Original Article

PREVALENCE OF HEARING IMPAIRMENT AMONG HIGH RISK NEONATES

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Abstract

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]

Introduction

To guarantees that the nature of their courses and the managerial systems, Higher Education Institutions (HEIs) from around world take on quality administration strategies for the advancement projects (IPs [1]. [3]. Also, [4] to say that out in the open Free HEIs have progressively presented quality administration framework over beyond

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.

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.[7,8]

If in a developed country such is economic burden then in developing countries like India it means not only value in money but also value of potentials lost in terms of development of cognition, language, communication and education.

Hence screening for hearing impairment among high risk neonates would be a cost effective strategy as well.

We performed this study to evaluate the possible burden of hearing disability in high risk neonates at a tertiary care hospital. We screened newborns with some high risk factors using Oto Acoustic Emissions (OAE) twice. Those who would test positive for hearing impairment in both OAE screenings, we confirmed and determined the degree of deafness in the neonates by BERA test

Aims and Objectives

Aim:

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

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

History:

The earliest written record of hearing loss is believed to date from 1550 BC in ancient Egypt, the ebers papyrus offers a remedy for "ear that hears badly" – injection of olive oil, red lead, ant eggs, bat wings and goat urine into the ears:- whether such ears that hear badly were due to wax or disease is not known. The ancient Egyptians were instructed to be kind towards disabled individuals including deaf.

In Greece around 350 BC writing indicate opinion that ability to reason was intrinsically linked with ability to speak and hence individuals who were deaf from the first (i.e. before they learned to speak or from birth) would inevitably be unintelligent

Writings of Plato also provide us first reference to sign language in "Cratylus"– "if we had no voice or tongue and wished to make things clear to one another, should we not try, as dumb (mute) people, actually do, to make signs without hands and heads and person generally"

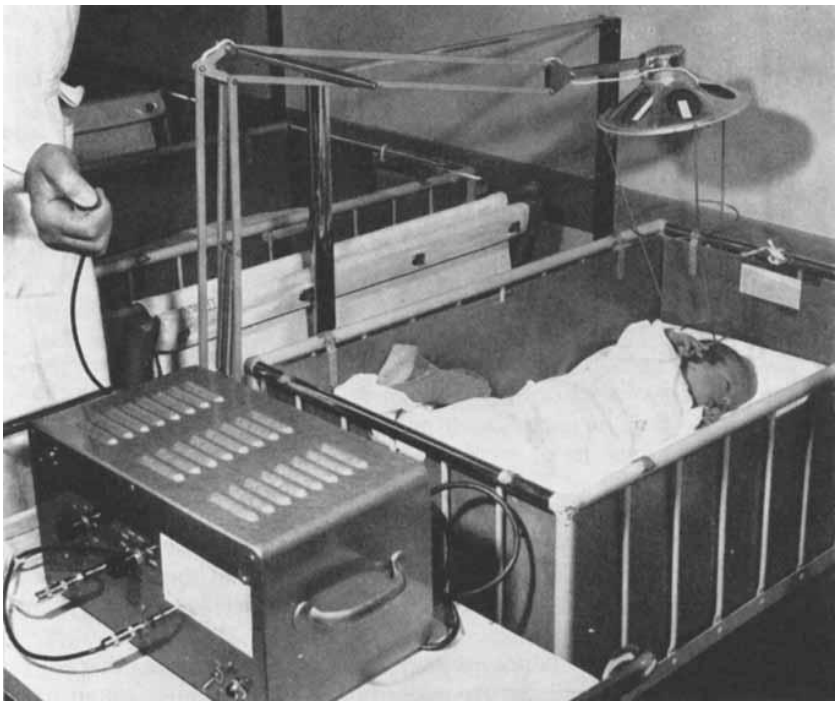
In early 10 th century, monks in Burgundy created a series of hand signals to communicate without speaking in order to keep their strict vows of silence this was known as Cluniac sign language .This was the inspiration for the manual alphabet (finger spelling) developed by Spanish benedictine Pedro Ponce de leon at the first deaf school in mid -1500 `s

Historical Perspectives And Review Of Literature Regarding Universal New Born Hearing Program9,10

Initially as in early part of 20th century it was thought PURE-TONE AUDIOMETRIC tests of children's hearing are difficult to perform until the child has attained an age of 6 to 7 years. In 1955, however, Barr was able to show that both with play-audiometry and with psycho-galvanic skin resistance audiometry (PGSR) which is based upon conditioned reflex, it was possible with a high degree of reliability to test the hearing in the majority of children aged 2 years, and in few children with PGSR close to the age of I year., however, it was not possible to carry out these auditory tests on children during their first year of life It was known that new-born infants respond in different ways to strong auditory stimuli. e.g. Contraction of the pupils followed by pupillary dilatation and nystagmus, changes in the respiration, pulse and EEG and so- called auro-palpebral reflex. The most easily observable response to a given auditory stimulus is the auro-palpebral or cochleo-palpebral reflex, i.e. a rapid and distinctive closing of the eyelids when they are open and screwing of them when they are closed. This screwing is brought about by contraction of muscle orbicularis oculi.

This reaction was described as early as 1882 by W. Preyer in his work “Die Seeledes Kindrs.”. Based on this reactions of infant in 1956, Erik Wedenberg used tuning forks, percussion sounds, pitch pipes, and cowbells to screen the hearing newborn infants. The author also noted, "until recently it has not been considered possible to carry out reliable auditory tests until the child has attained the age of 6–7 years."

FIGURE 1: INFANT BEING TESTED FOR BEHAVIOURAL CHANGES AFTER GIVING AN AUDITORY STIMULUS – AUDITORY RESPONSE CRADLE



In 1963, Marion Downs, affectionately referred to as the "mother of pediatric audiology", pioneered the first hospital based infant hearing screening program in Denver, Colorado using Behavioral Observation Audiometry (BOA). Several independent observers recorded eye-blink and/or startle responses after presentation of narrow-band (90 dB) stimulation. In her 1964 publication, the observers identified suspected hearing impairments, although disagreements were significant for 26% of the infants. In 1969, Marion led efforts for the formation of the Joint Committee on Infant Hearing (JCIH) to provide multi-disciplinary leadership and guidance in all areas of newborn and infant hearing issues.

In 2006, the HHS Secretary's Advisory Committee on Heritable Disorders in Newborns and Children (SACHDNC) IN USA included newborn hearing as one of the conditions to be included in their Recommended Uniform Screening Panel (RUSP).

With growing research evidence, in 2007 United States Preventive Services Task Force (USPSTF) recommended screening of hearing impairment in all newborn infants.” By 2010, 43 states enacted legislative statutes or written regulatory language related to universal newborn hearing screening.

In 2018, Health Level 7 (HL7) approved the Early Hearing Detection and Intervention (EHDI) Implementation Guide as a Normative Standard to be followed by all the states in USA.

In 1990, the JCIH recommended ABR as the screening procedure for newborns and very young infants [cited in Hayes and Northern, 1996]. Use of ABR for UNIVERSAL NEW BORN HEARING SCREENING was initially limited by cost factors. Specifically, in the early years of clinical application, audiologists, neurophysiologists, or other similarly trained professionals conducted ABR testing and performed on-line response identification. A typical test session, including subject preparation for electrode attachment and test interpretation, could extend beyond one- hour. Even screening applications utilizing a limited number of stimulus intensities could take 30

minutes or more. Clearly, performing UNIVERSAL NEW BORN HEARING SCREENING with a test technique requiring this amount of professional time was cost prohibitive. Techniques permitting use of nonprofessional personnel, less complex instrumentation, and shorter test times were eagerly sought.[10]

Gorga et al. [2001] compared cost of screening using A-ABR alone, OAEs alone, and a two-stage OAE/ABR protocol. In their analysis, they accounted for the effects of the number of babies screened on the cost of screening. Not unexpectedly, as number of babies screened increased, cost per baby screened decreased for all three screening protocols. Gorga and his colleagues estimated that hospitals with as few as 400 births per year could achieve UNIVERSAL NEW BORN HEARING SCREENING costs of less than $30 per infant screened utilizing any one of the screening methodologies.

As per Indian studies done by Dr.Jaideep Bhatt et al, BERA is an efficient screening method that can be used in universal newborn screening.[7]

Review of Literature From India:

In a study conducted by Prasad Kumar et al[1] in 2016 at JIPMER, PONDICHERRY titled "Screening for Hearing Impairment among High Risk Neonates– Experience from A Tertiary Care Center "a total of 1537 high risk neonates were screened for hearing impairment using OAE. In this study authors found incidence of hearing impairment among high risk neonates as 5.9 % Which was much higher than incidence when all neonates were screened. Various studies in India have shown 0.5 to 1.0 % incidence of hearing loss among neonates when all universal new born screening was done. Extreme low birth weight, extreme prematurity, mechanical ventilation and perinatal asphyxia were the predominant risk factors associated with hearing impairment among these high risk neonates and the authors have concluded that OAE can be used as a method of screening for hearing among high risk neonates.[8]

In a study conducted by Nagapoonirma p et al[13] in 2004-2006 in ST JOHN`S HOSPITAL, BANGALORE. A total of 1769 neonates (1490 NORMAL AND279 AT RISK NEONATES) were screened for hearing impairment using Two staged oae out of them 10 failed and 1759 neonates passed OAE. All 10 neonates who had failed in 2nd stage OAE had abnormal BERA. 279 at risk infants were screened and 3 were detected to have hearing impairment which is an incidence of approximately 10.75 per 1000 screened. Of the 1490 not at risk infants screened 7 had hearing impairment that is 4.70 per 1000 screened. So it is evident that hearing impairment tends to be more common in neonates with high risk factors.[13] 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

Need for Hearing Assessment In Newborn

The first 3 years of life, when the brain is developing and maturing, is the most intensive period for acquiring speech and language skills. These skills develop best in a environment that is rich with sounds, sights, and consistent exposure to the speech and language of others. This appears to be crucial periods for speech and language development in infants and young children when the brain is best able to absorb language. If these crucial periods are allowed to pass without exposure to such environment full of language, it will be a hinderance to learn. Moderate to profound hearing impairment in early infancy has been shown to be associated with impaired language development, as auditory stimuli during this period are critical to development of speech and language skills.[17]

This in turn leads to lower reading abilities, poor academic achievement and fewer career opportunities (Task Force on newborn and infant hearing)[18].

One more land mark in implementation of new born hearing screening programme in India is NEW BORN HEARING SCREENING PROGRAM using oto acoustic emission which was started at Kochi 2000 by Abraham K Paul and now Kochi is the first city in India to have a centralised hearing screening program

Numerous studies[1,4,6,12] till date have demonstrated that it will be of enormous benefit to a child with congenital hearing impairment if early identification and intervention is done. Despite of such emphasis on detection of hearing loss in neonates, NEW BORN HEARING SCREENING is in nascent stage and is not being advocated even in many tertiary care centers across India

Anatomy and Physiology of the Auditory system :24

The ear is divided into:

1. External ear
2. Middle ear
3. Internal ear or the labyrinth

THE EXTERNAL EAR

The external ear consists of the (a) auricle or pinna, (b) external acoustic canal and (c) tympanic membrane

A. AURICLE OR PINNA

The entire pinna except its lobule and the outer part of external acoustic canal are made up of a framework of a single piece of yellow elastic cartilage covered with skin.

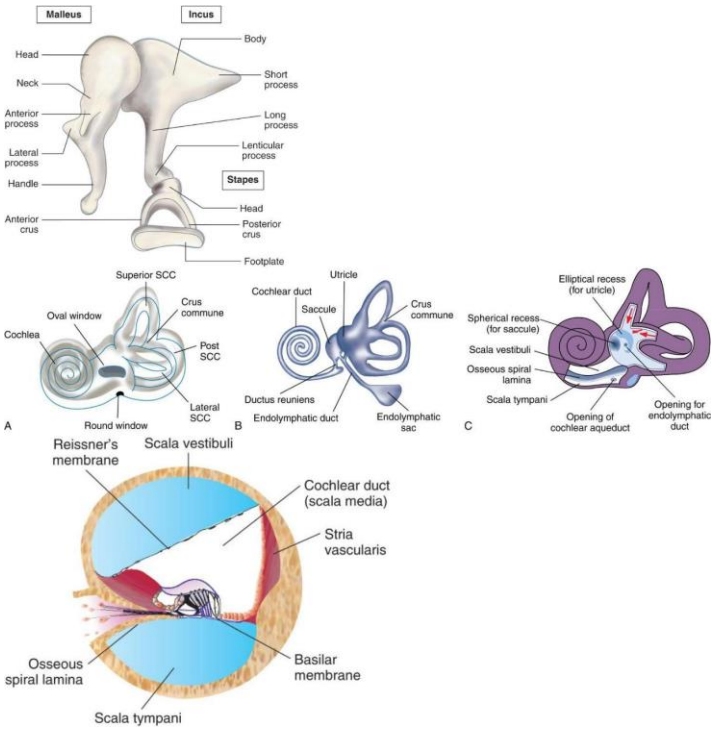


FIGURE 2

A) ANATOMY OF BONY LABYRINTH

B) ANATOMY OF MEMBRANOUS LABYRINTH

C) CROSS SECTIONAL VIEW OF LABYRINTH

Mechanism Of Hearing24

A sound signal in the environment is collected by the pinna, passes through the external auditory canal and strikes the tympanic membrane.

Vibrations of the tympanic membrane are transmitted to the stapes footplate through a chain of ossicles coupled to the tympanic membrane. Movements of the stapes footplate cause pressure changes in the labyrinthine fluids which move the basilar membrane. This stimulates the hair cells of organ of corti. It is the hair cells which convert mechanical energy into electrical impulse

Hair cells are innervated by dendrites of bipolar cells of spiral ganglion. Axons of these bipolar cells form the cochlear division of 8th cranial nerve which enters the brain at ponto medullary junction.

On entering the brainstem, fibres bifurcate. The upper division ends in **DORSAL COCHLEAR NUCLEUS (DCN) BILATERALLY**. The lower division ends in **VENTRAL COCHLEAR NUCLEUS(VCN).**

II order neurons from **DORSAL COCHLEAR NUCLEUS** ascend in **LATERAL LEMNISCUS** while II order neurons from **VENTRAL COCHLEAR NUCLEUS** relay in **SUPERIOR OLIVARY NUCLEUS**. From the superior olivary nucleus, III order neurons ascend in the lateral lemniscus

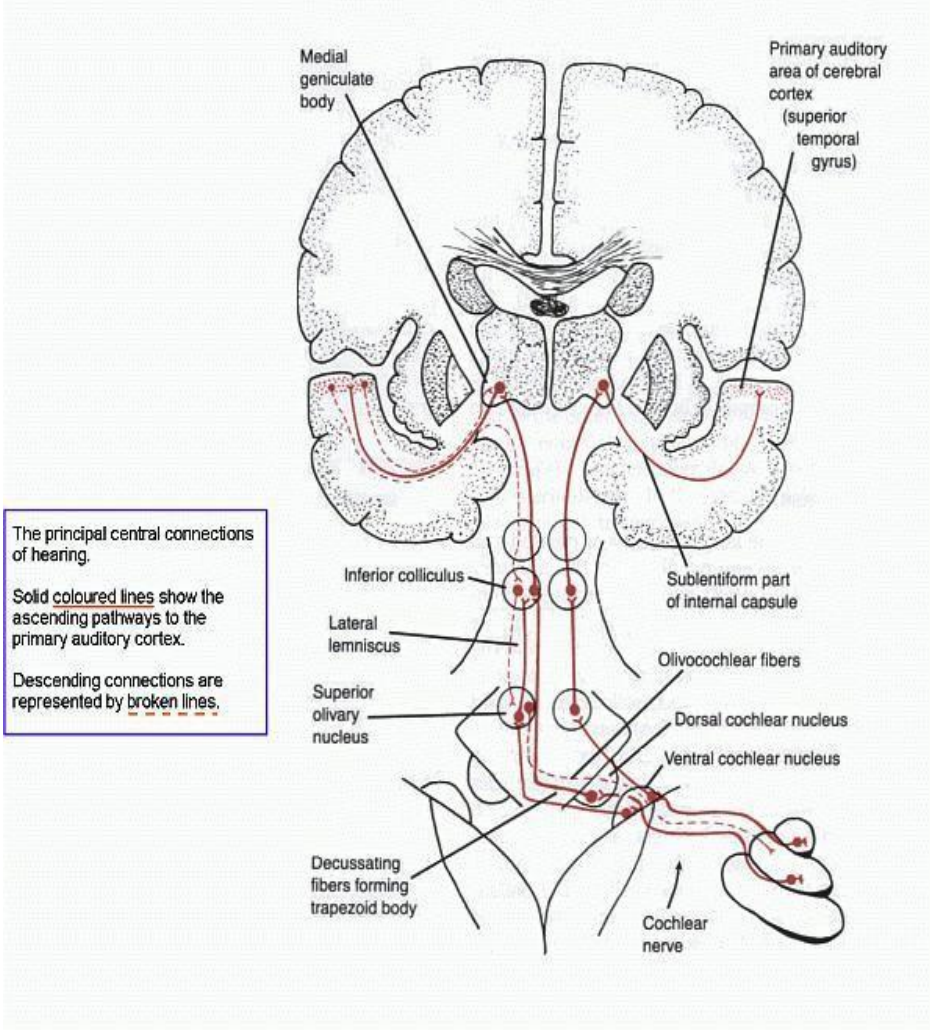
Lateral lemniscal fibres terminate in **INFERIOR COLLICULUS**. Intercollicular commissural fibers transmit impulses between the colliculi. From the inferior colliculus, impulses are projected into

Ipsilateral Medial Geniculate Body

From the medial geniculate body, impulses are projected to **AREA 41** or **HESCHL"S GYRUS** (Superior Temporal Gyrus) known as **Primary Auditory Cortex**. Some impulses are also projected to AREA 42, the Auditory Association Area.

AUDITORY PATHWAY 24

FIGURE 3



HEARING LOSS 8,25

Hearing loss falls into **four** major categories:

Sensory neural impairment is the result of abnormal development or damage to the Cochlear hair cells or auditory nerve.

Conductive impairment is the result of interference in the transmission of sound from the external auditory canal to the inner ear. The most common cause for conductive hearing impairment is fluid in the middle ear or middle ear effusion. **Less common are anatomic causes such as microtia, canal stenosis, or stapes fixation that often occur in infants with craniofacial malformation.**

Auditory dyssynchrony or auditory neuropathy – Here the cochlea receives sounds normally; however the transfer of signal from the cochlea to the auditory nerve is abnormal. The etiology of this condition is not understood; however, babies who have severe hyperbilirubinemia, prematurity, hypoxia and immune disorders are at increased risk.

Central hearing loss – In this type of hearing impairment there is an intact auditory canal and inner ear and normal neurosensory pathways but abnormal auditory processing at higher levels of the central nervous system.

ABNORMAL RESULTS IN OTOACOUSTIC EMISSIONS TESTING[28]:

Nonpathologic problems that can cause absence of OAEs

- Poor probe tip placement or poor seal: Most current equipment alerts clinicians to these problems.

- Standing waves: During conventional audiometric testing, there are opposite surfaces in the ear canal, the transducer (conventional earphone, insert earphone, otoacoustic emissions probe, etc.) at one end, and the eardrum at the other, a distance of approximately one inch in an adult. A standing wave in this situation is an apparently stationary waveform caused by reflections between these opposite surfaces. At certain points along the standing wave, the direct and reflected waves can partially cancel resulting in a lower level of the test signal, or even completely cancel resulting in no signal at all. Most current equipment alerts clinicians to standing waves.

- Amniotic fluid occluding the canal or blocking a probe port.

- Debris and foreign objects in the outer ear canal.

- Vernix caseosa in neonates: This is common immediately after birth.

- Uncooperative neonate: Usually, recordings simply are not obtained.

Pathologic problems that can cause absence of OAEs

Automated Auditory Brainstem Response (Bera)

Auditory brainstem response (ABR) audiometry is a neurologic test of auditory brainstem function in response to auditory (click) stimuli. First described by Jewett and Williston in 1971, The BERA provides complete screening of auditory pathway upto the brainstem (including middle ear, inner ear and 8th N). When BERA is performed electrodes are placed on the forehead, nape of neck and shoulder (ground). With BERA screening, a click stimulus at one loudness level is provided to each of the child's ears. The child's response is compared to a template of children with normal hearing. If the responses match, the child passes the screening; if they do not match then child has hearing impairment. Screening by BERA can be completed after birth and a stringent statistical pass criterion is employed that eliminates bias from interpretation.[29]

Responses from a large numbers of stimulus presentations are averaged and the automated screener uses a response algorithm to produce a PASS or REFER result. The pass level is set at about 35 decibels Babies are sedated to minimize electrical interference caused by muscle activity during testing. In a normal person 7 waves are produced in the first 10 milliseconds. Waves I, III and V can be obtained consistently in all age groups. Waves II and IV appear less consistently.

The latency of each wave (time of onset of wave peak after stimulus onset) increases and the amplitude decreases with reduction in stimulus intensity or loudness.[24]

The exact anatomic site of origin of waves is still disputed but they are thought to arise from following parts.

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

Results

This is an observational study. Objective of the study is to determine the prevalence of hearing impairment among neonates with high risk factors using oto acoustic emission test followed by BERA when indicated either inborn or out born Neonates with high risk factors were subjected to hearing assessment after 48 hrs of life but within one month of age using OAE as the first level of screening.

Neonates who failed the initial screening were subjected to repeat testing with OAE at six weeks of life during the first immunization visit.

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 outborn

Table 3: Perinatal Significant History Of Risk Factor

	NO.	PERCENTAGE
BIRTH ASPHYXIA	7	7.61%
BIRTH ASPHYXIA & MAS	4	4.35%
FETAL DISTRESS (AS DOCUMENTED IN OBSTRETICIAN NOTES) & BIRTH ASPHYXIA	3	3.26%
PROM > 48HR	3	3.26%
FETAL DISTRESS (AS DOCUMENTED IN OBSTRETICIAN NOTES) & MAS	1	1.09%
FETAL DISTRESS (AS DOCUMENTED IN OBSTRETICIAN NOTES) , BIRTH ASPHYXIA & MAS	1	1.09%
NO RISK FACTORS OF ABOVE CATEGORY	73	79.35%
TOTAL	92	100%

Table 4 Showing Distribution Of Very Low Birth Weight Neonates According To Birth Weight:

BIRTH WEIGHT	NUMBER OF NEONATES
<1000 GRAMS	2
1000- 1500 GRAMS	45

In our study there were 47 neonates with very low birth weight. Out of these 47 neonates, only 2 were under 1000 grams and rest all were having birth weight between 1000 to 1500 grams

Other risk factors noted among NEONATES WHO HAD **VERY LOW BIRTH WEIGHT** AS A RISK FACTOR are as follows

Ototoxic drugs	12
Preterm	47
Mechanical Ventilation	2
Sepsis	7
Birth asphyxia	1

Out of 47 LBW neonates other risk factors noted were Ototoxic drugs were administered in 12 ,47 were Preterm ,2 received Mechanical Ventilation , 7 had Sepsis, 1 had birth asphyxia

Table 5: Showing Data Regarding Neonates Who Were Pre Term

	First stage screening by OAE	**Second stage screening by OAE**	**Screening by BERA**
No of babies screened	48	04/05 < As one baby was lost to follow up>	02
No of babies who passed in the screening	43	02	01
No of babies with impairment in both ears	04	02	01
No of babies with impairment in one ear	01	00	00
Total No of babies who failed and eligible to undergo next stage hearing assesment	05	02	

- In our study there were 48 neonates who were PRETERM. Out of these 48 neonates, 43 neonates passed and 5 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.

Table 6: Showing Distribution Of Neonates Who Received Oto Toxic Drugs According To Drug Received And Number Of Days Received:

DRUGS RECIEVED FOR DAYS	NO OF BABIES	DRUG RECIEVED
1-5 DAYS	45	GENTAMYCIN
6-10 DAYS	5	AMIKACIN
11-14 DAYS	4	AMIKACIN

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. Drugs were administered to neonates as per following dose.

AMIKACIN	15 mg /kg as two divided doses per day infused over 10 min
GENTAMYCIN	4.5 mg /kg as a single dose per day infused over 10 min

Majority of the neonates had multiple risk factors, while few neonates had single risk factor. All neonates with single risk factor were passed on OAE stage 1, except one neonate who showed unilateral hearing impairment on OAE stage 1 but subsequently this neonate passed the OAE stage 2. All the 5 neonates who failed OAE 2nd Stage were having multiple risk factors.

- Total neonates screened initially by OAE : 92
- Total neonates who passed first screening by OAE : 83/92(90.2%)
- Total neonates who failed first screening by OAE : 09/92(9.8%)
- Of 9 neonates who failed initial screening One neonate was lost to follow up
- Total neonates subjected to second screening by OAE : 08/09
- Total neonates who passed second screening by OAE : 03/08

- Total neonates who failed second screening by OAE : 05/08 these had hearing impairment as diagnosed on OAE these 05 neonates were further tested with BERA
- Total number of neonates for whom BERA is done as they had persistent OAE failure: 05/92(5.4%)
- BY BERA testing 3 neonates out of 92 neonates were confirmed to have hearing impairment
- • The prevalence rate of hearing impairment in neonates with high risk factors when screened using OAE 2 STAGE and BERA is 3.2% which is similar to other studies done (2.5 -10%).
- Of these 15 neonates had other risk factors :-use of oto toxic drugs in all , one was preterm and low birth weight

In study by Nagapoornima et al[13] who screened 51 neonates with birth asphyxia and identified hearing impairment in 1 neonate. Prevalence in their study is much lower than prevalence in our study. Probable reason for this is they have included neonates with mild and moderate birth asphyxia in their study where as we have screened only those with severe birth asphyxia

Christine Oh et al [35] screened 12 neonateswith severe birth asphyxia and identified 4 neonates with hearing impairment this occurrence is much higher than our observation.

In study by suchitra et al [11] who screened 200 neonates with birth asphyxia they found persistent OAE failure in 20 neonates. In study done by Prasad et al [1] who screened 237 neonates with birth asphyxia they found persistent OAE failure in 16 neonates (6.8 %) with hearing impairment. Prevalence in their study is similar to prevalence in our study

Neonates Who Were Pre Term (Includes All Babies Who Gestational Age Is Less Than 37 Weeks Irrespective Of Birth Weight)

- In our study there were 48 neonates who were PRETERM. Out of these 47 neonates , 42 neonates passed and 5 neonates failed in **FIRST STAGE OAE SCREENING**
- out of these 5 neonates **,**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 as well**
- 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 loss in both ears and another baby had normal BERA.
- Out of 48 pre-term neonates other risk factors noted were Ototoxic drugs were administered in 13 ,47 had low birth weight ,2 received Mechanical Ventilation ,7 had Sepsis , 1 baby had hyperbillirubinemia requiring exchange transfusion , 1 had birth asphyxia
- In study done by Prasad et al[1] who screened 893 neonates with birth asphyxia they found persistent OAE failure in 62 babies 9 (7.0%) Prevalence in their study is similar to prevalence in our study (4.2%).

- Study done by Khairy et al[14] also found pre maturity as a important risk factor. They have screened 180 pre-term neonates out of which 54 neonates had hearing impairment. The prevalence in their study being much higher than our study. probable reason for this is neonates included in their study had multiple other risk factors than the neonates in our study

- In study done by Prasad et al[1] who screened 317 neonates with Ototoxic drugs administration as risk factor they found persistent OAE failure in 7 babies (2.2 %) The prevalence in their study being much lower than our study (9.4%). probable reason for this is neonates included in our study had multiple other risk factors more than the neonates in their study

- Study done by Khairy et al[14] also found administration of oto toxic drugs a important risk factor. They screened 260 neonates out of whom 78 neonates had hearing impairment. The prevalence in their study being much higher than our study. Probable reason for this is they have included more number of pre-term neonates (70%) than we included (50 %) in our study.

Neonates Who Had Sepsis As Risk Factor

- In our study there were 28 neonates who had sepsis. Out of these 28 neonates, 22 neonates passed and 6 neonates failed in **FIRST STAGE OAE SCREENING**

- out of these 6 neonates **, 5** 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 failed in SECOND STAGE OAE SCREENING also but had normal BERA on subsequent testing

- Out of 5 neonates with b/l hearing impairment in **FIRST STAGE OAE SCREENING**, 1 was lost to follow up and 4 were subjected to **SECOND STAGE OAE SCREENING.** 3 out of 5 neonates were detected to have b/l hearing impairment in **SECOND STAGE OAE SCREENING** also

- These 3 neonates were further tested by BERA In which one neonate had mild hearing impairment in both ears and another neonate had profound hearing impairment in both ears and 1 neonate had normal BERA.

- Out of 28 neonates who had sepsis other risk factors noted They were Ototoxic drugs were administered in 28, 7 had low birth weight, 2 received Mechanical Ventilation, 7 were preterm, 3 baby had hyper billirubinemia requiring exchange transfusion

- Out of these 28 neonates who had sepsis, 16 had clinical sepsis, 4 had culture positive sepsis, 8 had probable sepsis

Conclusion

- From this study of 92 high risk new born babies tested with two staged OAE for detection of hearing impairment, 5.4% new borns had hearing impairment detected.

- Hence prevalence of hearing impairment in our study when persistent OAE 2nd stage failure is taken into consideration is 5.4%

- When these new borns were further tested by BERA the hearing impairment was 3.2 %.

- Hence prevalence of hearing impairment after 2 STAGE OAE FOLLOWED BY BERA CONFIRMATION in neonates with the high risk factors is 3.2%

- There for out of 92 new borns with high risk factors more than 3 are likely to go undetected unless screened by OAE AND BERA in new born period and potentially become hearing impaired.

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