Original Article

HIGH RISK NEONATES AND PREVALENCE OF HEARING IMPAIRMENT – A STUDY USING 0T0 ACOUSTIC EMISSION

Dr. S.G. Lavand[1], Dr. Kanvikar Rashmi[2], Dr. Shailesh B. Patil[3], Dr. V.Y. Kshirsagar[4]

[1,2,3] Assistant Prof., Department of Pediatrics Krishna Institute of Medical Sciences, Krishna Institute of Medical Sciences Deemed to be University, Karad.
[4] Professor & Head, Department of Pediatrics Krishna Institute of Medical Sciences, Krishna Institute of Medical Sciences Deemed to be University, Karad.
Email: sunillawand102@gmail.com

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Abstract

The prevalence of hearing impairment in India in newborns in various studies is 1 to 6 per 1000 newborns screened. 50% of neonates with hearing impairment have associated high risk factors like birth asphyxia, low birth weight, pre term gestation, TORCH and other intra uterine infections, use of oto toxic drugs in neonatal period, hyperbilirubinemia requiring exchange transfusion, family history of sensory neural hearing impairment, mechanical ventilation > 5 days and sepsis.[1,2] To detect congenital deafness is important. It is equally important at what age it is detected. In our country usual age of detection of hearing impairment is 2 yrs.[3]

Introduction

Detecting hearing impairment before 6 months of age and appropriate treatment provides the best choice maximizing the critical period of hearing and thereby availing the resources to improve hearing and verbal communication skills. On the other hand late detection and treatment, leave such children with poor speech development and school achievement.

Programmes that focus on detecting hearing disabilities at an early age of child help in improving the overall development of the child in cognitive, motor and social domains.[4]

With the development and advances in technology and expertise occurring in neonatology in our country, many high risk new borns are saved but unfortunately they are saved with hearing impairment. This hearing impairment would need detection at earliest possible time to minimize its impact on cognition, language, communication and education.[4]

In developed countries like USA most of the states have started implementing strict UNIVERSAL NEW BORN SCREENING[5] with good adherence. In India although many organizations like IAP[6] have suggested a UNIVERSAL NEW BORN SCREENING it is still a distant dream due to lack of man power and resources.

Objectives

Primary Objective

To determine the incidence of Hearing impairment using oto acoustic emission test among high risk neonates in a tertiary care hospital

Secondary Objective

To confirm hearing impairment detected by OAE with BERA

Review of Literature

In year 1990- Joint Committee on Infant Hearing (JCIH), USA- Position Statement Recommended that high-risk infants be screened prior to their discharge from the hospital and no later than 3 months after their birth.

In September 1990, the Department of Health and Human Services, USA released Healthy People 2000: National Health Promotion and Disease Prevention Objectives, a strategy for improving the health of Americans by the end of the century in which one of the goal was to reduce the average age at which children with significant hearing impairment are identified to no more than 12 months by year 2000.

In year 1993- National Institutes of Health (NIH) Consensus Development Program USA recommended all newborns be screened for hearing impairment before leaving the hospital.

Less than a decade after the first description of the ABR, its application in newborn hearing screening was introduced by Schulman-Galambos and Galambos in year 1979. Indeed, the ABR appeared to be ideally suited for newborn hearing screening. It could be reliably recorded in newborn and even premature infants [Hecox and Galambos, 1974; Schulman Galambos and Galambos, 1975]; the response demonstrated a specific and predictable maturational course as proved by Hecox and Galambos in 1974; Starr et al in 1977; Gorga et al in1987; the response demonstrated an acceptable correlation between ABR threshold and behavioral audiometric results as proved by Kileny and Magathan in 1987; Hyde et al in1990.[10]

Important early investigations demonstrated that 1) OAEs were reliably present in premature and newborn infants [as cited by Bray and Kemp, 1987; Bonfilset al., 1990; Smurzynski et al., 1993], 2) infant OAEs are typically larger in amplitude than adult or even child OAEs [as cited by Prieve et al., 1997] and 3) OAEs in newborns are optimally obtained 48 hours or longer after birth [as cited in Kok et al., 1992; Doyle et al., 1997]. This latter finding probably reflects decreasing fluid and vernix in the newborn's outer and middle ear with increasing age, an important consideration when using OAEs for UNIVERSAL NEW BORN HEARING SCREENING.

In a study conducted by Dr.Jose.O et al in NICU, department of pediatrics, T.D.Govt. Medical College, Alappuzha in 2014titled "Assessment of Hearing Impairment Using Brainstem Evoked Response Audiometry (BERA) In Neonates with Various Otonoxious Risk Factors" 270 newborns with risk factors for hearing impairment were subjected to BERA initially with90 dB and subsequently stimuli at decreasing frequencies i.e. 75, 60, 45 dB were presented to each ear at an intensity of 90dB hearing level. An infant was considered as passed the test if wave V was present at 30 dB in both ears or in one ear at 30 dB and in the other at 45dB. Out of the 270 newborns, BERA was found to be impaired in 48 cases with increased hearing threshold, remaining 222 neonates had normal hearing threshold of 30dB bilaterally and 45dB in one ear and 30 dB in the other ear. Very low birth weight babies with impaired hearing was 25%, hyperbilirubinaemia in exchange range having hearing impairment were 45%, newborns with sepsis and hearing impairment were 32.5% It was concluded by the authors that proportion of newborn with impaired BERA was high in high risk newborn when compared to all neonates put together. Sepsis, very low birth weight and hyper bilirubinaemia in exchange range were found to have significant hearing impairment.[12]

In a study done by Baran Acar et al in 2014 at *Kecioren Training and Research Hospital,* Turkey One thousand babies with high risk factors were included. These babies were screened using TWO STAGED OAE (confirmation

with BERA was not done). The overall referral rate of OAE was 3.5%. Mechanical ventilation, history of familial CHL and familial consanguinity were found to be significantly related to CHL. High risk factors included in above study are birth asphyxia ,low birth weight, pre term gestation ,torch and intra uterine infection ,use of oto toxic drugs in neonate, hyperbilirubinemia requiring exchange transfusion ,family history of sensory neural hearing impairment , mechanical ventilation > 5 days and sepsis

The personal and social impacts of hearing impairment are enormous. People with hearing impairment "often have less desirable jobs and incomes than those without hearing impairment." The National Center for Hearing Assessment and Management, USA estimates that the detection and treatment at birth of hearing impairment saves $400,000 per child in special education costs[8] Other burdens arise because of "emotional stress, breakdowns in family communication, and isolation of hearing impaired persons from peers and educational systems."[18]

Despite these challenges, NEW BORN HEARING SCREENING programs have been implemented in India as part of research studies since the early 1970s. One of the early research attempts to determine the most effective method of screening for hearing impairment on a large scale was the study by Yathiraj, Sameer, and Jayaram in 2002 in rural and urban areas of Mysore district of Karnataka in South India. They screened 1000 babies from the high-risk register (HRR) and they assessed the infants with Behavioral Observation Audiometry (BOA) using calibrated noise-makers and pediatric screeners with Otoacoustic Emissions (OAEs). Based on the preliminary cost analysis, the HRR-based screening conducted by grass-root workers was found to be the most effective.

THE MIDDLE EAR

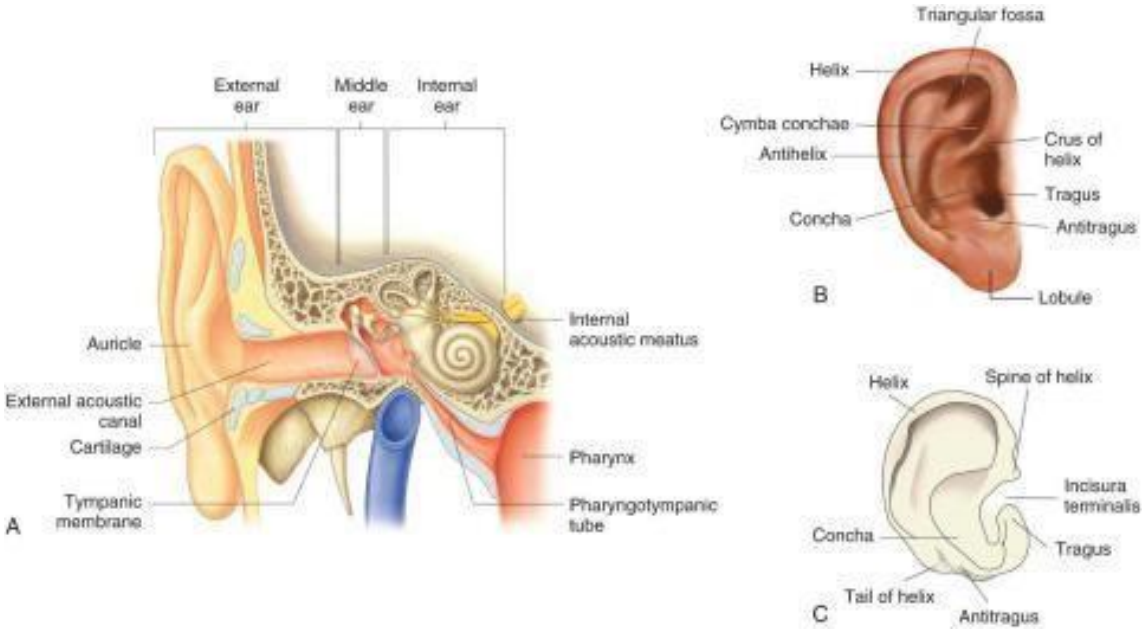
Middle ear can be likened to a six-sided box with a roof, a floor, medial, lateral, anterior and posterior walls which are formed by various structures but most important contents being ossicles as they play a role in conduction of sound

FIGURE 1

A) CORONAL SECTION SHOWING ANATOMY OF EAR

B) EXTERNAL ANATOMY OF EAR

C) DEVELOPMENTAL ANATOMY OF EAR



Physiology Of Hearing:[24]

Any vibrating object causes waves of compression and rarefaction and is capable of producing sound. A sound signal in the environment is collected by the pinna, passes through external auditory canal and strikes the tympanic membrane. Vibrations of the tympanic membrane are transmitted to stapes footplate through a chain of ossicles coupled to the tympanic membrane. Movements of stapes footplate cause pressure changes in the labyrinthine fluids, which move the basilar membrane.

This stimulates the hair cells of the organ of Corti. It is these hair cells which act as transducers and convert the mechanical energy into electrical impulses, which travel along the auditory nerve. Thus, the mechanism of hearing can be broadly divided into:

1. Mechanical conduction of sound (conductive apparatus).
2. Transduction of mechanical energy to electrical impulses (sensory system of cochlea).
3. Conduction of electrical impulses to the brain (neural pathways).

Screening Methods[10]

The principles of auditory screening at birth have proven to be the most effective means to ensure early identification, rehabilitation, and a satisfactory outcome for normal language and overall development.

Previously, the one of the standard hearing test was behavioral assessment (Murphy's Sound localization method). Under this technique, the infant would be subjected to a sound while observer watches a reaction from the baby in response to it (i.e., testing an infant's "startle response"). The method is often limited by the observer's ability to subjectively assess the infant's reaction to the sound at the time of the test. Many other methods are described in the past which include:

Subjective methods- Free field examination:

Objective Methods

Some of the most common methods that have been developed to detect hearing impairment includes:

Conventional audiometry (Adult type)

Can be used for children 5years and older. The child is seated in a sound treated room wearing headphones. The child is asked to raise his hand in response to sounds that are presented at variable intensities at frequency range of 250 - 8000Hz.

Neonates At High Risk When Universal Screening Is Not Available[8]

a) Family history of hereditary childhood sensorineural hearing impairment

b) In utero infection, such as cytomegalovirus, rubella, syphilis, herpes simplex, or toxoplasmosis

c) Craniofacial anomalies, including those with morphologic abnormalities of the pinna, ear canal, ear tags, ear pits, and temporal bone anomalies

d) Birth weight<1500 g (3.3 lb)

e) Hyperbilirubinemia at a serum level requiring exchange transfusion

f) Ototoxic medications, including but not limited to the aminoglycosides, used in multiple courses or in combination with loop diuretics

g) Sepsis

a) Apgar scores of 0-4 at 1 min or 0-6 at 5 min

b) Mechanical ventilation lasting ≥5 days

c) extracorporeal membrane oxygenation

d) Stigmata or other findings associated with a syndrome known to include a sensorineural and/or conductive hearing impairment; white forelock

While high risk newborns do have much higher rates of hearing impairment, they account for only about 50 percent of all newborns with hearing impairment at birth.

A consequence of screening only high risk neonates is that approximately only one in ten newborns is screened, and only about half of all hearing impaired infants are detected at birth.[28]

Materials and Methods

Source of Data:

Neonates having high risk factors either born in department of Gynecology and Obstetrics, KIMSDU, Karad or born outside and are referred to NICU, department of pediatrics, KIMSDU, Karad during the study period of December 2017 to September 2019

STUDY DESIGN:

Prospective study

TYPE OF STUDY:

Prospective, observational, cross sectional study

SAMPLE SIZE:

P=5.9% i.e. normal q= 94.1 %

$N = 4pq/L^2 = 4*5.9*94.1/5^2 = 2221/25 = 87$

A total of 92 neonates with some of the high risk factors were studied

INCLUSION CRITERIA:

- Inborn neonates with some of the high risk factors.

- Out borns with some of the high risk factors referred to NICU, Dept Of Pediatrics KIMS , Karad
- The above neonates were tested only after stabilization and proper assessment
- This study comprised of neonates with following high risk factors
- BIRTH ASPHYXIA
- LOW BIRTH WEIGHT
- PRE TERM GESTATION
- TORCH AND / OR OTHER INTRA UTERINE INFECTION
- USE OF OTO TOXIC DRUGS IN NEONATE
- HYPERBILIRUBINEMIA REQUIRING EXCHANGE TRANSFUSION
- FAMILY HISTORY OF SENSORY NEURAL HEARING impairment
- MECHANICAL VENTILATION > 5 DAYS :
- SEPSIS

EXCLUSION CRITERIA:

- Those who are not willing to give consent.
- Normal healthy neonates without any risk factors
- neonates born with anotia
- Unstable and very sick neonates who cannot be shifted outside nicu for OAE testing

METHOD OF EXAMINATION

- Approval from research and ethics committee was obtained
- Parents or the grandparents or care takers of the neonates with high risk factors were informed about the study and motivated to undergo the screening program.
- An informed consent was taken from the parent/guardian
- Using a pre tested questionnaire risk factors were identified
- Although we recorded various maternal factors like preeclampsia with magnesium sulphate administration , hypothyroidism , placenta previa we could not get any literature which proves association between these maternal factors and hearing loss in neonates so we didn`t mention these in results.
- Neonates with high risk factors underwent hearing assessment after 48 hrs of life and within one month of age using OAE as the initial screening. Before performing OAE first stage screening it was ensured none of the babies had debris in both ears.

- Neonates who failed the initial screening were tested again with OAE at six weeks of life during the first immunization visit. Before performing OAE second stage screening it was ensured none of the babies had ear infection or debris in both ears. This was done in the Department of Otolaryngology KIMS KARAD

- Infants who failed the screening with OAE twice were subjected to BERA evaluation. The BERA evaluation was done on the same day on which 2nd OAE screening was done. All neonates with abnormalities were advised detailed ENT audio logical evaluation and auditory rehabilitation

Analysis

Infants who failed both the screenings with OAE were subjected to BERA evaluation

- This study comprised of 92 neonates with following high risk factors
- BIRTH ASPHYXIA
- LOW BIRTH WEIGHT
- PRE TERM GESTATION
- TORCH AND INTRA UTERINE INFECTION
- USE OF OTO TOXIC DRUGS IN NEONATE
- HYPERBILIRUBINEMIA REQUIRING EXCHANGE TRANSFUSION
- FAMILY HISTORY OF SENSORY NEURAL HEARING impairment
- MECHANICAL VENTILATION > 5 DAYS :
- SEPSIS

- These 92 neonates with some of the above high risk factors were subjected to OAE testing. The age of the study group ranged between 3 days to 28 days. The gestational age of the neonates studied ranged between 28 to 40 weeks. Birth weight varied between 900grams and 3800 grams. 1 neonate was excluded from study after the first screening test due to lost to follow up.

Table 1: Demographic Characteristics Of Study Population

ENROLLED	92
COMPLETED STUDY	91
DROP OUT	01

There were 92 new borns in our study out of whom 1 neonate was lost to follow up. Rest all completed the study.

Table 2: Showing Number of Neonates Who Were Inborn and Number of Neonates Who Were Out Born:

	NUMBER	**PERCENT**
INBORN	85	92.39%

OUT BORN	7	7.61%
TOTAL	92	100%

There were 92 new borns in our study out of these 7 neonates were out born

Table 7 High Risk Factors Noted Among Neonates In Our Study Are As Follows:

(All Preterm Neonates Included In This Study Are Appropriate For Gestational Age)

RISK FACTOR NOTED	NO OF NEONATES
BIRTH ASPHYXIA , OTO TOXI C DRUGS	14
BIRTH ASPHYXIA, PRETERM , LOW BIRTH WEIGHT, OTOTOXIC DRUGS	1
FAMILY H/O SNHL	2
OTOTOXIC DRUGS	2
OTOTOXIC DRUGS, HYPERBILLIRUBINEMIA, SEPSIS	3
OTOTOXIC DRUGS, HYPERBILLIRUBINEMIA	3
OTOTOXIC DRUGS, SEPSIS	18
OTOTOXIC DRUGS,PRE TERM, HYPERBILLIRUBINEMIA	1
OTOTOXIC DRUGS, MECHANICAL VENTILATION > 5 DAYS	1
PRETERM, LOW BIRTH WEIGHT,	35
PRETERM, LOW BIRTH WEIGHT,OTOTOXIC DRUGS, SEPSIS,MECHANICAL VENTILATION >5 DAYS	2
PRETERM, LOW BIRTH WEIGHT, OTOTOXIC DRUGS, SEPSIS	5
PRETERM, LOW BIRTH WEIGHT, OTOTOXIC DRUGS	4
TORCH	1

- Out of these 5 neonates, 4 neonates underwent **SECOND STAGE OAE SCREENING** as 1 was lost to follow up and the results of **SECOND STAGE OAE SCREENING** of these 4 babies showed 2 had failed and 2 had passed

- out of the 5 neonates who failed in **FIRST STAGE OAE SCREENING** 4 neonates were found to have hearing impairment in both ears and 1 neonate was found to have hearing impairment in one ear

- 1 neonate who had U/L hearing impairment in **FIRST STAGE OAE SCREENING** had passed **SECOND**

STAGE OAE SCREENING

- Out of 4 neonates with b/l hearing impairment in **FIRST STAGE OAE SCREENING**, 1 was lost to follow up and 3 were subjected to **SECOND STAGE OAE SCREENING** . 2 out of 3 neonates were detected to have b/l hearing impairment in **SECOND STAGE OAE SCREENING** also

- These 2 neonates were further tested by BERA which showed one neonate had mild hearing impairment in both ears and the other neonate had normal BERA.

- These babies were twins and also had other risk factors in form of administration of ototoxic drugs, birth weight less than 1 kg and were provided mechanical ventilation for more than 5 days in view of RDS. 2 babies who failed in 2 nd stage OAE were subjected to BERA and one baby had mild hearing impairment and another baby had normal BERA.

- Out of these 5 neonates, 4 neonates underwent **SECOND STAGE OAE SCREENING** as 1 was lost to follow up and in the **SECOND STAGE OAE SCREENING** of these 4 babies 2 failed and 2 passed

- out of the 5 neonates who failed in **FIRST STAGE OAE SCREENING ,**4 neonates were found to have hearing impairment in both ears and 1 neonate was found to have hearing impairment in one ear

- 1 neonate who had U/L hearing impairment in **FIRST STAGE OAE SCREENING** had passed **SECOND**

STAGE OAE SCREENING

- Out of 4 neonates with b/l hearing impairment in **FIRST STAGE OAE SCREENING**, 1 was lost to follow up and 3 were subjected to **SECOND STAGE OAE SCREENING.** 2 out of 3 neonates were detected to have b/l hearing impairment in **SECOND STAGE OAE SCREENING** also

- These 2 neonates were further tested by BERA which showed one neonate had mild hearing impairment and the other neonate had normal BERA.

- These babies were twins and also had other risk factors in form of administration of ototoxic drugs, birth weight less than 1 kg and were provided mechanical ventilation for more than 5 days in view of RDS. 2 babies who failed in 2 nd stage OAE were subjected to BERA and one baby had mild hearing impairment and another baby had normal BERA

Other risk factors noted among NEONATES WHO WERE ADMINISTERED **OTOTOXIC DRUGS** are as follows

LBW	12
Preterm	13
Mechanical Ventilation	3
Sepsis	28
Hyper bilirubinemia	7
Severe Birth Asphyxia	15

54 neonates who received ototoxic drugs had other risk factors 12 were LBW, 13 were preterm, 3 received mechanical ventilation, 28 had sepsis 7 had hyperbilirubinemia, 15 had severe birth asphyxia

Characteristics Of Neonates Who Failed Bera:

	Degree of hearing impairment	Other risk factors Associated
Baby 1	Mild To Moderate Hearing Impairment	Birth Asphyxia, Ototoxic drugs, neonatal seizures
Baby 2	Mild Hearing Impairment	preterm, birth weight <1kg, ototoxic drugs, sepsis, mechanical ventilation> 5 days
Baby 3	Profound Hearing Impairment	ototoxic drugs, hyperbillirubinemia, sepsis, neonatal seizures with culture positive sepsis

Table 21: Showing Data Regarding Characteristics Of Neonates Who Failed In Second Stage Oae Screening

Risk Factors	**Number**	**Percentage**
Preterm	2	40%
Fetal distress (as documented in obstretician notes)	1	20%
Ototoxic drugs	5	100%
Hyperbilirubinemia	1	20%
Birth Asphyxia	1	20%
Sepsis	3	60%
Mechanical Ventilation	2	40%

Table 22: Showing Comparison Between OAE 1st Stage And OAE 2nd Stage Results In Neonates Who Had Failed OAE 1st Stage

S.NO	OAE 1^{ST} stage	OAE 2^{ND} stage
1	Fail	Pass
2	Fail	Fail
3	Fail	Lost To F/Up
4	Fail (Rt Ear) Pass (Lt Ear)	Pass (B/L Ears)
5	Fail (Rt Ear) Pass (Lt Ear)	Pass(B/L Ears)
6	pass (Rt Ear) Fail (Lt Ear)	pass (Rt Ear) fail (Lt Ear)
7	Fail	Fail
8	Fail	Fail
9	Fail	Fail

In our study we had 9 neonates who had failed in 1 st STAGE OAE SCREENING, out of these one was lost to follow up, eight had undergone 2ND STAGE OAE SCREENING

Comparison between OAE 2^{nd} stage and BERA results in neonates who had failed OAE 2nd stage

Table 23 Showing Comparison Between OAE 2nd Stage And BERA Results In Neonates Who Had Failed OAE 2nd Stage

Neonates	OAE 2nd Stage	BERA
1	Fail	Mild To Moderate Hearing Impairment
2	Lt Ear (Fail) Rt Ear (Pass)	Pass
3	Fail	Mild Hearing Impairment
4	Fail	Pass
5	Fail	Profound Hearing Impairment

2 neonates who had been diagnosed as persistent OAE failure on OAE 2nd stage were found to have normal BERA

5 neonates underwent BERA and their results were as follows:

	Frequency	Percent
Mild Hearing Impairment in both ears	1	1.1
Mild To Moderate Hearing Impairment in both ears	1	1.1
Profound Hearing Impairment in both ears	1	1.1
Pass in both ears	2	2.2

Comparison between OAE 1st stage and BERA results in neonates who had failed OAE 1st stage

Table 24: Showing Comparison between OAE 1st Stage And BERA Results In Neonates Who Had Failed OAE 1st Stage

OAE 1 ST STAGE SCREENING	**BERA**
Fail	Neonate Didn`t undergo BERA as HE/SHE passed OAE 2nd STAGE OAE SCREENING
Fail	Mild To Moderate Hearing Impairment in both ears
Fail	Neonate Didn`t undergo BERA as HE/SHE passed OAE 2nd STAGE OAE SCREENING
Fail (Rt Ear) Pass (Lt Ear)	Neonate Didn`t undergo t BERA as HE/SHE passed OAE 2nd STAGE OAE SCREENING
Fail (Rt Ear) Pass (Lt Ear)	Neonate Didn`t undergo BERA as HE/SHE

	passed OAE 2nd STAGE OAE SCREENING
pass (Rt Ear) Fail (Lt Ear)	pass
Fail	Mild Hearing Impairment in both ears
Fail	Pass
Fail	Profound Hearing Impairment in both ears

Amongst all 92 neonates, there were 5neonates (4.35%) with persistent OAE failure (2nd stage OAE failure) and 3 neonates (3.26%) HAD ABNORMAL BERA.

Characteristics Of Babies Who Failed In BERA

Table 25: Showing Data Regarding Characteristics Of Babies Who Failed In BERA

	Degree of hearing impairment	Other Associated risk factors	
Baby 1	Mild To Moderate Hearing Impairment	Birth Asphyxia, Ototoxic drugs, neonatal seizures	Seizures due to birth asphyxia , gentamycin was administered for 5 days at the dose of 4.5 mg /kg as a single dose per day infused over 10 min
Baby 2	Mild Hearing Impairment	preterm, birth weight <1kg, ototoxic drugs, sepsis , mechanical ventilation> 5 days	culture positive sepsis organism isolated was klebsiella, amikacin was administered for 14 days at the dose of 4.5 mg /kg as a single dose per day infused over , ventilation in view of RDS
Baby 3	Profound Hearing Impairment	ototoxic drugs, hyperbillirubinemia, sepsis, neonatal seizures with culture positive sepsis	Seizures , hyper billirubinemia , culture positive sepsis organism isolated was klebsiella , amikacin was administered for 14 days at the dose of 15 mg /kg as a two divided doses per day infused over 10 min

Comparison Between Risk Factors Of Babies Found To Have U/L Hearing Impairment And B/L Hearing Impairment In First Stage OAE:

Table 26: Showing Comparison between Risk Factors Of Babies Found To Have U/L Hearing Impairment And B/L Hearing Impairment In First Stage OAE

RISK FACTORS NOTED AMONG BABIES WITH U/L HEARING LOSS	RISK FACTORS NOTED AMONG BABIES WITH B/L HEARING LOSS
1:oto toxic drugs	1 :Preterm, Birth Weight >1 kg, Ototoxic

	drugs, clinical sepsis
2: preterm, birth weight >1kg, ante natal risk factor 3 ototoxic drugs, sepsis	2 :Birth Asphyxia, Ototoxic drugs, Preterm, Birth Weight >1 kg, Ototoxic drugs, clinical sepsis 3 :preterm, birth weight <1kg, ototoxic drugs, cuture positive sepsis, Mechanical ventilation >5 days 4 :preterm, birth weight <1kg, ototoxic drugs, culture positive sepsis, Mechanical ventilation >5 days 5 :ototoxic drugs, hyperbillirubinemia, culture positive sepsis, mechanical ventilation >5 days 6 : Preterm, Birth Weight >1 kg, Ototoxic drugs, clinical sepsis

It is observed that babies with u/l hearing loss in first stage OAE had less number of risk factors (2 or less) when compared to babies with b/l hearing loss (3 or more)

Neonates Who Had Birth Asphyxia As A Risk Factor

- In our study there were 15 neonates with severe birth asphyxia as classified by WHO. Out of these 15 neonates, 14 neonates passed and 1 neonate failed in the **FIRST STAGE OAE SCREENING**. This neonate was found to have hearing impairment in both ears in 1 st stage OAE
- This neonate was detected to have hearing impairment in both ears on SECOND STAGE OAE SCREENING also.
- This neonate was further tested by BERA which showed mild to moderate hearing impairment in both ears.
- This neonate also had other risk factors in form of administration of ototoxic drugs and neonatal convulsion on day 1

Neonates Who Were Administered Ototoxic Drugs

- In our study there were 54 neonates who were administered oto toxic drugs. Out of these 54 neonates , 46 neonates passed and 8 neonates failed in **FIRST STAGE OAE SCREENING**
- Out of these 8 neonates, 7 neonates underwent **SECOND STAGE OAE SCREENING** as 1 was lost to follow up and the results of **SECOND STAGE OAE SCREENING** of these 7 babies showed 5 had failed and 2 had passed
- out of the 8 neonates who failed in first stage OAE screening **,** 6 neonates were found to have hearing impairment in both ears and 2 neonates was found to have hearing impairment in one ear
- 2 neonates had U/L hearing impairment in FIRST STAGE OAE SCREENING out of these 2 , one had passed SECOND STAGE OAE SCREENING and other one had failed in SECOND STAGE OAE SCREENING but had normal BERA on subsequent testing

- Out of 6 neonates with b/l hearing impairment in **FIRST STAGE OAE SCREENING**, 1 was lost to follow up and 5 were subjected to **SECOND STAGE OAE SCREENING.** 4 out of 5 neonates were detected to have b/l hearing impairment in **SECOND STAGE OAE SCREENING** also

- These 4 neonates were further tested by BERA In which two neonates had mild to moderate hearing impairment in both ears and another neonate had profound hearing impairment in both ears and 1 neonate had normal BERA.

- Most babies (45/54) received gentamycin for 1 to 5 days. Only 9 babies received amikacin for more than 5 days. None of these neonates had hepatic or renal impairment as suggested by absence of clinical signs suggestive of hepatic or renal failure

- 54 neonates who received ototoxic drugs had other risk factors 12 were LBW, 13 were preterm, 3 received mechanical ventilation, 28 had sepsis 7 had hyperbilirubinemia, 15 had severe birth asphyxia

Summary and Conclusions

- In our study there were 92 high risk neonates who were screened for hearing impairment out of which 5 neonates had persistent OAE failure (5.4%) and it is similar to study by Prasad et al1 who identified prevalence of persistent OAE failure among high risk neonates as 5.9%. However Prasad et al1 have not further tested the neonates with BERA

- When BERA test confirming hearing impairment is taken into consideration the prevalence rate in our study is 3.2% which is similar to other studies done by Dora Jerina Jose et al4 and Kruthika Thangavelu et al38 (2.5 - 10%).

- In our study of high risk neonates for hearing impairment 5 neonates had persistent OAE failure and 3 had abnormal BERA. All the neonates had multiple risk factors .

- In our study all neonates with single risk factor had passed OAE first screening except one neonate who had U/L hearing impairment. This neonate later passed second stage OAE.

- This implies that neonates who are having more than one risk factors are at more risk for hearing impairment than those with single risk factor. This is similar to findings of study done by O Jose et al.12

Limitations

- Our study focused on high risk infants .High risk infants constitute only 50% of all neonates with hearing impairment. The other 50% who do not have some of the high risk factors would go undetected at birth by this approach as neonates who do not have any of the high risk factors were not included in this study .

- All high risk neonates require hearing assessment every 6 months upto 3 years of age. This follow up was not included in our study

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