"COMPARISON OF HEARING STATUS IN PRETERM CHILDREN WITH AND WITHOUT JAUNDICE USING BRAINSTEM EVOKED RESPONSE AUDIOMETRY"

BY

REGISTRATION NO: BE0121008

Dissertation

Submitted to the KLE Academy of Higher Education and Research, Belagavi, Karnataka

In Partial Fulfilment

of the Requirements for the Degree of

MASTER OF SURGERY

IN

OTORHINOLARYNGOLOGY

AND HEAD AND NECK SURGERY

DEPARTMENT OF OTORHINOLARYNGOLOGY AND HEAD AND NECK SURGERY
JAWAHARLAL NEHRU MEDICAL COLLEGE, BELAGAVI, KARNATAKA

DECEMBER 2024/JANUARY 2025

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Sub: Institutional Ethical Clearance for the study.

With reference to the above, we wish to inform you that your proposed research project titled **"COMPARISON OF HEARING STATUS IN PRETERM CHILDREN WITH AND WITHOUT JAUNDICE USING BRAINSTEM EVOKED RESPONSE AUDIOMETRY."**, is ethical and justifiable. The proposed research project has been cleared by the JNMC Institutional Ethics Committee.

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LIST OF ABBREVIATIONS

GLOSSARY	ABBREVIATIONS
ABC	Absolute bone conduction
ABRs	Auditory evoked brainstem response
AC	Air conduction
AEP	Auditory evoked potentials
AL	Abnormal latency
AT	Abnormal threshold
BC	Bone conduction
BERA	Brain stem evoked response audiometry
BOA	Behavioral observation audiometry
Ca2+	Calcium ion
CERA	Cortical evoked response audiometry
CHL	Conductive hearing loss
CM	Cochlear microphonics
CS	Centimetre square
CSOM	Chronic suppurative otitis media
dB	Decibel
DS	Discrimination score
ECog	Electrocochleography
EEC	Electroencephalogram

ft	Metric feet
Hz	Hertz
K+	Potassium ion
KHz	Kilo Hertz
MHL	Mixed hearing loss
mm2	Milimetre square
ms	Miliseconds
mv	Milivolts
Na2+	Sodium ion
Na+K+ATPase	Sodium potassium adenosine triphosphatase
NICU	Neonatal intensive care unit
OME	Otitis media with effusion
Pa	Pascal
PTA	Pure tone audiometry
sec	Seconds
SNHL	Sensory neural hearing loss
SOM	Serous otitis media
SP	Summation potential
SPL	Sound pressure level
SRT	Speech reception threshold
WHO	World Health Organization

ABSTRACT

Background:

Children with hearing impairment often experience delayed development of speech and cognitive skills, which may result in slower learning and difficulty in progressing at school. The present study was undertaken to know the prevalence of hearing impairment in preterm children with and without jaundice.

Objectives:

To Assess and compare the hearing status of preterm children with and without jaundice using Brainstem Evoked Response Audiometry.

Methodology:

The present study was conducted in the Department of Otorhinolaryngology and Head and neck surgery KLES Dr. Prabhakar Kore Hospital and Medical Research Centre, attached to Jawaharlal Nehru Medical College and Medical Research Centre, Belgaum, between October 2022 to September 2023 on 50 children with and without jaundice. All the children underwent otoscopic examination to note external and middle ear pathology. Hearing sensitivity was assessed by BERA.

Results:

In this study male preponderance was seen. Mean age group of 13.30 ± 18.75 months. Commonest presenting history of preterm birth, neonatal intensive care admission, delayed development of speech and inconsistent or no response to sound. Out of 50 samples, 19 were preterm with jaundice, and 31 were preterm without jaundice. 30% presented with abnormal report in bilateral ear. 16 (32%) showed

abnormal BERA report in the right ear. In right ear, among 16 samples with abnormal study 12 (38.72%) were preterm with jaundice and 5 (21.05%) were preterm without jaundice. Among the abnormal report wave V pattern mildly elevated and sensory pathology were reported. Among 16 (32%) abnormal BERA report, 9 (27%) of preterm with jaundice and 02 (10%) preterm without jaundice were reported with wave V elevation pattern and sensory pathology in the right ear. In left ear, among 19 (38%) abnormal report, 14 (45.14%) were preterm with jaundice and 5 (26.31%) were preterm without jaundice. Among the abnormal report, 09 (28%) Preterm with jaundice and 05 (25%) Preterm without jaundice were reported with wave V pattern elevation and sensory pathology.

Conclusion and interpretation;

This study showed the high prevalence rate of hearing impairment among preterm children with jaundice compared to pereterm children without jaundice and have a major role to play for universal newborn screening.

Keywords: BERA; Hearing impairment; Hearing loss; Prevalence.

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INTRODUCTION:

Globally, the rate of severe hearing loss in infants is thought to be more than 2:1000 live births, and the real incidence of hearing impairment, in any degree, may reach 5:1000.[1]

Early detection and management of hearing loss are recommended primarily because of its potentially adverse effects on language acquisition. Here, the first few months are crucial because normal language development is rapid. Before language expression, the child has experienced over a year of language reception, during which complex intellectual events have occurred.[1]

Even mild conductive losses may have deleterious effects. According to estimates, up to 30% of newborns in intensive care units have middle-ear effusions, particularly if they are intubated.[1]

It should be noted that hearing loss may occur in conjunction with preterm, sepsis, multiple neurologic defects, *e.g.*, in low birth weight babies. In their habilitation, accurate quantification of sensory deficit is especially important.[2]

The consequences of late detection and treatment are borne both by the individual and society. In general, the deaf individual is deficient linguistically, educationally and vocationally, despite average nonverbal Intelligence Quotient.[2]

In order to acquire language and communication as well as cognitive abilities, hearing is required. A developing child's ability to hear aids in their ability to identify sounds, recognize objects and events, and assimilate concepts.[2]

The cost and complexity of Brainstem Evoked Response Audiometry preclude its general use as a screening test, but when used in conjunction with a high-risk register, the test may prove cost-effective both for early auditory evaluation and as a contributor to the total pediatric assessment.[2]

The ideal mechanism for early detection and habilitation has three main parts such as:

Early patient identification, reliable, quantitative hearing tests, and An appropriate habilitation program. Current systems may be deficient on any or all of these counts.[2]

Patient identification, in the absence of any obvious and severe accident or disease, relies upon parental vigilance, awareness, and reporting. It also requires considerable knowledge, patience, and a high index of suspicion on the part of the primary care physician, lack of which is a frequent point of failure.[2]

Three major studies found that the incidence of similar risk variables varied from 5.5% to 10.7%. Within the high-risk group, hearing loss occurred at a rate of 1% to 2%. Mild and unilateral hearing losses were not considered. These data reflect an approximate 10-fold incidence increase on the register, with a specificity of 75% to 100%. However, the use of risk registers as part of an early-detection system is still uncommon.[1]

There has been a lack of accurate screening tests and of quantitative audio metric procedures for preterm neonate and young infant.[1]

Brainstem Evoked Response Audiometry (BERA) is an objective non-invasive method of evaluating auditory function, with special relevance to pediatric assessment and otoneurologic diagnosis. The Auditory Brainstem Response (ABR) comprises up to 7 vertex-positive electrical waves, usually occuring within 10 ms of stimulus onset. They originate in the cochlear nerve and then in the auditory pathway neurons that go all the way to the midbrain.[1]

In normal hearing adults, click stimuli cause waves I through VII to appear in their most legible form 1–10 millisecond after the event. The cost and complexity of BERA preclude its general use as a screening, but when used in conjunction with a high-risk register, the test may prove cost-effective both for early auditory evaluation and as a contributor to the total pediatric assessment.[1]

This study is done to assess and compare the hearing status of preterm children with and without jaundice using Brainstem Evoked Response Audiometry.

OBJECTIVE OF THE STUDY

- To Assess and compare the hearing status of preterm children with and without jaundice using Brainstem Evoked Response Audiometry.

REVIEW OF LITERATURE:

Children with hearing loss have significant challenges to their growth and education, particularly in the classroom. Early detection and identification are crucial. While many countries have implemented school hearing screening programs, India lacks a nationwide initiative. Research suggests that school screening is an effective method for detecting hearing problems in children.[2]

PREVALENCE OF HEARING IMPAIRMENT

Global Scenario:

Hearing loss creates a significant global economic burden, estimated at $150 million annually. Early detection is crucial, and the World Health Organization aims to identify hearing loss at birth Studies show a strong link between hearing loss and learning disabilities, with 30% of affected children falling into this category. Unfortunately, detection in children is often delayed, causing them to miss critical speech development periods. Notably, 90% of deaf children are born to parents with normal hearing. Therefore, implementing infant screening tests for hearing loss is essential. For children with hearing loss, early identification and intervention within the first six months of life provide the best opportunity for optimum language development.[3] Africa and Southeast Asia had the highest percentages for Exchange blood transfusion (EBT) and Albumin replacement therapy (ABE) treatments. The same regions, along with the Eastern Mediterranean region, had the highest rates of jaundice-related hearing loss.[3]

Indian Scenario:

Since the year 2000, several perinatal risk factors have been identified that can increase a baby's chance of deafness. Early detection of hearing loss is crucial, as it's an invisible disability that can significantly impact development if left unidentified. Unfortunately, the average age of diagnosis for childhood deafness remains between 24 and 30 months. This delays intervention during a critical period of brain development known as cerebral plasticity.[3] Studies in India show that hearing impairment is more common among young children. Children between ages of zero to four years have a prevalence rate of 0.60%, while those between five years and nine years old have a rate of 0.28%. This is higher than the prevalence rate for all other disabilities in this age group (0.32%).[3]

In India, hearing impairment is more prevalent in young children than other disabilities. However, unlike other countries, established universal newborn hearing screening programs (UNHS) are not yet commonplace due to limited resources and competing public health priorities.[3]

Severe Neonatal Jaundice:

The percentage of newborns with severe neonatal jaundice compared to all admissions varied significantly between World Health Organization (WHO) regions, ranging from 0.73% to 3.34%[3]. Among admitted neonates, different markers for severe jaundice showed varying prevalence:

- Exchange blood transfusion (EBT): 0.74% to 3.81%
- Albumin replacement therapy (ABE): 0.16% to 2.75%[3].

AUDIOLOGY AND ACOUSTICS

Our sense of hearing allows us to perceive vibrations as sound. Some key concepts in understanding sound:

Sound Waves: A type of energy known as sound is created when vibrations move through a material such as solids, liquid or air. These vibrations cause variations in pressure, creating compression and rarefaction zones within the medium. The speed of sound varies depending on the medium; it's fastest in solids, followed by liquids and slowest in air.[4]

Frequency: This describes how often the pressure variations occur in a sound wave, measured in Hertz (Hz). A sound 1000 Hz means pressure cycles 1000 times per second. Higher frequencies are perceived as higher pitches.[4]

Pure Tones: Sounds with a single, well-defined frequency are called pure tones. Examples include tuning fork tones or sounds of specific frequencies like 250 Hz, 500 Hz, or 1000 Hz. In audiometry, pure tones are used to assess hearing thresholds across different frequencies.[4]

Complex Sounds: Most sounds in our environment, including human speech and music are complex. They contain a combination of multiple frequencies at varying intensities.[4]

Pitch: This refers to the perceived "highness"/"lowness" of a sound. It's primarily ascertained by sound's fundamental frequency, the lowest frequency present in the complex sound. Pitch perception is enhanced by higher fundamental frequencies.[4]

Overtones & Timbre: In complex sounds, overtones are frequencies present above the fundamental frequency. These overtones contributes to unique quality or "timbre" of a sound, which allows us to distinguish between different instruments or voices.[4]

Sound strength, intensity determines its loudness. We measure it in units called decibels (dB). The following (Table.1) sound's intensity from one meter's distance away are :[4]

Table.1 Sound perceived at varying intensity.

whisper	30dB
normal Conversation	60dB
shout	90dB
discomfort of the ear	120dB

PHYSIOLOGY OF HEARING :

EXTERNAL EAR: The outer ear, also called the external ear or auricle, is made up of two main parts:

Auricle:

This portion of the ear is exposed and folded. When sound waves are collected and directed into the ear canal, it functions as a funnel. The direction from which sounds are coming is another thing the pinna aids with.[4]

External Auditory Canal:

This is a narrow, S-shaped tube 2.5 cm that runs from pinna to tympanic membrane. It channels sound waves towards tympanic membrane. Canal also helps protects inner ear by acting as a barrier against dust, dirt and other small objects.[4]

MIDDILE AND INNER EAR:

Middle ear consists of a space spanned by three small bones called the **ossicles**. The three ossicles are the **malleus**, **incus** and **stapes**, which are Latin names that roughly translate to hammer, anvil and stirrup. The malleus is attached to the tympanic membrane and articulates with the incus. The incus, in turn, articulates with the stapes. The stapes is then attached to the **inner ear**, where the sound waves will be transduced into a neural signal. The middle ear is connected to the pharynx through the Eustachian tube, which helps equilibrate air pressure across the tympanic membrane. The tube is normally closed but will pop open when the muscles of the pharynx contract during swallowing or yawning.[5]

The inner ear is often described as a bony labyrinth, as it is composed of a series of canals embedded within the temporal bone. It has two separate regions, the **cochlea** and the **vestibule**, which are responsible for hearing and balance, respectively. The neural signals from these two regions are relayed to the brain stem through separate fiber bundles. However, these two distinct bundles travel together from the inner ear to the brain stem as the vestibulocochlear nerve. Sound is transduced into neural signals within the cochlear region of the inner ear, which contains the sensory neurons of the **spiral ganglia**. These ganglia are located within

the spiral-shaped cochlea of the inner ear. The cochlea is attached to the stapes through the **oval window.**[5]

The oval window is located at the beginning of a fluid-filled tube within the cochlea called the **scala vestibuli**. The scala vestibuli extends from the oval window, travelling above the **cochlear duct**, which is the central cavity of the cochlea that contains the sound-transducing neurons. At the uppermost tip of the cochlea, the scala vestibuli curves over the top of the cochlear duct. The fluid-filled tube, now called the **scala tympani**, returns to the base of the cochlea, this time travelling under the cochlear duct. The scala tympani ends at the **round window**, which is covered by a membrane that contains the fluid within the scala. As vibrations of the ossicles travel through the oval window, the fluid of the scala vestibuli and scala tympani moves in a wave-like motion. The frequency of the fluid waves match the frequencies of the sound wave. The membrane covering the round window will bulge out or pucker in with the movement of the fluid within the scala tympani.[5]

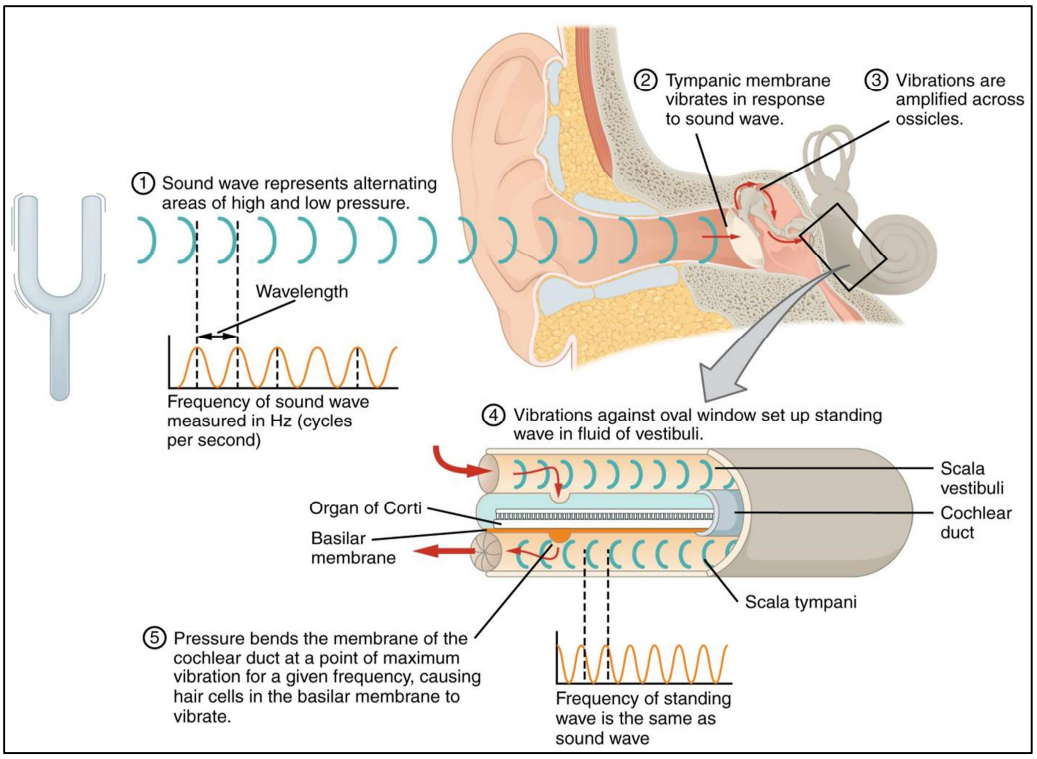


Figure 1 –Transfer of sound waves: sound reaches the external ear then reaches the middle ear and frequency and vibration travels to the inner ear. And the sound is produced according to the frequency and pressure.[5]

The scala vestibuli and scala tympani run along both sides of the cochlear duct, as can be seen from a cross-sectional view of the cochlea. The Corti organs found in cochlear duct convert wave movement of the two scala into brain impulses (Fig. 1). The Corti organs are covered by the basilar membrane, which is portion of cochlear duct that lies between them and the scala tympani. Subject to waves' repetition, basilar membrane shifts at a specific location when liquid waves pass through scala vestibuli and scala tympani. Higher frequency waves move basilar membrane, which is situated toward the base of the cochlea. Basilar membrane's nearby region is moved by lower frequency waves.[5]

Hair-like stereocilia that protrude from apical surfaces of the cells (Fig.2). The stereocilia are a group of microvilli-like structures that are organized from tallest to shortest. Within each display, protein filaments bind adjacent hairs together to the point that the cluster twists in response to changes in the basilar film.

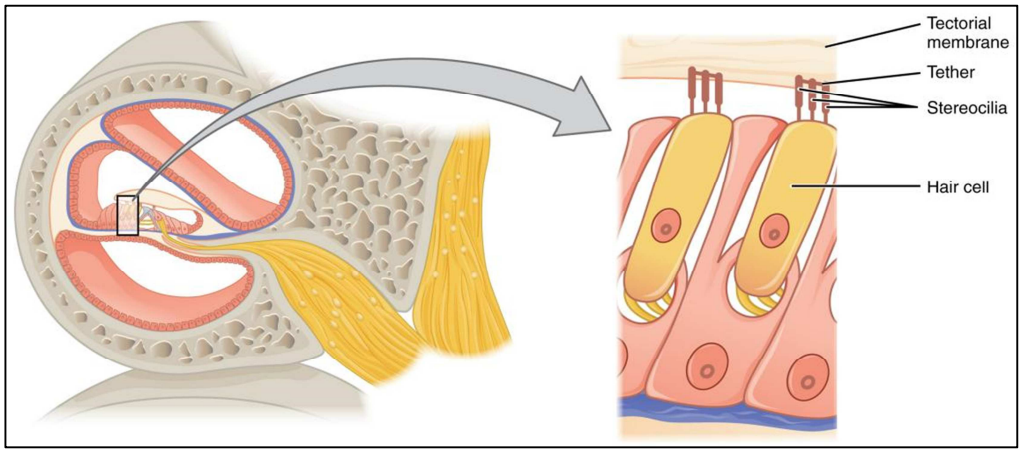


Figure 2 – Hair cell: according to the movement of hair cell the mechanical reception is produced. [5]

Only when sound is at a certain frequency the basilar membrane move. Range of frequencies that human ears can perceive, from 20 to 20,000 Hz, is the range for which the cochlea encodes auditory data. Sound wave frequency is expressed in terms of cycles generated one second using the Hertz unit of measurement. The hair cells at the apex, or tip, of the cochlea are capable of detecting frequencies as low as 20 Hz.[5]

Endocochlear potential (Endolymphatic potential):

The inner ear contains a fluid-filled chamber called the scala media. This chamber is bathed in a special fluid called endolymph. The potassium ion concentration (K+) in endolymph is higher than the sodium ion concentration (Na+). The different from perilymph fluid that surrounds scala media, which has a low K+ concentration and a high Na+ concentration, similar to extracellular fluid.[7]

This difference in ion concentration creates an electrical voltage across the wall of the scala media, with a positive charge inside (endolymph) and a negative charge outside (perilymph). This voltage is called the endocochlear potential (also known as endolymphatic potential). It's around +80 millivolts (mV).[7]

Hair cells, which are responsible for converting sound waves into electrical signals, are located within the scala media and bathed in endolymph. The inside of these hair cells has a resting electrical potential of about -60 to -70 mV.[7]

The combined effect of the endocochlear potential (+80 mV) and the hair cell's resting potential creates a large voltage gradient (around +140 to 150 mV) across the hair cell membrane. This large gradient makes the hair cells very sensitive to even small changes in sound waves.[7]

When sound waves cause vibrations in the inner ear, these vibrations move the endolymph relative to the hair cells. This movement changes the electrical potential across the hair cell membrane, resulting in a receptor potential. The receptor potential triggers changes in the hair cell's ion flow, which creates a current. This current can be measured as the cochlear microphonic potential, an electrical signal that reflects the frequency of sound wave.[7]

The cochlear microphonic potential represents the combined activity of many hair cells. This activity is further processed and transmitted by auditory nerve fibers to the brain, where it is ultimately perceived as sound.[7]

Neural / Auditory Pathway:

The 1st order neurons - The axons of the spiral ganglion, which innervates the hair cells in the ear, create the first order neurons, which constitute the cochlear (auditory) division of the VIII nerve. They come to an end at the medulla's ventral and dorsal cochlear nuclei.[9]

The 2nd order neurons - In the superior olivary nucleus and trapezoid body on each side of the brainstem, which is where the third order neurons originate, the second order neurons from the cochlear nuclei terminate.[9]

The 3rd order neurons - The inferior colliculus, the hub for bilateral auditory reflexes, receives projections from third-order neurons via a variety of routes in the horizontal lemniscus. Furthermore, several fibers send collaterals to the thalamus's medial geniculate bodies and reticular formation. Numerous fibers from the inferior colliculi project and relay in the thalamus's medial geniculate body. Medial geniculate body neurons eventually reach the primary auditory cortex (area 41), situated in the superior temporal gyrus of the cerebral cortex (Auditory association areas: Areas 22, 21, and 20).[9]

ELECTROPHYSIOLOGICAL TESTS

Valuable tools in diagnosing hearing loss. The electrical activity of the auditory system in reaction to sound is measured by these tests.

Here are the main types of electrophysiological tests used for hearing assessment:

I. Brainstem Evoked Response Audiometry (BERA)

II. Oto Acoustic Emissions (OAE)

III. Auditory Steady State Responses (ASSRs)

IV. Electrocochleography.[12]

I. Brainstem Evoked Response Audiometry (BERA):

Brainstem Evoked Response Audiometry (BERA) assesses hearing by measuring the electrical activity generated in the brain in response to sound. When a sound wave enters the ear, hair cells convert it into an electrical signal. This signal travels along the auditory pathway to the brainstem and then to the cortex. BERA records the electrical activity at specific points along this pathway.[12]

The test typically uses clicking sounds delivered through earphones. Electrodes placed on the scalp pick up the brain's electrical response. The timing and amplitude of these responses are measured and displayed as a graph similar to an electroencephalogram (EEG).[12]

Within the first 10 milliseconds after the sound, a series of distinct waves appear, labeled I to V. These waves reflect the activation of different parts of the auditory pathway. The presence and timing of these waves help assess hearing function and identify potential abnormalities.[12]

WAVES OF BERA

Wave I: This originates from the distal auditory nerve, with an average latency of around 1.5 ms.

Wave II: Corresponds to activity of proximal auditory nerve and cochlear nucleus, typically occurring around 2.5 ms after sound presentation.

Wave III: Arise from the cochlear nucleus and superior olivary complex, with an average latency of 3.5 ms. Abnormalities in this wave are often more prominent on the side ipsilateral to the lesion due to the bilateral connections of the superior olivary complex.

Wave IV: Represents activity in the superior olivary complex and ascending auditory fibers, occurring at around 4.5 milliseconds.

Wave V: Reflects activation of the lateral lemniscus and inferior colliculus, with an average latency of 5.5 milliseconds. Waves IV and V are frequently affected by brainstem lesions.[12]

Hearing loss can be categorized based on the affected part of the auditory system: peripheral or central.

Peripheral hearing loss: This type involves problems in the outer or middle ear, or the auditory nerve. It can be caused by conductive issues or cochlear damage[12].

Central hearing loss: This type involves problems in the brainstem or higher auditory centers.[12]

ABR :

Auditory Brainstem Response, is a test test quantifies the electrical activity of the auditory pathway in response to sound. It can help distinguish between peripheral and central hearing loss.[13]

i. **Delayed Waveform Response:** Delayed response in wave I or absence of waveforms suggests peripheral hearing loss. Increased sound intensity can sometimes normalize responses in conductive hearing loss but not in neural conduction issues.

ii. **Prolonged Interwave Peaks:** Increased latency between specific wave peaks (e.g., I-III interval) suggests auditory nerve or cochlear problems. Increased latency between later waves (e.g., III-V interval) suggests central nervous system involvement.

iii. **Abnormal Wave Patterns:** Absent waveforms in specific regions or abnormal synchrony can indicate pathologies in different areas of the brainstem and auditory pathway.[13]

II. OTOACOUSTIC EMISSIONS

Origin: OAEs are believed to be generated by the OHC's within cochlea. Hair cells actively respond to sound by vibrating, and in some cases, producing these acoustic signals

TYPES OF OAES: There are four main categories of OAEs, distinguished by how they are triggered:

i. Spontaneous OAEs (SOAEs): These emissions occur naturally, without any external sound stimulation.

ii. Transient Evoked OAEs (TOAEs): They appear in reaction to quick clicks or tones that are played in the ear.

iii. Distortion Product OAEs (DPOAEs): These are created when two specific tones of different frequencies are presented simultaneously. The cochlea interacts with these tones, producing a new sound wave at a specific frequency (the distortion product).

iv. **Recording OAEs:** These minimal echoes are detected by a sensitive microphone inserted into the ear canal. The microphone might be part of a sealed probe that also delivers sound for evoking certain OAE types (TOAEs and DPOAEs).[12]

CHALLENGES IN OAE RECORDING:

1) Separating the weak OAE signal from background noise is crucial.

2) Minimize noise: A tight seal around the probe reduces external noise. Patients are instructed to stay still and quiet.

3) Enhance signal: Averaging the recordings over time or frequency can strengthen the OAE signal.

4) Identify potential issues: Examining the eardrum (tympanometry) helps identify any middle or outer ear problems that might block OAE transmission.[12]

Importance of OAEs:

The presence of OAEs often indicates healthy outer hair cell function in the cochlea. OAE testing is valuable tool for:

Newborn hearing screening: Identifying potential hearing problems in infants even before they can respond to traditional hearing tests.Evaluating hearing loss: Assessing the type and severity of hearing loss (sensorineural vs. conductive).[12]

Monitoring hearing health: Tracking changes in hearing over time.

III. Auditory Steady State Responses (ASSRs):

Patients of all ages have their Auditory Steady State Response, an auditory evoked potential that is produced with modulated tones, and are used to predict their hearing sensitivity. It is an electrophysiologic reaction to quick auditory cues that yields an estimated audiogram with statistical validity.[14]

IV.Electrocochleography:

The method of recording inner ear and auditory nerve responses to stimuli or electrical potentials is called electrocochleography (ECog). Summating possibilities (SM), activity potential (AP) and cochlear microphonics (CM) are the component potentials of the human electrocochleogram. These options can be listed alone or in different combinations. The organ of corti produces CM and SP, a form of receptor potential. Neural potentials (AP) from the cochlear nerve are what are referred to as AP.[14]

AUDIOLOGIC IMPAIRMENT ASSOCIATED WITH BILIRUBIN-INDUCED NEUROLOGIC DAMAGE :

Elevated total bilirubin (TB) levels can damage the auditory pathway, leading to hearing loss. This damage primarily affects the brainstem, rather than the cochlea itself.

Brainstem Vulnerability:

Brainstem cochlear nuclei are the most susceptible structures, followed by the auditory nerve. Higher brain centers are affected last. The cochlea is spared from direct bilirubin toxicity.[14]

Secondary Cochlear Damage:

Damage to the brainstem nuclei or auditory nerve can indirectly harm the cochlea. This might be due to the loss of essential factors for cochlear function provided by these brainstem structures.

ABR Assessment:

Auditory Brainstem Response (ABR), valuable tool which evaluates auditory pathway and identifies the location of damage. It measures the electrical activity of neurons as sound travels from the cochlea to the brainstem.[14]

ABR Findings in Bilirubin-Induced Hearing Loss:

Studies in jaundiced animals and infants with elevated TB levels show abnormal ABR results.

These abnormalities include:

Decreased amplitudes of specific ABR waves (indicating reduced neural activity)

Increased wave latencies (slower signal transmission)

Loss of certain ABR waves at very high TB levels.[14]

HYPERBILIRUBINEMIA AND NEUROTOXICITY IN PRETERM CHILDREN:

The pathology and the neurological area affecting hearing in preterm infants consists of a combination of cerebral white matter injury (WMI), subsequent dysmaturational events in both white matter and neuroaxonal structures.

This combination of WMI and disturbances of gray matter structures has been termed the encephalopathy of prematurity. In the initial review describing this encephalopathy, a particular emphasis was placed on the initial injury. Subsequent work now suggests that although WMI is an important and likely initiating event, multiple subsequent dysmaturational events are most critical in determining the outcomes.

Moreover, because these dysmaturational events evolve over a very prolonged period (many months), a relatively long time window exists for interventions to prevent, counteract, or ameliorate the dysmaturation, i.e., Neurorestorative Interventions.

Unconjugated bilirubin, rather than conjugated bilirubin, is believed to be the neurotoxic form responsible for hearing loss. Studies suggest a stronger correlation

between unconjugated bilirubin levels and abnormal ABR findings compared to total bilirubin levels.

The auditory brainstem nuclei and the inferior colliculi are thought to be affected by bilirubin toxicity with the consequent development of hearing defects. In addition, abnormalities have been observed in the spiral ganglion neurons and the myelinated.[15]

MATERIALS AND METHODS

Source of Data:

The preterm children with jaundice and without jaundice who underwent screening for hearing status using Brainstem Evoked Response Audiometry at the Department of Paediatric Neurology, KLE's Dr. Prabhakar Kore Hospital & Medical Research Centre, Belagavi over a period of one year.

Study Design:

A hospital based one-year comparative study.

Study Period:

1 Year

Sample Size:

Sample Size: Sample Size: 50

The minimum sample size formula based on Mean and Standard deviation is

$$n = \frac{(z_\alpha + z_B)^2 (S_1^2 + S_2^2)}{(\overline{X_1} - \overline{X_2})^2}$$

where z_α is Linked with the level of Significance and z_B is linked with the Power of the test. For 5% Level of significance z_α =1.96 and z_B = 0.84 for 80% ower of the test. Ref: Auditory brainstem response in term and preterm infants with neonatal complication

The parameter considered in the calculation is level of latencies at wave V

$\overline{X_1}$ is the mean of first group ($\overline{6.79}$) and X_2 is the mean of second group (6.53). s_1 is the standard deviation of the first group (0.36) and s_2 is the standard deviation of the second group (0.29).

With the values of the sample size obtained is 25.

There will be two groups with 25 cases in each group.

Sampling technique:

The preterm born children with and without jaundice who are referred from Pediatric High Risk Clinic from KLE's Dr. Prabhakar Kore Hospital & Medical Research Centre, Belagavi for Brainstem Evoked Response Audiometry at 3rd week of after birth to do screening for the hearing impairment .

Inclusion Criteria:

Children born preterm less than 37 weeks of gestational age with and without jaundice who are undergoing screening for hearing status using Brainstem Evoked Response Audiometry in KLE's Dr. Prabhakar Kore Hospital & Medical Research Center, Belagavi.

Exclusion Criteria:

- People who have not given consent for the study
- Children who are born on term gestational age
- Children who have other associated developmental anomalies

Study protocol:

Proforma questionnaire has been used as the study protocol for this study .

Data collection procedure:

After taking informed consent from the parents of the preterm children with Jaundice and preterm children without Jaundice, their details and a thorough clinical history will be obtained for compliance with inclusion and exclusion criteria.

All preterm children will be clinically examined including general physical examination and careful examination of the ear, nose and throat.

The patient will then undergo BERA in the Department of Pediatric Neurology at KLE's Dr. Prabhakar Kore Hospital & Medical Research Centre, Belagavi.

Data processing and analysis/statistical analysis:

Comparing two groups is the main goal of the study. The mean and standard deviation for the continuous quantitative variables will be computed. The unpaired student's t test and other appropriate statistical methods will be used to compare the intergroup continuous variables. The student's paired t test will be used to compare two quantitative variables within a group.

Rates, ratios, and percentages will be used to express the categorical data. Using the Fisher's exact test or the Chi-square test, the relationship between the result and clinical and demographic factors will be examined.

In addition to the aforementioned, appropriate techniques such as ANOVA, correlation, regression, etc., will be employed based on the situation.

The median will be used to represent discrete variables.

Discrete variables will be compared using non-parametric testing.

Suitable graphs will be used to depict the comparison.

For all the tests the value of p less than 5% (0.05) will be considered significant.

RESULTS

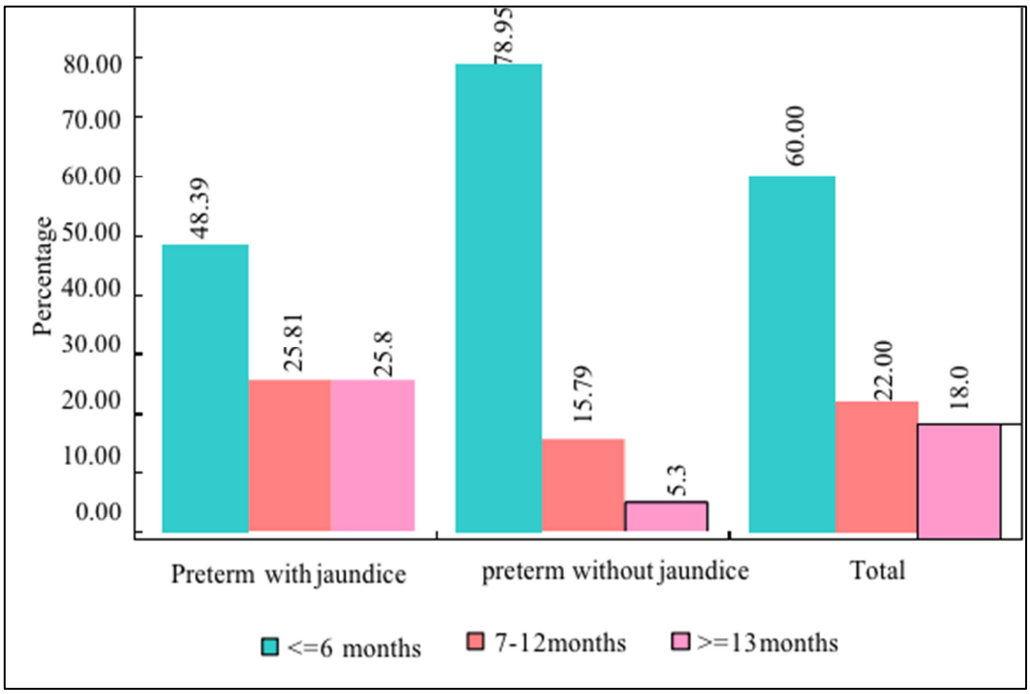
Fifty children aged less than five years, who were diagnosed with jaundice or without jaundice, who had undergone hearing screening using Brain Stem Evoked Response (BERA) at KLES Dr. Prabhakar Kore Hospital and Medical Research Centre were studied from October 2022 to September 2023. All observations recorded in the study are described under the following headings.

Age distribution:

Table 2 - Age distribution of the sample.

Age groups	Total	Percentage (%)
<=6 months	30	60
7-12months	11	22
>=13months	9	18
Total	50	100
Mean	13.3	
Standard deviation (SD)	18.75	

Graph 1 - Age distribution of the sample.



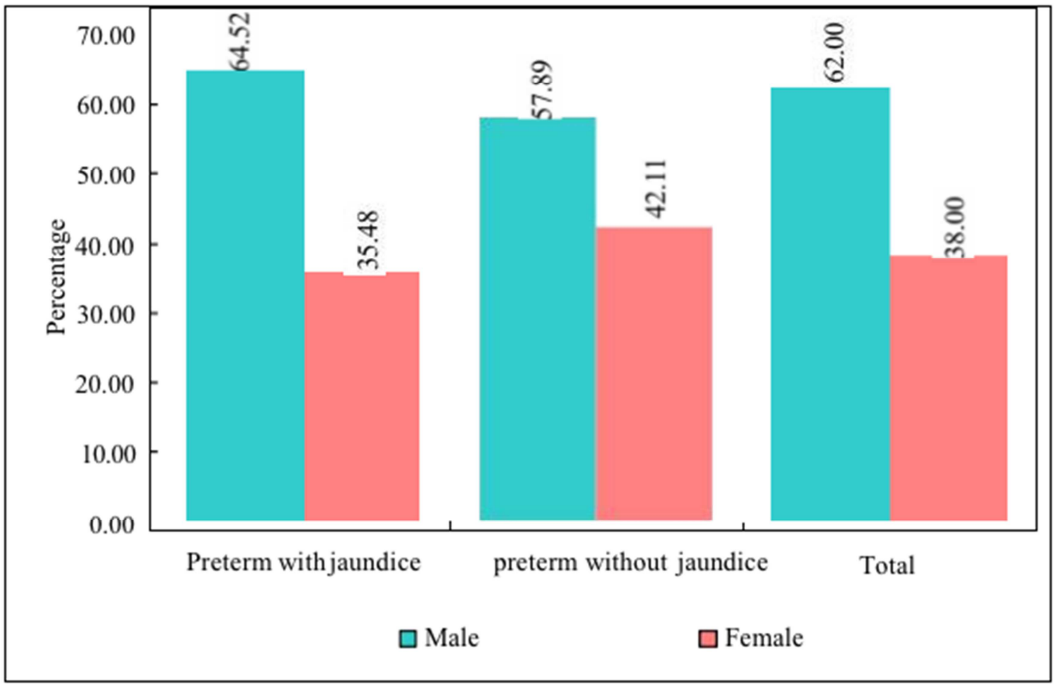
In our study, children's age ranged from 15 days to five years were included. Out of which 30 (60%) were between zero days to 6 months, 11 (22%) were between 7 months to 12 months old and 9 (18%) were between 13 months to five years of age, with mean age of 13.30 ± 18.75 months.

Sex distribution:

Table 3 - Sex distribution of the sample.

Gender	Total	Percentage (%)
Male	31	62.00
Female	19	38.00
Total	50	100.00

Graph 2 - Sex distribution of the sample



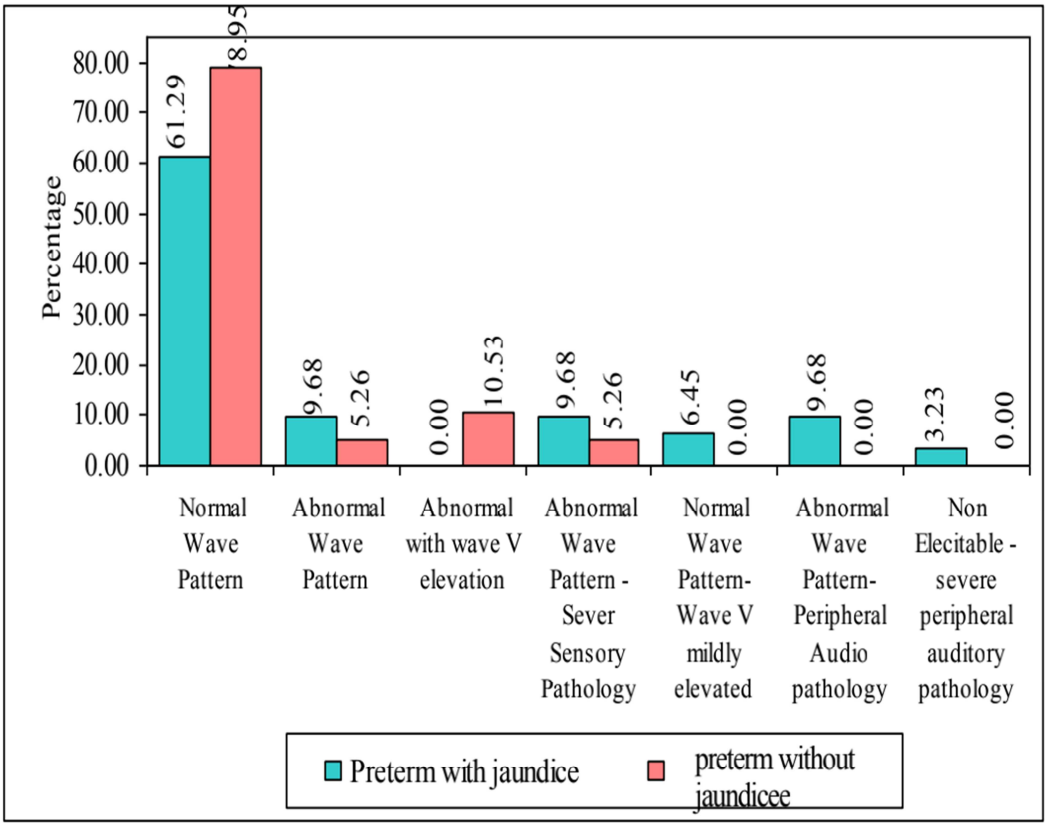
In our study, there were 31 males (62%) and 19 females (38%) with male predominance.

Comparing hearing status of both preterm with jaundice and preterm without jaundice groups for right ear:

Table 4: Comparison of preterm with jaundice and preterm without jaundice by BERA report in right ear (*p value being 0.2340,calculated by chi-square.)

BERA report right ear	Preterm with jaundice	Percentage (%)	Preterm without jaundice	Percentage (%)	Total	Percentage (%)	Chi-square	P-value
Normal wave pattern	19	61.29	15	78.95	34	68	8.055	0.2340*
Abnormal wave pattern	3	9.68	1	5.26	4	8		
Abnormal with wave v elevation	0	0	2	10.53	2	4		
Abnormal wave pattern -sever sensory pathology	3	9.68	1	5.26	4	8		
Normal wave pattern- wave v mildly elevated	2	6.45	0	0	2	4		
Abnormal wave pattern- peripheral audio pathology	3	9.68	0	0	3	6		
Non elicitable - severe peripheral auditory pathology	1	3.23	0	0	1	2		
Total	31	100	19	100	50	100		

Graph 3 - Comparison of preterm with jaundice and preterm without jaundice by BERA report in right ear



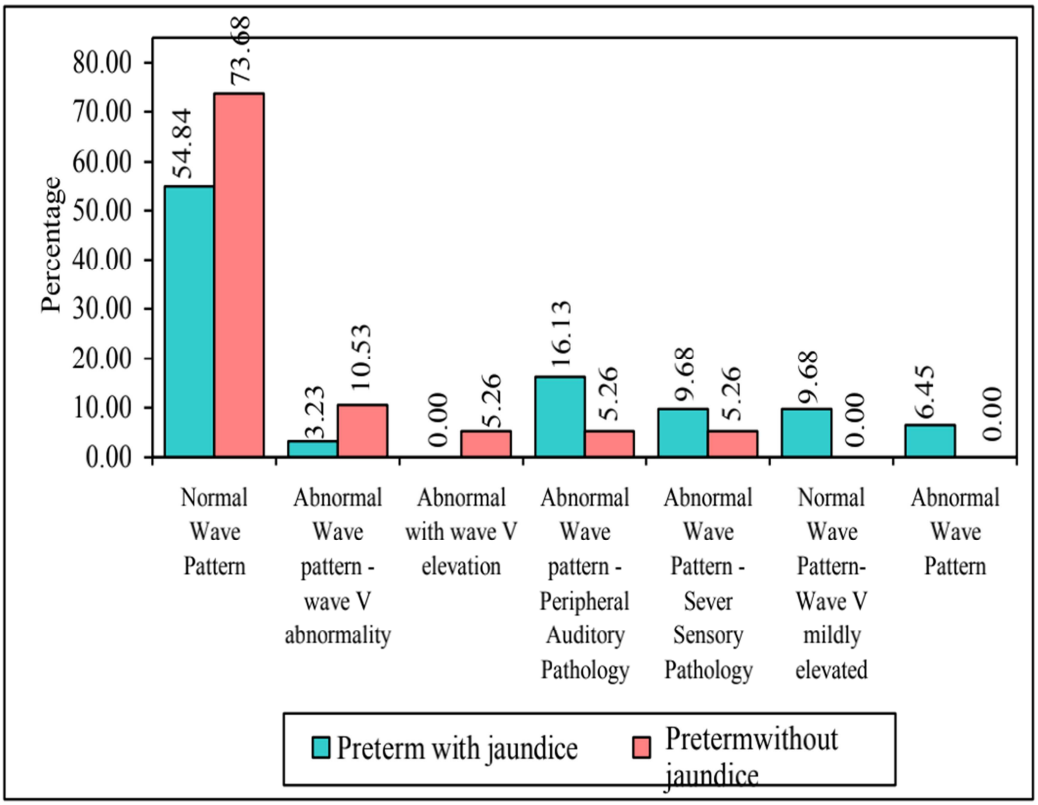
In our study, out of 50 samples 34 (68%) showed normal BERA report and 16 (32%) showed abnormal BERA report on the right ear. Among 16 samples with abnormal study 12 (38.72%) were preterm with jaundice and 5 (21.05%) were preterm without jaundice. Among the abnormal report wave V pattern mildly elevated and sensory pathology were reported. Among 16 (32%) abnormal BERA report, 9 (27%) of preterm with jaundice and 02 (10%) preterm without jaundice were reported with wave V elevation pattern and sensory pathology in the right ear. However p value being 0.2340, there was no statistical significance.

Comparisng hearing status of both preterm with jaundice and preterm without jaundice group for left ear:

Table 5 - Comparison of preterm with jaundice and preterm without jaundice by BERA report in left ear (*p value is 0.2480 calculated by chi-square.)

BERA report left ear	Preterm with jaundice	Percentage (%)	Preterm without jaundice	Percentage (%)	Total	Percentage (%)	Chi-square	P-value
Normal wave pattern	17	54.84	14	73.68	31	62	7.863	0.2480*
Abnormal wave pattern - wave v abnormality	1	3.23	2	10.53	3	6		
Abnormal with wave v elevation	0	0	1	5.26	1	2		
Abnormal wave pattern - peripheral auditory pathology	5	16.13	1	5.26	6	12		
Abnormal wave pattern -sever sensory pathology	3	9.68	1	5.26	4	8		
Normal wave pattern- wave v mildly elevated	3	9.68	0	0	3	6		
Abnormal wave pattern	2	6.45	0	0	2	4		
Total	31	100	19	100	50	100		

Graph 4 - Comparison of preterm with jaundice and preterm without jaundice by BERA report in left ear.



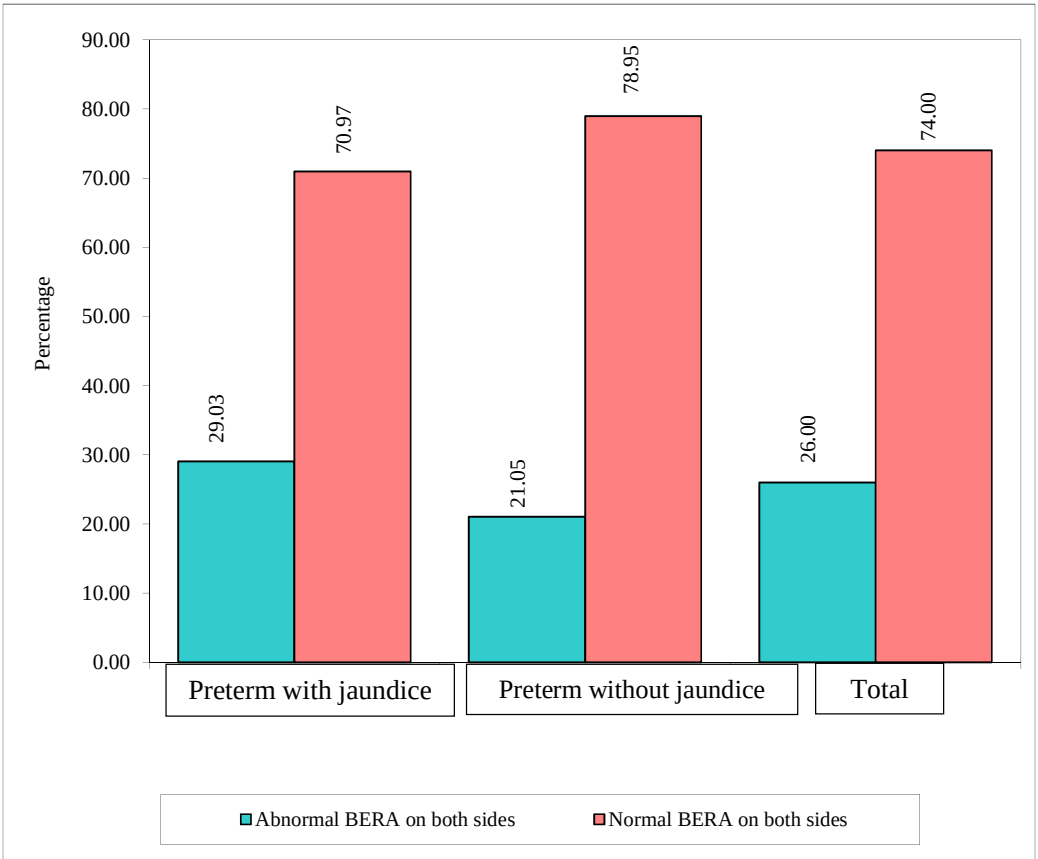
In our study, out of 50 samples 31(62%) showed normal BERA report, 19(38%) showed abnormal report. Among 19 (38%) abnormal report, 14 (45.14%) were preterm with jaundice and 5 (26.31%) were preterm without jaundice. Among the abnormal report, 09 (28%) Preterm with jaundice and 05 (25%) Preterm without jaundice were reported with wave V pattern elevation and sensory pathology. However, p value being 0.2480, there was no statistical significance.

Comparison of preterm with jaundice and preterm without jaundice according to status of BERA in both side

Table 6: Comparison of preterm with jaundice and preterm without jaundice according to status of BERA in both ears.

BERA	Preterm with jaundice	%	Pre term without jaundice	%	Total	%	Chi-square	p-value
Abnormal BERA on both sides	9	29.03	4	21.05	13	26.00	0.3899	0.5323
Normal BERA on both sides	22	70.97	15	78.95	37	74.00		
Total	31	100.00	19	100.00	50	100.00		

Graph 5: Comparison of preterm with jaundice and preterm without jaundice according to status of BERA in both ears



In our study, out of 50 samples 19 were preterm with jaundice, and 31 were preterm without jaundice. Among 19 preterm with jaundice, 09 (29.3%) presented with abnormal report in bilateral ear. Among 31 Preterm without jaundice , 4 (21%) presented with abnormal report in bilateral ear.

DISCUSSION

Early detection and treatment of hearing loss is advised due to possible negative impact on language learning. The initial months are critical since typical language development happens during this period. The child has been listening to speech for more than a year, during which time significant intellectual activities have taken place, before they express themselves verbally.[1] Language learning can be negatively impacted by even minor conductive hearing losses, the impacts are not limited to severe hearing impairment. In neonates in the intensive care unit, the incidence of middle ear effusion is estimated to be 30%, particularly if the infant is intubated.[1] It should be mentioned that hearing loss can happen in association with various neurologic abnormalities, sepsis and premature birth, more commonly seen in low birth weight babies. In their habilitation, accurate quantification of sensory deficit is especially important. The consequences of late detection and treatment are borne both by the individual and society. In general, the hearing impaired individual is deficient linguistically, educationally and vocationally, despite average nonverbal Intelligence Quotient.[2] In order to acquire language, communication and cognitive abilities, hearing is required. A developing child's ability to hear, helps to detect noises, recognize events and things, and assimilate concepts.[2] In our study, age group varying from 15 days to five years were included. Out of which 30 (60%) were between 15 days to 6 months, 11 (22%) were between 7 months to 12 months of age and 9 (18%) were between 13 months to 5 years of age, with mean age of 13.30 ± 18.75 months. This was comparable with the study conducted by K.K. Desarda, which comprised age group of under 5 years.[13] In a research conducted by Rout et al, the age ranged from 1-15 years. Sculerati et al conducted study in the age range of 2

weeks to 18 years. The above study aimed at assessing the hearing loss in zero to five years of age which is the most vulnerable age for risk factors which can cause hearing loss and also speech development occurs in this age group.[14] In our study we observed, 31 males (62%) and 19 females (38%), thus showing a male preponderance. This was comparable with the study done by Rout et al, with males commonly presenting with complaints such as inconsistent or no response to sound which was seen in 69 children (69%), delayed or no development of speech was seen in 53 children (53%) and ear malformations were seen in 11 children (11%).[27] There were no cases with complaints such as learning disability or craniofacial malformations. Children who have hearing loss frequently endure delayed speech and cognitive ability development, which can cause learning to go more slowly. The degree, compassionate, and age of hearing impairment all affect a child's speech, language, education, and social integration. This is especially true if the hearing impairment starts before the kid reaches the typical speech development age. This was comparable with the study conducted by Desarda et al which comprised “age group of under five years concluded that, in cases of high risk babies BERA should be carried out as a routine procedure to detect hearing loss. BERA test helps us to conclude regarding the cause of delay in speech and language development. BERA is the only tool which can confirm the normal sensitivity of hearing whenever required”. In our study normal results were found in 34 cases (68%) in the right ear and 31 cases (62%) in left ear. Abnormal results including abnormal latency and threshold in preterm with jaundice was found in 12 cases (38.72%) in right ear and 14 (45.14%) in preterm with jaundice of left ear were reported. In the present study normal threshold in our setup was taken as threshold values less than or equal to 50 db which are eliciting all the waves (wave I to wave V) and which are having proper morphology. Threshold

values more than normalcy were taken as abnormal threshold for hearing, having some form of hearing impairment. When comparing the results of this study to the 100 children studied in the study by Nazir et al., it was discovered that 49 of the 100 children had abnormal BERA reports. The study also examined the peak and latency of wave I, III, and V in normal infants and compared them to similar data in 49 high-risk.[15] In comparison to the above mentioned study, in this study we have 16 abnormal report noted in the right ear and 19 abnormal report noted in the left ear and the abnormal reports were further studied for the peak and latency of the wave forms. Abnormal reports are further studied with wave V threshold being peaked among 04 (61.98%) of 16 (32%) abnormal BERA report in the right ear and 07 (28.70%) of 19 (38%) abnormal reports in left ear. In a research conducted by Nazir et al., the wave V threshold of 30 normal newborns and 49 high-risk infants were compared.[15] It showed significant increase in wave V latency in high risk group. Warasanti et al, have also reported that V wave was detected at 60 db of 76 infant aged 3–4 months and had elevated threshold among waves I, III and V. On comparing the two groups in our study, we observed that the preterm with jaundice children 12 (35.49%) had abnormal BERA report when 05 (21.05%) preterm children without jaundice had abnormal BERA report suggesting preterm with jaundice group as high risk and are requiring the confirmatory BERA evaluation for deduction of hearing impairment in the early peroid of life. Warasanti et al, stated that an individual's brain growth and hearing development are tightly correlated.[28] Early in life, throughout the first three years of life, cortical neurons mature, and during the first twelve months, the brain grows rapidly. Given that the first six months of life are crucial for the development of the speech and hearing systems and that these periods last until the age of two years, it is imperative that preterm infants who are jaundiced have early hearing screening.

Katarzyna et al, from their study "Hearing impairment in preterm newborn based on database of national screening in Poland" discovered that the relationship between hyperbilirubinemia and hearing loss in preterm infants is significant and is influenced by other risk factors like birth weight, the mean duration of hyperbilirubinemia, and acidotic incidents. Hyperbilirubinemia can cause selective injury of the Brainstem auditory nuclei, as well as damage to the auditory nerve and ganglion cells.[20] In our study the birth wight and acidotic incidents were not followed up frequently and so comparing the other risk factors would given an much more better view of the association of pretrem born childrens correlation to impaired hearing.

As stated by De Vries et al," preterm infants with hyperbilirubinemia, those with very low birth weight (≤ 1500 g) have a higher risk of deafness than healthy infants with birth weight > 1500 g".[26] In our study all the children underwent BERA where preterm with low birth wight, and compared to preterm children who did not have neonatal jaundice, children born or had history of preterm birth with neonatal jaundice and had history of low birth wight found to have positive reports in the screening for hearing impairment. As stated by Katarzyan et al, pathophysiology of this delayed process was unclear, but they suspect it may be caused by demyelinization or degeneration at points along the auditory pathway, which might play a major role in causing hearing impairment among children who are born prematurely. Numerous studies have shown that some infants treated in NICU may begin to develop hearing impairment at the age of 2-4 years.[20] In our study, we have studied 50 children with the history of NICU stay after birth and children below age 2 were reported with abnormal BERA report as in comparison to children above age of 2. In our study contrary to the study conducted by Katarzyan et al, had shown that

children below 2 years being reported with abnormal report might be because of the age group range, 30 children were below 6 months of age that is 60% of the children were under this age group and thus, the results were the age group of less than 2 years reported with abnormal BERA report compared to the children who were age group more than 2 years. In our study we have elevated 50 children presented with history of decreased hearing, low birth wight, NICU admission with jaundice and without jaundice presented to ENT OPD and Pediatric Neurology OPD and after evaluating they underwent appropriate management for the same. In a study conducted by Harlor et al, "Hearing impairment assessment beyond neonatal screening" he concluded that the hearing health care team, which includes the otorhinolaryngologist, audiologist, teachers of the child with hearing impairment, speech-language pathologists and other medical and educational personnel, is equally important for a child with hearing loss to ensure appropriate case management. Pediatric health care professionals should work together to refer the child for comprehensive educational counseling and treatment services, this will help in ensuring appropriate case management.[21]

CONCLUSION

Hearing impairment is an existing problem in our community. Speech and cognitive ability development are frequently delayed in children with hearing impairments. Our study found that compared to preterm babies without jaundice, children under five who were born preterm with jaundice and had a high prevalence of hearing impairment were more likely to experience hearing loss. As demonstrated by this, hearing impairment is more prevalent in children under five who have a history of preterm and jaundice. According to the WHO, this means that “primary ear and hearing care” or PEHC, is important. The BERA test is a more appropriate and sensitive test that is also reasonably priced. It can be used to screen all neonates and children at risk, parents who are concerned about their child's hearing, children who have a positive family history of hearing loss, children whose speech development is abnormal, and other groups affected by craniofacial malformations if universal screening for hearing is not practical. In our study majority of the cases were having wave V threshold elevation among the children screened for hearing. Early detection of hearing impairment and its associated problems is prevented in susceptible children with the use of BERA. Early rehabilitation promotes social and psychological well-being in the community, helps the child avoid disability, and aids in the development of cognitive abilities and speech.

SUMMARY

This research was conducted in KLES Dr. Prabhakar Kore Hospital and MRC, Belagavi between October 2022 to September 2023. This research was taken with the objective, comparing the prevalence of hearing impairment among the preterm children with jaundice and preterm children without jaundice by assessing the hearing sensitivity using BERA. Fifty cases (i.e. 100 ears) fulfilling the inclusion criteria of our study and after obtaining approval from participation they were enrolled in the study. All the fifty cases underwent BERA test after taking history, general and ENT examination as per the format mentioned in the proforma. Our study showed the following results: Age group varies from 15 days to 5 years of children were included in this study. Out of which 30 (60%) were between 15 days to 6 months, 11 (22%) were between 7 months to 12 months old and 9 (18%) were between 13 months to 5 years of age, with mean age of 13.30 ± 18.75 months**.** There were 31 males (62%) and 19 females (38%) with male predominance our study. Out of 50 samples, 19 were preterm with jaundice, and 31 were preterm without jaundice. Among 19 preterm with jaundice, 09 (29.3%) presented with abnormal report in bilateral ear. Among 31 Preterm without jaundice, 4 (21%) presented with abnormal report in bilateral ear. Report analysis of right ear showed 16 samples were abnormal. Among 16 samples, 12 (38.72%) were preterm with jaundice and 5 (21.05%) were preterm without jaundice. Among the abnormal report, wave V pattern mildly elevated and sensory pathology were reported. Among 16 (32%) abnormal BERA report, 9 (27%) of preterm with jaundice and 02 (10%) preterm without jaundice were reported with wave V elevation pattern and sensory pathology in the right ear. Report analysis of left ear showed 19(38%) showed abnormal report. Among 19 (38%) abnormal report,

14 (45.14%) were preterm with jaundice and 5 (26.31%) were preterm without jaundice. Among the abnormal report, 09 (28%) Preterm with jaundice and 05 (25%) Preterm without jaundice were reported with wave V pattern elevation and sensory pathology. In summary preterm children without jaundice have reported with more number of abnormal BERA report, but when analyzed in detail with different parameters of abnormal BERA report preterm children with jaundice showed more wave V threshold elevation and sensory pathology. Hence, proving the importance of assessing hearing status in preterm children with jaundice.

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ANNEXURES

ANNEXURE I:

INFORMED CONSENT FORM

"COMPARISON OF HEARING STATUS IN PRETERM CHILDREN WITH AND WITHOUT JAUNDICE USING BRAINSTEM EVOKED RESPONSE AUDIOMETRY"

Name of Student/Principal Investigator: **REG NO: BE0121008**

Name of Guide/Co Investigators: **_____**

Objective:

To assess and compare the hearing status of preterm children with and without jaundice using Brainstem Evoked Response Audiometry at KLE's Dr. Prabhakar Kore Hospital & Medical Research Center

Introduction:

Brainstem Evoked Response Audiometry (BERA) is an objective non-invasive method of evaluating auditory function, with special relevance to pediatric assessment and otoneurologic diagnosis. In this study we are comparing the hearing status of the preterm children with and without jaundice for earlier deduction of hearing impairment in those children.

Explanation of procedure:

If you agree to participate in this study, the relevant data will be collected as per the proforma and the final diagnosis will be confirmed. After getting inducted in the study, you will be evaluated on clinical examination. Following this the patient will then have to undergo CT scan examination and the scan will be studied.

Withdrawal from participation in the study:

Participation in this study is voluntary. You will be free to decide whether to participate in this study or continue participation once enrolled. In case you decide to withdraw your participation, you are free to do so.However, please convey the decision to the principal investigator.

Possible benefits from participating in the study: You will/will not have nor get any benefits by participating in this study. The data gathered will help the population at large.

Possible risks from participating in the study: There are no risks involved in participating in this study.

Privacy and confidentiality: The information collected from you will be coded, to prevent any person from identifying you. Your identity will never be revealed. The data collected from you will be kept confidential and only processed or aggregated data will be used for publication.

Financial incentives: You will not receive any payment for participating in this study.

Authorization for publication of aggregated data: Results obtained after processing of the aggregated data will be published for scientific purposes and or presented to scientific groups. However, your identity will never be revealed.

Questions:

If you have any question or complaints with regard to your right as study participant you may contact Dr Harsha Hegde, Chairperson, Ethical committee of JNMC, 0831-2473777 Extension 4052.

Legal rights: By signing this consent form, we are not waving any of your legal rights.

CONSENT STATEMENT

I am making a voluntary decision to participate in the study "**COMPARISON OF HEARING STATUS IN PRETERM CHILDREN WITH AND WITHOUT JAUNDICE USING BRAINSTEM EVOKED RESPONSE AUDIOMETRY**". My signature below indicates that I have decided to participate and I have read the information provided above or the information provided above has been read to me in the language that I understand best. I was given the opportunity to ask questions and that they have been answered to my satisfaction.

Name of the participant:

Signature or left thumb impression of the participant:

Name of the witness:

Signature or left thumb impression of the witness:

Name of the investigator:

Signature of the investigator:

ANNEXURE II:

PROFORMA

"COMPARISON OF HEARING STATUS IN PRETERM CHILDREN WITH AND WITHOUT JAUNDICE USING BRAINSTEM EVOKED RESPONSE AUDIOMETRY"

Date: Date of Birth:

Name: Address:

OP/IP No.: Date of Assessment:

Sex:

Gestational Age:

Corrected Gestational Age:

CHIEF COMPLAINTS:

HISTORY OF PRESENTING ILLNESS:

PAST HISTORY:

BIRTH HISTORY :

FAMILY HISTORY:

PERSONAL HISTORY:

GENERAL EXAMINATION:

Physical Examination

Pulse: Pallor

Respiratory Rate: Icterus

Temperature Cyanosis

Lymphadenopathy

Oedema

ENT Examination

NOSE EXAMINATION

External appearance

Root

Bridge

Dorsum

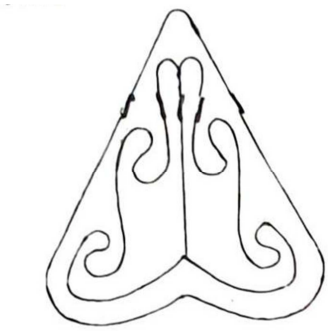
Alae

Tip

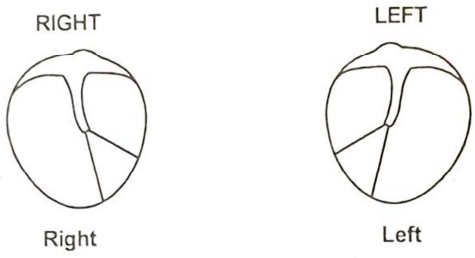
Columella

Tip elevation test

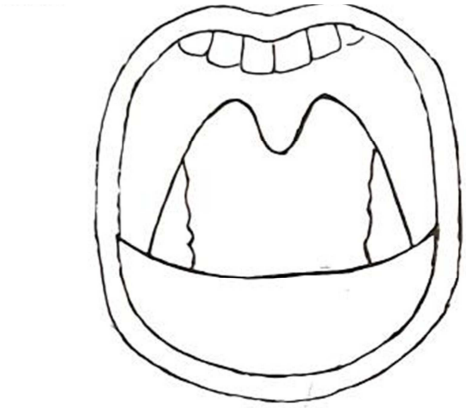
Anterior Rhinoscopy



EAR EXAMINATION:	RIGHT EAR	LEFT EAR
Pinna		
Preauricular area		
Post auricular area		
External auditory canal		
Tympanic membrane		



ORAL CAVITY and OROPHARYNX:



BLOOD REPORTS :

COMPLETE BLOOD COUNT :

HEMOGLOBIN :

TOTAL WBC COUNT:

LIVER FUNCTION TESTS:

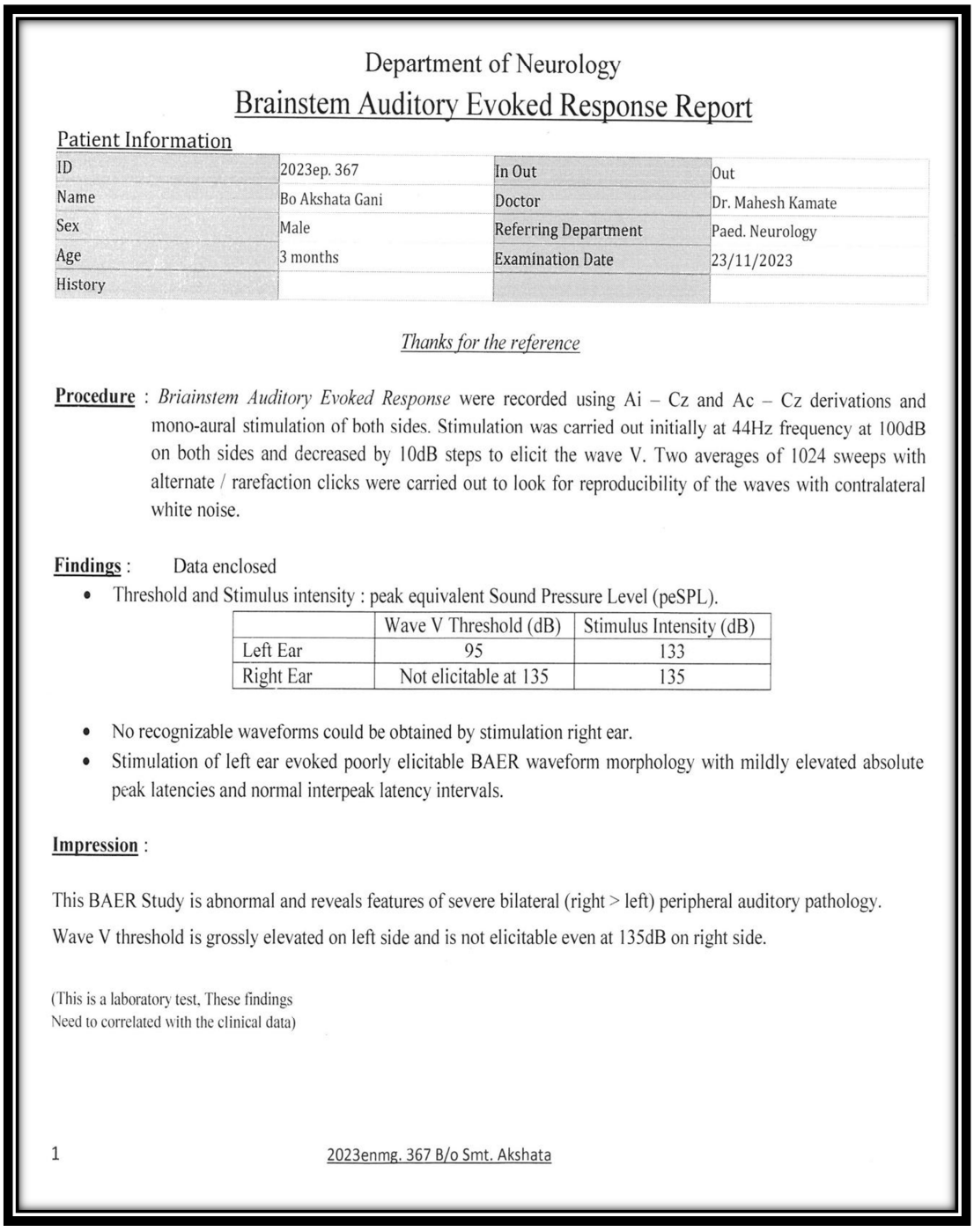
TOTAL BILIRUBIN :

DIRECT BILIRUBIN :

INDIRECT BILIRUBIN :

BRAINSTEM EVOKED RESPONSE AUDIOMETRY RESULT:

ANNEXURE III: PHOTOGRAPHS



Department of Neurology

Brainstem Auditory Evoked Response Report

Patient Information

ID	2023ep. 367	In Out	Out
Name	Bo Akshata Gani	Doctor	Dr. Mahesh Kamate
Sex	Male	Referring Department	Paed. Neurology
Age	3 months	Examination Date	23/11/2023
History			

Thanks for the reference

Procedure : *Briainstem Auditory Evoked Response* were recorded using Ai – Cz and Ac – Cz derivations and mono-aural stimulation of both sides. Stimulation was carried out initially at 44Hz frequency at 100dB on both sides and decreased by 10dB steps to elicit the wave V. Two averages of 1024 sweeps with alternate / rarefaction clicks were carried out to look for reproducibility of the waves with contralateral white noise.

Findings : Data enclosed

- Threshold and Stimulus intensity : peak equivalent Sound Pressure Level (peSPL).

	Wave V Threshold (dB)	Stimulus Intensity (dB)
Left Ear	95	133
Right Ear	Not elicitable at 135	135

- No recognizable waveforms could be obtained by stimulation right ear.
- Stimulation of left ear evoked poorly elicitable BAER waveform morphology with mildly elevated absolute peak latencies and normal interpeak latency intervals.

Impression :

This BAER Study is abnormal and reveals features of severe bilateral (right > left) peripheral auditory pathology.

Wave V threshold is grossly elevated on left side and is not elicitable even at 135dB on right side.

(This is a laboratory test, These findings
Need to correlated with the clinical data)

1 2023enmg. 367 B/o Smt. Akshata

PHOTO 1 - BERA NORMAL REPORT

Department of Neurology

Brainstem Auditory Evoked Response Report

Patient Information

ID	2023ep. 325	In Out	Out
Name	Siddi	Doctor	Dr. Manisha Bandankar
Sex	Female	Referring Department	Neonatology
Age	2 years	Examination Date	15/09/2023
History			

Thanks for the reference

Procedure : *Briainstem Auditory Evoked Response* were recorded using Ai – Cz and Ac – Cz derivations and mono-aural stimulation of both sides. Stimulation was carried out initially at 44Hz frequency at 100dB on both sides and decreased by 10dB steps to elicit the wave V. Two averages of 1024 sweeps with alternate / rarefaction clicks were carried out to look for reproducibility of the waves with contralateral white noise.

Findings : Data enclosed

- Threshold and Stimulus intensity : peak equivalent Sound Pressure Level (peSPL).

	Wave V Threshold (dB)	Stimulus Intensity (dB)
Left Ear	50	120
Right Ear	50	120

- Stimulation of both the ears evoked normal BAER waveform morphology.
- The absolutepeak latencies and interpeak latency intervals are within normal limits on both sides.

Impression :

Normal BAER Study on both sides including wave V threshold for the age.

(This is a laboratory test, These findings
Need to correlated with the clinical data)

1 2023ep. 325 Siddi

PHOTO 2 - BERA NORMAL REPORT SHOWING WAVE V CHANGES.

Department of Neurology

Brainstem Auditory Evoked Response Report

Patient Information:

ID NO.:	2023ep. 050		
Name:	Kavya Hegde	Date:	17/02/2023
Sex:	Female	In/Out Patient:	In/1170995 MCH
		Refer Dept:	Paed. Neurology
Age:	5 month	Doctor:	Dr. Mahesh Kamate
History	ROP with obstructed hydrocephalus (resolved)		

Thanks for the reference

Procedure : *Brainstem Auditory Evoked Response* were recorded using Ai – Cz and Ac – Cz derivations and mono-aural stimulation of both sides.

Stimulation was carried out initially at 44Hz frequency at 100 dB on both sides and decreased by 10 dB steps to elicit the wave V.

Four averages of 1024 sweeps with alternate clicks were carried out to look for reproducibility of the waves with contralateral white noise.

Findings : Data enclosed

- Threshold and Stimulus Intensity : peak equivalent sound pressure level (peSPL)

	Wave V Threshold (dB)	Stimulus Intensity (dB)
Left Ear	70	135
Right Ear	50	120

- Stimulation of both the ears evoked normal BAER waveforms morphology.
- The absolute peak latencies and interpeak latency intervals are within normal limits on both sides for the age.

CONCLUSION :

Normal BAER Study on both sides for the age.

Wave V threshold is elevated on left side.

(This is a laboratory test. These findings need to correlated with the clinical data).

Page 1

2023ep. 250 Kavya

PHOTO 3- BERA ABNORMAL REPORT SHOWING WAVE V ELEVATION IN LEFT EAR

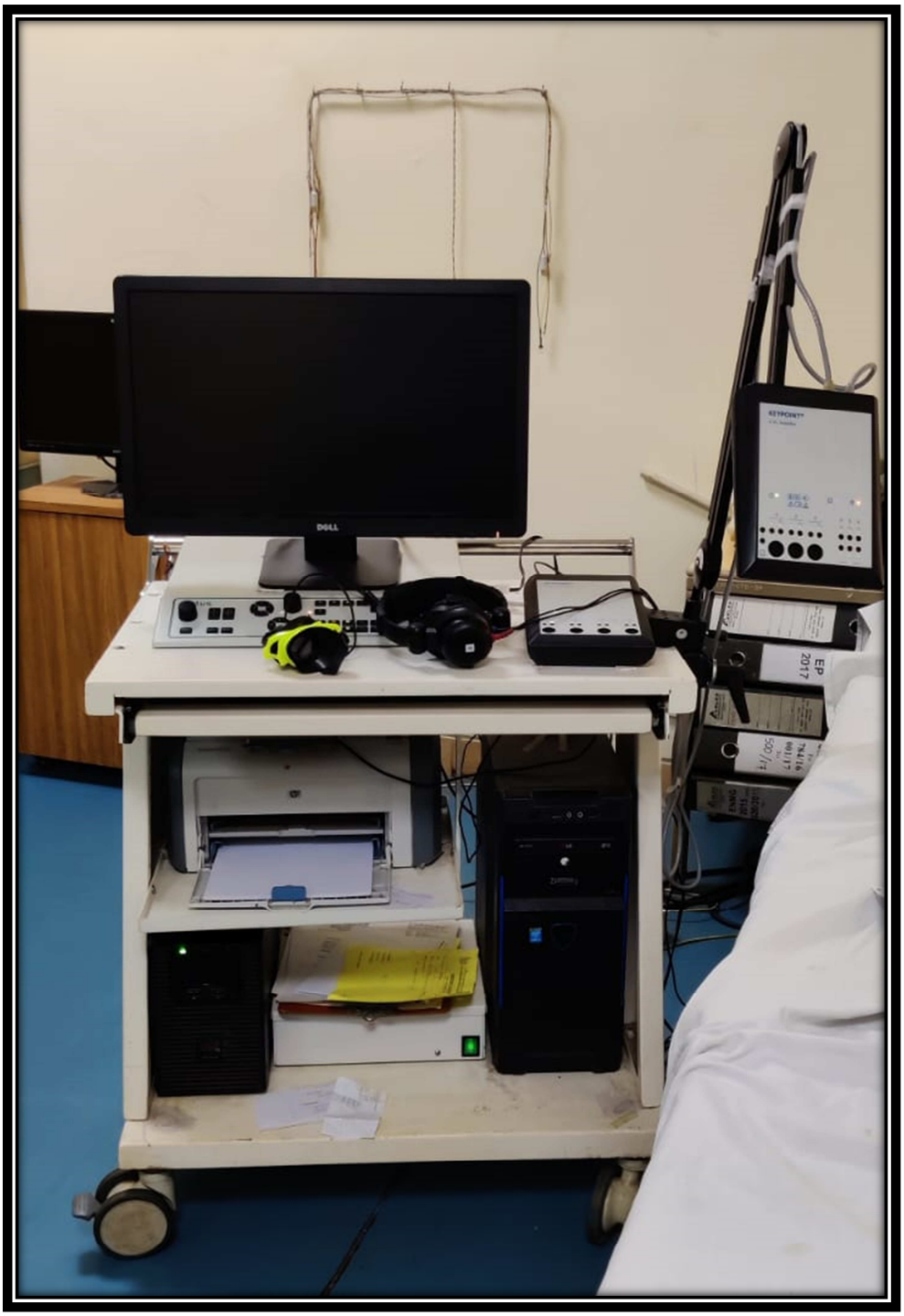


PHOTO 4- BERA CONSOLE ROOM AND MECHINE

ANNEXURE IV: MASTER CHART

S.NO	IP.NO	AGE/SEX	SEX	PRETERM+JAUNDICE	PRETERM-JAUNDICE	BERA REPORT RIGHT EAR	BERA REPORT LEFT EAR	OAE RIGHT	OAE LEFT
1	1125670	4 Month	Male		Yes	Normal Wave Pattern	Normal Wave Pattern	Pass	pass
2	6550665	3 Month	Male	Yes		Normal Wave Pattern	Normal Wave Pattern	Pass	pass
3	6690048	17 Days	Male	Yes		Abnormal Wave Pattern	Abnormal Wave pattern - wave V abormality	Refer	Refer
4	1154383	!7 Days	Male	Yes		Normal Wave Pattern	Normal Wave Pattern	Pass	pass
5	6718916	3 Month	Female		Yes	Normal Wave Pattern	Normal Wave Pattern	Pass	pass
6	6738568	3 Month	Female	Yes		Normal Wave Pattern	Normal Wave Pattern	Pass	pass
7	6626184	6 Month	Male	Yes		Normal Wave Pattern	Normal Wave Pattern	Pass	pass
8	1161231	1 Month	Female		Yes	Normal Wave Pattern	Normal Wave Pattern	Pass	pass
9	6708125	3 Month	Female	Yes		Normal Wave Pattern	Normal Wave Pattern	Pass	pass
10	6731642	3 Month	Female	Yes		Normal Wave Pattern	Normal Wave Pattern	Pass	pass
11	6882632	3 Month	Male	Yes		Normal Wave Pattern	Normal Wave Pattern	Pass	pass
12	1170995	5 Month	Female	Yes		Normal Wave Pattern	Normal Wave Pattern	Pass	pass
13	1173778	1 Year	Male	Yes		Normal Wave Pattern	Normal Wave Pattern	Pass	pass
14	1180343	5 Month	Male		Yes	Normal Wave Pattern	Normal Wave Pattern	Pass	pass
15	6781412	4 Month	Male	Yes		Normal Wave Pattern	Normal Wave Pattern	Pass	pass
16	6731334	6 Month	Male	Yes		Abnormal with wave V elevation	Abnormal with wave V elevation	Refer	Refer
17	6809468	5 Years	Male	Yes		Normal Wave Pattern	Normal Wave Pattern	Refer	Pass
18	1177465	3 Month	Yes			Normal Wave Pattern	Normal Wave Pattern	Pass	Pass
19	1149895	5 Month	Male		Yes	Normal Wave Pattern	Normal Wave Pattern	Pass	pass
20	6781689	5 Month	Male	Yes		Normal Wave Pattern	Normal Wave Pattern	Pass	pass
21	1173778	1 Year	Male	Yes		Normal Wave Pattern	Normal Wave Pattern	Pass	pass
22	6994480	10 Month	Female	Yes		Normal Wave pattern	Abnormal Wave pattern - Right Peripheral Auditory Pathalogy	Refer	Refer
23	5120389	5 Years	Male		Yes	Normal Wave Pattern	Normal Wave Pattern	Pass	pass
24	6782384	3 Month	Female	Yes		Abnormal with wave V elevation	Abnormal Wave pattern - wave V abormality	Refer	Refer
25	1178632	1 Year	Male		Yes	Normal Wave Pattern	Normal Wave Pattern	Pass	pass
26	6325687	4 Month	Female	Yes		Normal Wave Pattern	Normal Wave Pattern	Pass	pass
27	3796565	10 Month	Male		Yes	Abnormal Wave Pattern -Sever Sensory Pathology	Abnormal Wave Pattern -Sever Sensory Pathology	Refer	Refer
28	1263348	14 Days	Female	Yes		Abnormal Wave Pattern -Sever Sensory Pathology	Abnormal Wave Pattern -Sever Sensory Pathology	Refer	Refer
29	6326899	3 Years	Female		Yes	Abnormal Wave Pattern -Sever Sensory Pathology	Abnormal Wave Pattern -Sever Sensory Pathology	Refer	Refer
30	2653282	3 Month	Male		Yes	Normal Wave Pattern- Wave V mildly elevated	Normal Wave Pattern- Wave V mildly elevated	Refer	Refer
31	282562	3 Month	Female		Yes	Abnormal Wave Pattern -Sever Sensory Pathology	Abnormal Wave Pattern -Sever Sensory Pathology	Refer	Refer
32	3122023	5 Years	Male		Yes	Normal Wave Pattern	Normal Wave Pattern- Wave V mildly elevated	Refer	Refer
33	3292023	4 Year	Male		Yes	Normal Wave Pattern	Normal Wave Pattern	Refer	Refer
34	30923204	2 Month	Female		Yes	Abnormal Wave Pattern- Pheripharal Audio pathology	Abnormal Wave Pattern- Pheripharal Audio pathology	Refer	Refer
35	3252023	2 Years	Female		Yes	Normal Wave Pattern	Abnormal Wave Pattern	Refer	Refer
36	2662018	5 Years	Male		Yes	Abnormal Wave Pattern	Normal Wave Pattern	Refer	Refer
37	3652023	4 Month	Female		Yes	Normal Wave Pattern- Wave V mildly elevated	Normal Wave Pattern- Wave V mildly elevated	Refer	Refer

38	3642023	8 Month	Male		Yes	Abnormal Wave Pattern	Abnormal Wave pattern - Peripheral Auditory Pathalogy	Refer	Refer
39	3292023	4 Year	Male		Yes	Normal Wave Pattern	Normal Wave Pattern	Pass	pass
40	3612023	3 Month	Female		Yes	Normal Wave Pattern	Normal Wave Pattern	Pass	pass
41	3442023	5 Month	Male		Yes	Normal Wave Pattern	Normal Wave Pattern	Refer	Refer
42	3402023	6 Years	Male		Yes	Abnormal Wave Pattern- Pheripharal Audio pathology	Abnormal Wave pattern - Peripheral Auditory Pathalogy	Refer	Refer
43	7203034	1 Year	Male		Yes	Normal Wave Pattern	Normal Wave Pattern	Refer	Refer
44	3582023	1 Month	Female		Yes	Normal Wave Pattern	Abnormal Wave pattern - wave V abormality	Refer	Refer
45	3662023	1 Year	Female		Yes	Abnormal Wave Pattern	Abnormal Wave Pattern	Refer	Refer
46	3672023	9 /month	Female		Yes	Normal Wave Pattern	Normal Wave Pattern	Pass	pass
47	3782023	7 Month	Male		Yes	Non Elecitable - severe peripharal auditory pathology	Non Elecitable- severe peripharal auditory pathology	Refer	Refer
48	7892320	10 Month	Male		Yes	Normal Wave Pattern	Normal Wave Pattern	Refer	Refer
49	3802320	2 Month	Male		Yes	Normal Wave Pattern	Normal Wave Pattern	Refer	Refer
50	3672023	3 Month	Male		Yes	Abnormal Wave Pattern- Pheripharal Audio pathology	Abnormal Wave pattern - Peripheral Auditory Pathalogy	Refer	Refer