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TITLE : **"OTO- ACOUSTIC EMISSIONS AS A COMPONENT OF UNIVERSAL NEONATAL HEARING SCREENING" – AN INSTITUTIONAL CROSS SECTIONAL STUDY**

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ABSTRACT :

AIM OF STUDY : To Evaluate and Screen Hearing in every Neonate using Oto Acoustic emissions (OAEs).

OBJECTIVES: 1. To Establish and Screen Universal Neonatal screening services for all the neonates delivered at our Hospital

2. To Correlate the results with maternal and neonatal history.

3.To Refer the Deaf children for Rehabilitation at the earliest so that the window period for Language and social development are not missed.

Results : In our study of 500 neonates screened by OAE, 51(18.2%) out of 279 males and 38 (16.2) out of 183 neonates were given the result as REFER in the first screening.

ISSN: 0975-3583, 0976-2833 VOL 13, ISSUE 05, 2022

In the second screening only 10 male and 6 female neonates were given REFER. In the third screening only one male baby was given REFER

Conclusion: In this study of 500 neonates, 87 (17%) neonates were having TEOAE REFER in the first screening, which was decreased to 16(3%) in the second screening and finally only one (0.2%) baby was screened REFER and was subsequently diagnosed as profound hearing loss by ABR.

Key words: Universal Neonate screening, OAE, BERA, Congenital Hearing loss

INTRODUCTION : Screening is looking for a condition in an apparently normal individual. It is done for early detection of the condition and in doing so, is helpful in preventing the worst outcome. Universal neonatal hearing screening is screening all neonates in that area irrespective of risk factors or NICU admission. Hearing screening in neonates aims at finding hearing loss as early as possible, so that early intervention can be attempted for improving the overall development of the neonate. Screening is not diagnostic test and the individual must undergo further evaluation before diagnosing the condition. Signs of hearing loss in neonates are very subtle, so universal neonatal screening is the most effective way to detect hearing loss in the early days so that treatment is started and early and the baby will have normal development.

Hearing is one of the five special senses and is necessary not only for linguistic development but also overall development of the neonate. Hearing loss can be either partial or total, leading to poor language and speech development and thus, affecting the complete development of the individual and his efficiency. Early diagnosis and intervention plays an important role in the development and prognosis of the child with hearing loss. And by doing so we can decrease the impact of hearing loss on not just linguistic development, but also the child's social, emotional and intellectual province.

In India, hearing loss has a higher prevalence in children of age 0-4 years (0.60%) compared to all other disabilities (0.32%) [1]. Unfortunately, most programs in India do not attend neonatal hearing screening, which cause a negative impact on the development of a neonate. To implement neonatal hearing screening there are many challenges, like scarcity of audiologists and the lack of infrastructure in rural areas where 72% of the population resides [2].

In spite of these challenges, neonatal hearing screening programs have been started in India as part of research studies in the early 1970s [3, 4]. One of the early research attempts to determine the most effective method of screening for hearing loss on a large scale was the study by Yathiraj, Sameer, and Jayaram in 2002 [4] in rural and urban areas of Mysore.

In 2006, India launched the National Program for Prevention and Control of Deafness(NPPCD). This program is currently implemented in more than 60 districts of the country. NPPCD aims at identifying babies with bilateral severe-profound hearing loss by 6

ISSN: 0975-3583, 0976-2833 VOL 13, ISSUE 05, 2022

months of age and initiate rehabilitation by 9 months of age [5]. Whereas, according to the Joint Committee on Infant Hearing (JCIH) screening should be done by 1 month of age, diagnosis to be made by 3 months, and intervention and treatment should commence by 6 months [6].

Oto-acoustic Emissions (OAEs) are an objective and easy-to-use method for hearing screening in a clinical setting. Because they do not require a behavioral response, they are not influenced by language, cognitive function, motivation or attention of the patient. Transient Evoked Oto-acoustic Emissions (TEOAEs) are used for hearing screening as they are accurate, economic, and of simple execution[7].For various above reasons, we have opted this topic which may help in analysis of development and wellbeing of children.

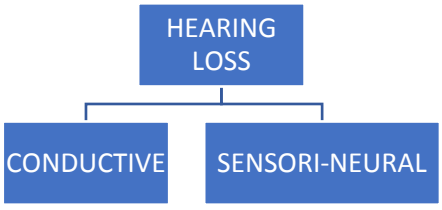
NEED FOR HEARING ASSESSMENT IN NEWBORN

Most of the language and speech development occurs in the first 3 years of life. And for normal linguistic development there has to be normal hearing. If the hearing is impaired, so does the language and speech development. Hearing is also required for the child's intellectual and social development. If the child has impaired hearing, the child cannot cope up with his peer group in the intellect and also becomes unsocial and withdrawn. These children are not only unsocial but also need lot of support and special attention from parents and family members as the child cannot communicate.

But, lot of studies have shown that early detection of hearing loss and timely interval can help the child not only in the language and speech development but also the child's intellectual development. So that the child can be social and be on par with peer group.

This early detection can be made only through universal neonatal hearing screening. Previously the children who were high risk individual were subjected to screening test. But, by doing so, about 30 to 50% of children with hearing impairment are missed. So, JCIH recommended that all infants should be screened for hearing within the first month of age and those who do not pass screening should have a complete audiological evaluation within 3 months of age. They also recommended that, once the Infants was diagnosed with hearing impairment, appropriate intervention must be done by 6 months of age [8].

HEARING LOSS[9]



Hearing loss in a child can be due to causes which occur before, during or after the birth. So the causes can be prenatal, peri-natal and post-natal.

ISSN: 0975-3583, 0976-2833 VOL 13, ISSUE 05, 2022

New Born screening programmes : The permanent hearing loss identified in newborn screening programmed varies from a minimum level of 40dBHL in the United Kingdom to 35 dBHL in the United States. The Joint Committee on Infant Hearing (JCIH, 2000) define the target population for the infant screening programs as unilateral or bilateral permanent hearing loss averaging 30-40dB in the speech frequency range. Conductive hearing loss, as a result of anomalies to the outer or middle ear, is also included in the targeted screening population.

Patients & Methods :

Study Type: Cross sectional study with a Sample size: 500

Duration of the study: From January 2019 to December 2019

Target population:

1. All newborns delivered at Bhaskar General Hospital in the Department of Obstetrics and Gynecology.

2. All neonates attending Department of Pediatrics in Bhaskar General Hospital.

3. All neonates whose parents gave informed written consent to the study.

Inclusion criteria:

1. All newborns delivered at Bhaskar General Hospital.

2. Neonates attending Bhaskar General Hospital.

Exclusion criteria:

1. Neonates meatal atresia, anomalies of external ear where probe insertion is not possible.

2. Those neonates whose parents are not willing to participate in the study

Fig. 1 OAE instrument

ISSN: 0975-3583, 0976-2833 VOL 13, ISSUE 05, 2022

Methodology:

This is a one year Cross-sectional study where hearing screening in done in all newborns delivered at Bhaskar Medical College & Hospital, Moinabad and neonates attending the same for a period of one year from January 2019 to December 2019.

The parents of the neonates fitting into inclusion criteria will be interviewed about the maternal and neonatal history and assessed with written, informed and valid consent. Then the neonate will be screened for hearing by using Oto-Acoustic Emissions in a sound proof room.

Initially screening is done on all neonates and the responses are recorded as PASS or REFER. The average time for OAE measurement is 5 min. The follow-up is done on neonates with results as REFER after one month. If the result is REFER on the follow-up then we have to rescreen the neonate again after another month. If it is REFER again on the third follow-up, then BERA is performed for conformation and assessing the type and degree of hearing loss.
Investigations: Regular Ear, Nose & Throat investigations

SAMPLE CASE PROFORMA :

Once the Neonate comes for the ENT Department ,the following Examination proforma is done ,followed by OAE and BERA .

OTOSCOPIC FINDINGS		
	RIGHT	LEFT
PINNA	NORMAL	NORMAL
PRE AURICULAR REGION	NORMAL	NORMAL
POST AURICULAR REGION	NORMAL	NORMAL
TRAGAL TENDERNESS	ABSENT	ABSENT
MASTOID TENDERNESS	ABSENT	ABSENT
EAC	NORMAL	NORMAL
TYMPANIC MEMBRANE	NORMAL	NORMAL
MEM	NORMAL	NORMAL
FACIAL NERVE	INTACT	INTACT

ISSN: 0975-3583, 0976-2833 VOL 13, ISSUE 05, 2022

TABLE : 1 : FINDINGS OF SAMPLE CASE

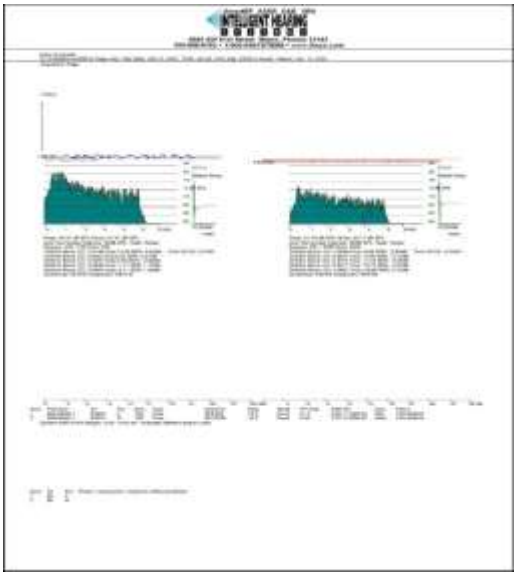


Fig : 2 : OAE Report

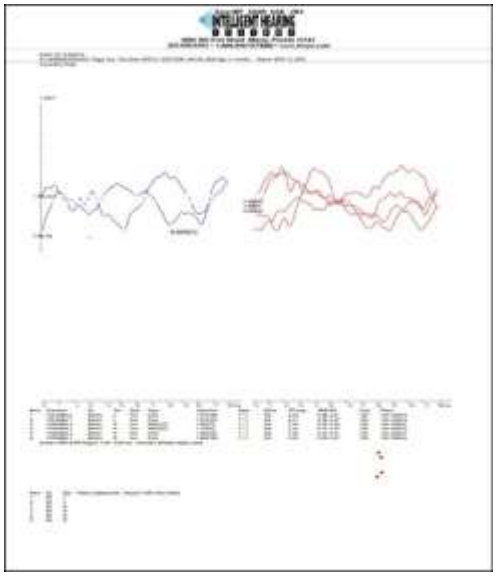


Fig 3 : BERA Report

OBSERVATIONS AND RESULTS :

During this study, 500 neonates born and attending Bhaskar General Hospital were subjected to OAE testing. And the results were analyzed by percentages. The age of the study group ranged between 3 days to 90 days. Among them, 279 neonates (56%) were male and 221 neonates (44%) were female. The gestational age of the study group ranged between 30 to 38 weeks. Birth weight varied between 1000g and 3800g. At the end of three stage screening test, 499 neonates (99.8%) had normal hearing and 01 neonates (0.2%) had hearing impairment.

- Total neonates screened initially by OAE: 500
- Total neonates who passed first screening by OAE: 413 (82.6%)
- Total neonates who failed first screening by OAE and subsequently screened for second time by OAE: 87 (17.4%)
- Total neonates who passed after second screening by OAE: 71 (81.6%)
- Total neonates who failed after second screening by OAE subsequently screened for third time by OAE: 16 (18.4%)
- Total neonates who failed after third screening by OAE: 01

ISSN: 0975-3583, 0976-2833 VOL 13, ISSUE 05, 2022

- Total number of neonates for whom ABR is done: 01(0.2%)
- Only ONE baby was diagnosed to have hearing impairment out of 500 neonates on doing ABR. The incidence rate is 0.2% .

SEX	PASS	REFER	TOTAL
MALE	228	51	279
FEMALE	185	36	221
TOTAL	413	87	500

TABLE- 2 : MALE : FEMALE

SEX DISTRIBUTION OF SCREENEED INFANTS

Of 500 neonates screened for OAE, 279 were males and 221 were females. 51(18.2%) out of 279 males and 38(16.2) out of 183 neonates were given the result as REFER in the first screening. In the second screening only 10 male and 6 female neonates were given REFER. In the third screening only one male baby was given REFER.

TOTAL NUMBER SCREENED	500	
PASS	413 (83%)	
REFER	87 (17%)	
	U/L	B/L
TOTAL	18 (3%)	69 (14%)

TABLE : 3: FIRST SCREENING BY OAE

After the first screening, out of 500 neonates 413 neonates i.e., 83% neonates were given result as PASS and 87 neonates i.e., 17% neonates were given REFER. Of them 18(3%) neonates were having REFER in one ear and 69(14%) neonates having REFER in both the ears.

ISSN: 0975-3583, 0976-2833 VOL 13, ISSUE 05, 2022

TOTAL NUMBER SCREENED	87	
PASS	71	
REFER	16	
	U/L	B/L
	5	11

TABLE: 4: SECOND SCREENING BY OAE

87 neonates whose results were REFER the first time were subsequently called for second test after a month. Of them 71 neonates were PASSED and 16 neonates were given result as REFER. Of the 16 neonates 5 neonates have REFER in only one ear and 11 neonates have REFER in both the ears.

TOTAL NUMBER SCREENED	16	
PASS	16	
REFER	01	
	U/L	B/L
	-	01

TABLE: 5: THIRD SCREENING BY OAE

Out of 16 neonates whose results were REFER on second screening only one baby was given REFER in both the ears on the third screening. This baby was further evaluated by ABR and was having B/L profound hearing loss.

DELIVERY	PASS	REFER	TOTAL
NVD	178	26	204
LSCS	235	61	296
TOTAL	413	87	500

TABLE : 6: TYPE OF DELIVERY

ISSN: 0975-3583, 0976-2833 VOL 13, ISSUE 05, 2022

Out of 500 neonates who were studied, 204 neonates were delivered by NVD and 296 neonates were delivered by LSCS. In most of the cases the LSCS was done electively because of previous deliveries and the other reasons were oligomennorhea, LBW, twinning. Of the 204 neonates delivered by NVD, 26(12.7%) neonates were given REFER. Of 296 neonates, 61(20.6%) neonates were given REFER.

	PASS	REFER	TOTAL
TERM	409	86	495
PRETERM	4	1	5
TOTAL	413	87	500

TABLE: 7 : TERM VS PRETERM

Of the 500 neonates studied, 492 neonates were of term and only 5 neonates were delivered preterm. In one case it was because of twinning, and in one case it was because of abruption-placenta and two other neonates due to pre-eclampsia. Of these 5 neonates only one(20%) baby was given B/L REFER. The baby whose result was given REFER on the third test was a preterm baby delivered by NVD due to abruption placenta.

TYPE OF MARRIAGE	PASS	REFER	TOTAL
CONSANGUINEOUS	60	17	77
NON-CONSANGUINEOUS	353	70	423
TOTAL	413	87	500

TABLE : 8 : TYPE OF MARRIAGE

Of 500 neonates studied, 77 neonates were born out of consanguineous marriage and 423 neonates were born out of non-consanguineous marriage. Of them 17 (24.2%) neonates and 70 (16.5%) neonates were given the result as REFER respectively. Only one baby (1.2%) born of consanguineous marriage was given TEOAE REFER in the third test and subsequently evaluated by ABR.

BIRTH WEIGHT	PASS	REFER	TOTAL
Low Birth Weight	42	7	49

ISSN: 0975-3583, 0976-2833 VOL 13, ISSUE 05, 2022

Normal	368	80	451
TOTAL	410	87	500

TABLE : 9 : BIRTH WEIGHT

In our study, 49 neonates of 500 neonates were having low birth weight (LBW) and of them 7(14.3%) neonates were having result as REFER. And 451 neonates were having birth weight within normal limits (WNL) and of them 80 (17.7%) neonates were having the result as REFER. Only one baby with LBW was screened REFER on the third test.

Heaing Loss	PASS	REFER	TOTAL
PRESENT	5	2	7
ABSENT	408	85	493
TOTAL	413	87	500

TABLE : 10 : FAMILY HISTORY OF HL

In the 500 neonates studied, 7 neonates were having a family history of HOH and of them only two (28.5%) neonates were having results as REFER on the first test. Both the neonates were given results as pass on the second visit. And 85(17.2%) out of 493 neonates without a positive family history were given result as REFER. Of these 85 neonates without positive family history only one baby was having hearing impairment.

Hering loss	PASS	REFER	TOTAL
LOW APGAR	41	15	56
Normal	372	72	444
TOTAL	413	87	500

TABLE: 11: APGAR SCORE

Of the 500 neonates studied, 56 neonates were having low APGAR score and of them 15 neonates were having results as REFER on the first test. And out of 444 neonates with APGAR score within the normal limits, 72 neonates are having results as REFER on the first test. The baby who has a REFER result on the third test was having a low APGAR score of 4/1 and 5/5.

ISSN: 0975-3583, 0976-2833 VOL 13, ISSUE 05, 2022

DISCUSSION

SEX DISTRIBUTION :In our study of 500 neonates screened by OAE, 51(18.2%) out of 279 males and 38 (16.2) out of 183 neonates were given the result as REFER in the first screening. In the second screening only 10 male and 6 female neonates were given REFER. In the third screening only one male baby was given REFER. This result is consistent with an analysis by C W Cremers et al where there is a male predominance in childhood deafness [10].

TYPE OF DELIVERY: Out of 500 neonates studied, 26 (12.7%) of 204 neonates delivered by NVD and 61 (20.6%) of 296 neonates delivered by LSCS were given results as negative. In the third screening only one neonate delivered by NVD was given as REFER. This result is similar to the results of a retrospective study by Xiao et al where the association between the mode of the delivery and failure of neonatal OAE was found to have higher rates of failure in the first test among those born by LSCS [11]. In our study only one neonate delivered by NVD was having hearing impairment.

TERM v/s PRE-TERM:

According to American Speech-Language Hearing Association [ASHA] Hearing loss is one of the most common birth defects for premature neonates.

In our study 5 out of 500 neonates were delivered preterm. Of them 3 neonates (60%) were given REFER in the first visit and only one (20%) baby was B/L REFER in the third test. A study in a Tertiary Care Hospital in India has TEOAE REFER in 88.75% of preterm neonates on the first screening [12] and in our study it was 60%.

TYPE OF MARRIAGE : In our study 77 out of 500 neonates were born out of consanguineous marriage. Of them 17(24.2%) neonates were given TEOAE REFER. And only one neonate (1.3%) was having B/L REFER in the third visit. A study from Iran by Amini et al has shown that the prevalence of hearing impairment in consanguineous marriage was 61.4% [13]. A study by Shrikrishna B. H. and Deepa G. has shown that there is a strong association between family history of deafness and consanguinity of parents and congenital hearing loss[14].

BIRTH WEIGHT In our study, 49 neonates of 500 neonates were having low birth weight (LBW) and of them only one neonate was having the result as REFER in the third test. R Cristobal and J S Oghalai have studied that the prevalence of failed hearing screening is higher in neonates with VLBW than neonates with normal birth weight. In most of the cases it is transient and conductive hearing loss because of middle ear fluid accumulation. The relation of VLBW and sensori-neural hearing impairment in remains unclear [15]. Similarly in our study all neonates born with normal weight had normal hearing, but one baby with LBW had B/L hearing impairment.

ISSN: 0975-3583, 0976-2833 VOL 13, ISSUE 05, 2022

FAMILY HISTORY: Family history and consanguinity are strongly associated with congenital permanent hearing impairment. According to Indian Journal of Otology Jun 2013, a child with family history has six times more chances of having permanent hearing impairment. But in our study 7 out of 500 neonates were having a family history of HOH and of them only two neonates were having TEOAE REFER in the first test. And these two neonates PASSED in the second screening test [16].

APGAR SCORE :Low APGAR score is a risk factor for Non-Genetic Hearing Loss. When the neonates having a score of 0-4 at one min or 0-6 at five minutes, their risk of having hearing loss increases. In our study 56 neonates were having low APGAR score and of them 15 neonates were having results as REFER in the first test. The baby who has a TEOAE REFER on the third test was having a low APGAR score of 4/1 and 5/5.

CONCLUSION:

- In this study of 500 neonates, 87 (17%) neonates were having TEOAE REFER in the first screening, which was decreased to 16(3%) in the second screening and finally only one (0.2%) baby was screened REFER and was subsequently diagnosed as profound hearing loss by ABR.
- In this study of 500 neonates, 279 were males and 221 were females, only one (0.3%) male baby was given REFER on the third test.
- Of the 500 neonates screened, 204 neonates delivered by NVD and 296 neonates delivered by LSCS. Of them only one baby (0.4%) delivered by NVD was screened REFER on the third test.
- Only 5/500 neonates studied, were delivered preterm. Of these 5 neonates only one (20%) baby was given B/L REFER in the third screening.
- In our study 500 neonates, 77 neonates were born out of consanguineous marriage and 423 were of non-consanguineous marriage. Of them only one (1.3%) baby born of consanguineous marriage was TEOAE REFER on the third screening.
- 49 neonates of 500 neonates were having low birth weight and of them only one (2%) baby with birth weight of 1.1kg was having TEOAE REFER on the third test.
- In our study, 7 out of 500 neonates were having a family history of HOH. But all the 7 neonates PASSED the second test.
- 56 of 500 neonates were having low APGAR score and of them only one baby (1.7%)TEOAE REFER on the third test was having a low APGAR score of 4/1 and 5/5.

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ISSN: 0975-3583, 0976-2833 VOL 13, ISSUE 05, 2022

ISSN: 0975-3583, 0976-2833 VOL 13, ISSUE 05, 2022