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Original Research Paper

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SCREENING OF NORMAL AND HIGH RISK INFANTS FOR HEARING IMPAIRMENT BY OTO ACOUSTIC EMISSIONS TEST

Dr Prarthana Kalgaonkar — Speciality Medical Consultant Pediatrician, Dr R. N. Cooper Hospital And HBT Medical College, Vile Parle Mumbai

Dr Geeta Karambelkar — Professor, Dr D Y Patil Medical College And Hospital Pimpri Pune

ABSTRACT

Title- To screen the normal and high risk newborns and infants for hearing impairment by Oto acoustic emission. (OAE) Significant bilateral hearing loss is present in ~1 to 3 per 1000 newborns in well baby nursery and in ~ 2 to 4 per 100 newborns in NICU. Hearing loss if undetected will impede speech, language, and cognitive development. Thus, all infants should be screened at no later than 1 month of age and should get appropriate intervention at least by 6 months of age. We conducted a hearing screening test, OAE on 500 newborns which included normal as well as high risk newborns & infants. The study was conducted in tertiary care medical institution, and associated risk factors were studied. We found 5 in 500 babies (1%) to have suspected hearing deficit out of which 4 babies were confirmed to have hearing loss by BERA (brainstem evoked response audiometry) test.

KEYWORDS : Oto acoustic emission, Neonatal hearing screening test / Risk factors for hearing loss

Introduction:

Significant hearing loss is one of the most common major abnormalities present at birth and if undetected, will impede speech, language, and cognitive development of the child. The goal of early evaluation of hearing, early detection and intervention, is to maximize linguistic competence and literacy development for children who have hearing impairment. [1] Thus all infants should be screened at no later than 1 month of age. Those who do not pass screening should have a comprehensive audio-logical evaluation at no later than 3 months of age. Infants with confirmed hearing loss should receive appropriate intervention at no later than 6 months of age. [2]

Significant bilateral hearing loss is present in ~1 in 3 per 1000 newborns in well baby nursery and in ~ 2 to 4 in 100 in NICU. [1] OAE (oto acoustic emission) and ABR (auditory brainstem response) are being used to screen newborns and infants with hearing loss. Both these tests provide non invasive recordings of physiologic activity underlying normal auditory functions. Both have bed side availability, are easily performed in neonates and have been successfully used for universal newborn hearing screening. [3-7]

Although most hearing loss in children is congenital, a significant portion of the hearing loss is acquired after birth. Regardless of the age of onset, all children with suspected hearing lossrequire prompt identification and intervention by appropriate professionals with pediatric training and expertise. [8,9]

Methodology:

The study was conducted after approval from ethics committee of the institute and with informed written consent from the parents.

Study duration- 2 years (June 2007- June 2008)
Sample size- 500

Study population- Normal newborns as well as the high-risk infants admitted in NICU and the infants visiting the outpatient department (OPD).

Inclusion criteria- Normal as well as high-risk neonates and infants with suspected hearing loss. (upto age one).

Exclusion criteria- Neonates within 48 hours
Prerequisites-

- Unobstructed outer ear canal
- Seal of the ear canal with the probe
- Optimal positioning of the probe
- Functioning cochlear outer hair cell
- A quiescent patient
- Quiet recording environment

Study methodology-

The neonates enrolled in the study were examined for hearing impairment and their risk factors were studied. The test used for the study was OAE (Oto Acoustic Emission), with the instrument AuDX® Pro-Natus portable OAE recording system. The method used was distortion product OAE. The test was done with an appropriate size soft probe which is inserted in the ear canal. The results were obtained within few seconds. The results were categorized as "PASS" or "REFER" depending upon the findings. When the result is suggestive of "PASS" no further evaluation is needed whereas the results suggestive of "REFER" indicates further evaluation which includes repeat OAE test after one month , confirmation by BERA and follow up every 6 monthly. Possibility of "REFER" results are observed in patients with excessive debris, middle ear fluid or anomalies and cochlear hearing loss >25-30 db. Thus, the infant was referred for comprehensive audiological assessment and medical evaluation to confirm the presence of hearing loss, to determine the type and nature of hearing loss, and the etiology. The test results and the available treatment options were discussed with the parents.

Results

In the present study 500 newborns were screened by OAE, out of which 368 (73.6%) were normal newborns without any risk factors and 132 (26.4%) were high-risk newborns. The male to female ratio was 3:1.

Table 1: Test results of OAE

Result		No of cases showing 'Refer' results		P Value
		Normal (n=368)	High risk (n=132)	
After 1st test	Right	3 (0.81%)	15 (11.36%)	<0.001
	Left	1 (0.27%)	16 (12.12%)	<0.0001
After 2nd test	Right	0 (0%)	5 (3.79%)	<0.05
	Left	0 (0%)	5 (3.79%)	<0.05

After the 1-st screening test done by OAE total 18 cases showed REFER results in right ear, out of which 3 belonged to normal group and 15 were from the high risk group. Similarly total 17 cases showed REFER results in left ear, out of which 1 belonged normal group and 16 belonged to high risk group.

After conducting second screening test by OAE, 5 cases showed REFER results in right as well as left ear.

REFER results in the second OAE were seen in 3 males and 2 females belonging to the high risk group who were further evaluated.

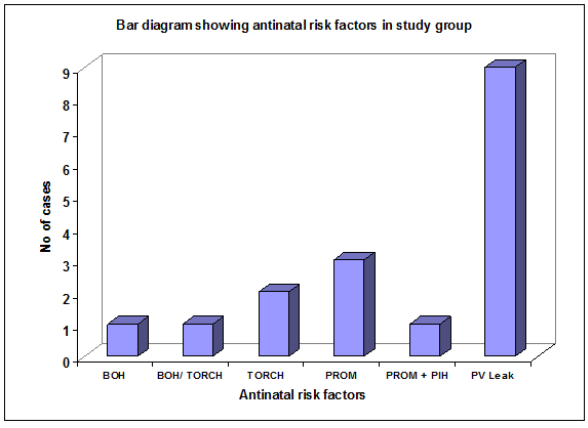
Table 2-Correlation of antenatal risk factor and second result by OAE in study group

Antenatal risk factor	2nd result by OAE		Total
	Refer	Pass	
Yes	0	17	17
No	5	478	483
Total	5	495	500

$X^2 = 2.76, P>0.05$

Above table shows 17 babies were having one or more antenatal risk factors out of which none showed hearing impairment. On the other hand 5 babies showed hearing impairment who had no antenatal risk factors.

This reflects no statistical relation between antenatal risk factors and hearing impairment in the study.



The antenatal risk factors considered were Bad Obstetric History (BOH), TORCH group of infections , Premature Rupture Of Membranes (PROM) ,Pregnancy Induced Hypertension (PIH) and Per Vaginal Leak (PV leak) over 12 hours. PV leak contributed the maximum number of patients' i.e.1.8%.

Out of 500 study sample, 19 had history of birth asphyxia from which 2 showed hearing impairment by OAE which contributed 10.5%, stating highly significant relation with hearing loss having a P value of <0.001.

Table 3-Post natal risk factors in study group

Post natal risk factors	No of cases (n=500)	Percentage
Convulsion	1	0.2
Hypocalcemic convulsion	1	0.2
Hyperbilirubinemia	20	4
TORCH infection (CMV)	1	0.2
LBW	24	4.8
LBW + IUGR	1	0.2
Meconium aspiration syndrome	1	0.2
PT + LBW	17	3.4
Pyogenic meningitis	2	0.4
Hypoxic Ischemic Encephalopathy	3	0.6
Sepsis	1	0.2

Post natal risk factors that we came across in the present study were Hyperbilirubinaemia, Low Birth weight (LBW), Intra uterine growth retardation (IUGR), Meningitis, Hypoxic ischaemic injury (HIE), Sepsis, Convulsions and Meconium aspiration syndrome(MAS). Out of these, LBW contributed to maximum number of cases (4.8%) followed by Hyperbilirubinaemia(4%) and Preterm (3.4%).

72 babies out of 500 had post natal risk factors. Out of these 2 showed REFER result. But we observed no statistical significance among the postnatal risk factors and hearing impairment.

We found that association of ear discharge and hearing impairment was highly significant. There was statistically significant relation with the family history of hearing impairment and hearing loss.

Though, there was statistically significant relation found between the NICU admissions and hearing impairment, 3.5% babies admitted in NICU were found to have hearing impairment.

Pharmacological ototoxicity is known to cause hearing impairment, though our study did not show any such results. We found to have congenital anomalies in 0.6% of patients, but none of them showed hearing impairment.

We found parental concern about probable hearing impairment has strong association as we noticed 2 babies out of 500 to have this concern out of which both confirmed to have REFER OAE results and hearing impairment was confirmed on BERA.

After considering all these risk factors, and conducting OAE twice, we found to have 5 cases with REFER results on second OAE. These babies were further subjected to confirmation by BERA Out of which 4 cases were confirmed to have hearing loss

Table 4 : Table showing Hearing Impairment of normal and high risk infants confirmed by BERA

Result	Incidence		P Value
	Normal (n=368)	High risk (n=132)	
Final	0 (0%)	5 (3.79%)	>0.05

Further these 5 cases out of 132 (high risk group) confirmed to have hearing impairment by BERA.

Table 5: Details of patients with hearing impairment in the study

PATIENT	RISK FACTORS	2ND O.A.E	BERA
1	IgM CMV + , NICU admission , Microcephaly	REFER	POSITIVE
2	Ear Discharge, Parental Concern	REFER	POSITIVE
3	Family History , Parental Concern	REFER	POSITIVE
4	Asphyxia , NICU admission , HIE , aminoglycoside use ,	REFER	POSITIVE
5	Hyperbilirubinaemia , Kernicterus	PASS	POSITIVE
6	Birth Asphyxia , Hyperbilirubinaemia , NICU admission	REFER	NEGATIVE

We observed that there was one baby in the high risk group who had hyperbilirubinemia, required exchange transfusion and clinically had developed kernicterus. OAE was done for the baby as the routine protocol, which showed PASS result. However, considering the limitation of OAE, which cannot detect cortical hearing loss, BERA was advised for the baby. After conducting BERA, the results showed auditory dyssynchrony suggestive of hearing loss.

Thus, out of total 500 babies 5 showed REFER result on 2nd test done by OAE, out of which 4 were confirmed to have hearing loss by BERA, and 1 of them had normal test by BERA.

Whereas remaining 495 who showed PASS result by OAE 2nd test, 1 of them showed to have confirmed hearing loss by BERA This showed highly significant correlation between 2nd results of OAE and results of BERA.

According to this study, sensitivity of the test was 80% while specificity was 99.80%.

Table 6 : Comparison of 2nd result by OAE and Hearing Impairment by BERA in study group

2nd result by OAE	Hearing Impairment by BERA		Total
	Positive	Negative	
Refer	4	1	5
Normal	1	494	495
Total	5	495	500

$X^2 = 242.88, P<0.0001$

Sensitivity of OAE = 80% **PPV = 80% (positive predictive value)**

Specificity of OAE = 99.80% **NPV = 99.80% (negative predictive value)**

Accuracy of OAE= 99.6%

Limitations of the study-

1-Small sample size due to limited period of study. Inadequate sample size due to the limited duration of the post graduation course.

2- Difficulties in conducting follow up due to lack of awareness in the society towards hearing screening, and further follow up till confirmatory test.

3- Cost of BERA test.

4- Limitation of OAE in diagnosing neural dysfunction, neural conduction disorders or auditory neuropathy/ dys-synchrony.

5- Excessive debris in the ear canal and middle ear fluid, and cochlear hearing loss greater than 25-30 db can affect the results of OAE.

Discussion-

Hearing loss is an etiologically heterogeneous trait with many known genetic and environmental causes.10 Every Pediatrician should recommend hearing screening , not only during early infancy but also through early childhood for those children at risk for hearing loss and for those demonstrating clinical signs of possible hearing loss.9 According to American Academy of Pediatrics, significant bilateral hearing loss is present in 1 to 3 per 1000 newborns in the well baby nursery population, and in 2 to 4 per 100 infants in the intensive care unit population.5,8 Currently, the average age of detection of significant hearing loss is 14 months.2.

In the present study birth asphyxia showed statistically significant relation with hearing loss with P value <0.001. Nagapoornima et al showed the similar finding where the incidence of hearing impairment by OAE in the infants with birth asphyxia was 1 per 51 screened.[11]

There was no statistically significant relation among the postnatal risk factors and hearing impairment which were similar to the study conducted by P.Nagapoornima et al which showed that there was no hearing impairment seen in the neonates with antenatal and postnatal infections.[11]

The relation of birth weight and hearing loss was not found to be statistically significant in the present study. This finding could probably be because of the lower number of VLBW babies enrolled in the present study. A study done in Norway by Folkehelseinstitut et al, showed that the risk of hearing loss is reduced as the weight increases.12 Another study from London by Solomon J. Abramovich et al showed that out of 111 babies weighing <1500 gms, 9% showed sensorineural hearing loss and only 1% showed conductive hearing loss done by ABR.[13]

In this study , 14.6% babies were preterm (<37 wk) out of which none of the baby showed REFER result , the statistical relation between gestational age and hearing loss was not significant, this could be because of minimum gestational age in the study was 32 wks. This finding did not correlate with other studies conducted by Pereira PK et al which showed that lower the gestational age (30 wk) and birth weight, 3 times higher incidence of hearing loss 14 , and another study done by Lubica Aghora et al showed 5.4% incidence unilateral hearing loss and 4.2% incidence bilateral hearing loss in preterm neonates. [15]

In the present study 84 babies required NICU admission out of which 3 showed REFER results, thus proving statistically significant relation between the NICU admissions and hearing impairment. In the study conducted by Hill Elysee T.M.et al showed that prevalence of hearing loss in NICU population was 3.2%. Independent risk factor for hearing loss were severe birth asphyxia and assisted ventilation >5 days.[16]

We found to have History of ear discharge, family history of hearing impairment and history of parental concern about hearing impairment has very strong association with hearing loss, whereas use of aminoglycosides , external congenital anomalies has no statistical significance with hearing loss.

Conclusion-

1. All infants should have access to hearing screening using a physiologic measure at no later than 1 month of age.

2. All infants who do not pass the initial hearing screening and the subsequent rescreening should have appropriate audiological and medical evaluations to confirm the presence of hearing loss at no later than 3 months of age.

3. All infants with confirmed permanent hearing loss should receive early intervention services as soon as possible after diagnosis but at no later than 6 months of age.

4. The child and family should have immediate access to high-quality technology including hearing aids, cochlear implants, and other assistive devices when appropriate

5. The most important role for the family of an infant having hearing loss is to love ,nurture and communicate with the infant. Thus to meet the special needs of their infant.

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