screening programs. In the United States, where nearly 95% of neonates are screened only half of those who do not pass the initial screening undergo confirmatory testing and rehabilitation [6,7]. Measures to increase awareness regarding neonatal hearing loss, its effect on the individual and society, available rehabilitation modalities, and the effectiveness of early identification and rehabilitation are essential for the successful implementation of such a program.

IV. Results

The study included 1518 patients including 1200 newborn that were born in Pacific hospital, Udaipur and rest 318 children were primarily presented to specially run deafness clinic and carried out in department of otolaryngorhinology in the same hospital. Neonates were tested for hearing by applying OAE test before discharging from the hospital NICU. They were followed up for the next 6 months and underwent repeat OAE testing failing on which ABR was done.





All candidates who passed the test were sent to home while the 148 hearing impaired children who were confirmed of their hearing deficit using OAE and ABR testing were set for early rehabilitation. 55 patient among them were successfully underwent CI surgery in our institute till date.

V. Conclusion

Congenital hearing loss is one of the most common congenital anomalies which can be identified early in life. Neonatal hearing loss has a prevalence that is more than twice that of other newborn disorders amenable to screening such as congenital hypothyroidism and phenyl-ketonuria [8,9]. 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 demonstrate herein that the surest and most feasible strategy for early detection of auditory impairment is to utilize a combined OAE and ABR screening technique for all infants. These electro physiologic and acoustic responses can be safely applied without reliance on a behavioral response. However, neither OAE

nor BERA tests evaluate hearing or describe how a particular person will use available hearing. OAE and BERA are physiologic responses related to peripheral hearing status but constitute indirect measures of hearing.

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