

## Research Article

# A study of brainstem evoked response audiometry in term neonates with hyperbilirubinemia

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## ABSTRACT

**Background:** Brainstem evoked response audiometry (BERA) has been one of the non-invasive methods to identify the hearing abnormalities in the newborn. This study was done to determine the Incidence of hearing abnormalities during hyperbilirubinemia and to assess the Correlation of high bilirubin levels with abnormal BERA finding in the study population.

**Methods:** This was a longitudinal observational study comprising of 54 term babies with a mean gestational age of 38.1wks which also included 10 term low birth weight babies. Babies selected for the study had hyperbilirubinemia (>15mg/dl) due to various causes in a tertiary care hospital in Bangalore city. BERA was done in all these babies separately in the both ears using 40db and 80db stimuli at birth, 1st month and 3rd month. Consent was obtained before the start of the study. Student t-test was applied wherever necessary to analyze the data.

**Results:** Mean age of appearance of jaundice was 5.2 days (4-7 days). Abnormal Auditory Brain Response (ABR) changes were seen in 28 (51.9%) babies at birth, 19 infants (37%) at 1st month and 7 (13%) at 3rd month during follow up.

**Conclusions:** Hearing loss due to hyperbilirubinemia is a transient phenomenon, which reverts back to normal gradually, with only a small percentage going for permanent damage.

**Keywords:** Hearing loss, BERA, ABR and hyperbilirubinemia

## INTRODUCTION

Neonatal hyperbilirubinemia continues to be a problem, responsible for neonatal morbidity and mortality and Jaundice is one of the most common problems occurring in newborns.<sup>1</sup> Although most of the jaundiced babies are normal, because of the Bilirubin toxicity, high serum levels can lead to kernicterus Bilirubin encephalopathy. Therefore it is very important to identify and evaluate the jaundice early, to prevent the complication like Bilirubin encephalopathy, leading to hearing loss. Such early detection is possible only if some routine screening is used. Neonates and infants cannot be tested reliably by

conventional audiometric methods. Therefore in order to get reliable results, a test which does not require the patient's active co-operation is needed. The Auditory Brain Response (ABR) is such a test.

ABR is a non –invasive technique to find the integrity of central auditory pathways through the 8<sup>th</sup> nerve, pons and mid brain. BERA is a useful, non-invasive tool to test the difficult to test neonates.<sup>2</sup> In this method, electrical potentials are generated in response to several click stimuli and picked from the cortex by surface electrodes.

The brain stem evoked audiometry is of great value to find out the threshold of hearing in infants, particularly the high- risk groups, one of it being hyperbilirubinemia, and also in the diagnosis of retro cochlear pathology. Early identification of hearing impairment improves prognosis.<sup>3</sup>

## METHODS

This was a Longitudinal Observational study which was conducted on 54 babies with neonatal jaundice. They were subjected to BERA tests soon after the appearance of jaundice and were followed up at first month and third month. This study approved by the ethical committee was conducted in the Neonatal Intensive Care Unit, Department of Paediatrics, Kempegowda institute of Medical sciences, Bangalore.

Informed consent was obtained from the parents for the Brain Stem Evoked Response Audiometry test. 54 term neonates with Hyperbilirubinemia were studied during one year period from June 2003 to June 2004.

### Inclusion criteria

- Term Neonates with indirect serum Bilirubin levels more than 15mg/dl.
- Low birth weight babies with indirect serum Bilirubin levels more than 15mg/dl.

### Exclusion criteria

- Neonates with Hyperbilirubinemia associated with complications like RDS, Sepsis (Kernicterus) and Birth Asphyxia.
- Babies born to Mothers consuming drugs producing ototoxicity. E. g. Amino glycosides.
- Babies delivered outside the Institute.
- Babies born to mothers who do not Consent for the study.

### Auditory brain response method

The test was performed with the subject in a quiet resting state. The stimuli consist of many (one to three thousand) clicks of a pre-set intensity. They are delivered to the ear being tested by either headphones or special earplugs, at an intensity of 40dB and 80dB .The electric potentials that are evoked by each response are detected by 3scalp electrodes, amplified and averaged by Computer .The averaged recordings were displayed graphically. Only the potentials occurring within 10 milli seconds of the stimulus were studied for the ABR. Since electrodes are not in direct contact with the neurophysiologic electric generators, this process is known as 'far field' recording. Of the 5 to7 waves that constitute an ABR, waves I, III, V can be obtained consistently, whereas waves II and IV appear inconsistently between and within the subjects.

## Data analysis

The numerical data is presented as percentages. Tests of significance like Student t test was applied wherever necessary. The data was entered in MS Excel and SPSS 16 was used to analyse the data.

## RESULTS

**Table 1: Day of Appearance of Jaundice among the study population.**

Day	Frequency	Percent
3	4	7.4
4	8	14.8
5	16	29.6
6	22	40.7
7	4	7.4
Total	54	100.0

Out of 54 neonates, large number of babies showed peak of Jaundice on day 6.i.e 22 (40.7%) and 16 (29.6%) on day 5, 4 (7.4%), 8 (14.8%) and 4 (7.4%) babies had peak Jaundice on day 3, 4 and 7 respectively.

**Table 2: BERA at the time of appearance of jaundice.**

BERA findings	Frequency	Percent
Normal	26	48.1
Abnormal	28	51.9
Total	54	100.0
BERA findings	Frequency	Percent

BERA test was done in all 54 babies, out of which 28 (51.9%) were abnormal and 26 (48.1%) were normal at the time of appearance of jaundice.

**Table 3: BERA at 1st month.**

BERA findings	Frequency	Percent
Normal	34	63.0
Abnormal	20	37.0
Total	54	100.0
BERA findings	Frequency	Percent

Out of the BERA test done in 1<sup>st</sup> month, 34 (63%) were normal and 20 (37%) were abnormal

**Table 4: BERA at 3rd month.**

BERA findings	Frequency	Percent
Normal	47	87.0
Abnormal	7	13.0
Total	54	100.0

Among the BERA done in 3<sup>rd</sup> month, 47 (87%) were normal, 7 (13%) were abnormal.

**Table 5: Mean, SD of indirect serum Bilirubin, t-value & significance level of BERA at the time of appearance of jaundice.**

BERA	N	Mean	Std. Deviation
Normal	26	16.3346	2.14400
Abnormal	28	17.5500	2.75822

T=1.798; D. F=52 p>0.05

Student t-test was applied to test the mean difference between normal and abnormal BERA at the time of appearance of jaundice and no significance mean difference was found.

**Table 6: Mean, SD of indirect serum Bilirubin, t-value and significance level of BERA at 1st month.**

BERA	N	Mean	Std. Deviation
Normal	34	16.4000	2.26849
Abnormal	20	17.9250	2.72549

T=2.213; D.F=52; p<0.05

Student's t-test was applied to test the mean difference between normal and abnormal BERA at 1<sup>st</sup> month. There was a significance difference between normal and abnormal BERA at 1<sup>st</sup> month.

**Table 7: Mean, SD of indirect serum Bilirubin, t-value and significance level of BERA at 3rd month.**

BERA	N	Mean	Std. Deviation
Normal	47	16.8298	2.52878
Abnormal	7	17.8714	2.56497

T=1.015; D.F=52; p>0.05

Student's t-test was applied to test the mean difference between normal and abnormal BERA at 3<sup>rd</sup> month and no significant difference was found.

## DISCUSSION

It is widely accepted fact that the earlier rehabilitation of a child with hearing loss starts, better outcome. Yet the diagnosis of the hearing impairment is often delayed. Even in the advanced countries it is an exception rather than a rule for the hearing loss to be detected in the first or even second year of the child's life.

Many centers in developed countries have program for hearing screening, both in the neonatal period and infancy and such programs have helped to detect the infants with hearing loss in time to ensure normal language development by appropriate intervention; like hearing aids and infant stimulation.<sup>3</sup> Of all the screening programs for neonates it is the screening for deafness, which gives the maximum yield and is the most cost-effective.<sup>4</sup> BERA is a simple, reliable and effective technique for determining auditory functions in the neonates especially changes of early bilirubin toxicity.<sup>5</sup>

Unfortunately neonatal screenings of any kind, let alone for hearing loss, has been neglected field India. A feasible system would be one where a hospital like ours offers facilities for ABR to neonates referred from peripheral hospitals and health centers. A high-risk register could be maintained for those children with suspect hearing loss so that recalling them for follow-up and periodic monitoring is facilitated.

With the increasing emphasis on neonatal care and the improving survival of high-risk neonates, the chances of hearing impairments in survivors are likely to be quite high. We studied the auditory functions of jaundice neonates from the neonatal intensive care unit using Auditory Brainstem Response (ABR) to find out the prevalence of abnormalities at the time of discharge.

Various authors have used stimuli ranging from 25db to 80db eliciting the ABR. There has been no uniformity in the number of stimuli used. The rate of click presentation and the polarity of the clicks and even in criteria for ABR failure.

Although neonates can appreciate 20db level stimuli, a stimuli levels 80db has been found to be specific for persistent hearing abnormality.<sup>6</sup>

A Causative relationship between neonatal jaundice and irreversible brainstem damage has been established on the basis of clinicopathological correlation and audiometry. The findings of evidence of an apparently specific functional lesion of hyperbilirubinemia indicating severe neural damage but sparing of cochlear hair cells, has reinforced the contention that Bilirubin toxicity involves the neural auditory pathways than the cochlea.

In the present study, 54 babies with hyperbilirubinemia satisfying the inclusion criteria were selected. The Average gestational age was 38+1 wks with average birth weight of 2.71kgs. Appearance of jaundice was between 5-7 days average being 5.26 days.

In the present study, ABR was done in term-jaundice babies with their serum bilirubin levels >15mg/dl, average bilirubin levels being 17.125mg/dl. No correlation was found between the high serum bilirubin levels and BERA abnormality indicating that ABR abnormalities due to bilirubin toxicity are a transient process. The finding of an evidence of acute toxic process in brainstem, in otherwise well infants, in this study challenges the concepts of mechanism of transfer of bilirubin to brain, similar observations was also made in the study by Max Perlman et al.<sup>7</sup>

In the present study 27 babies were found to be having abnormal BERA initially, out of which majority reverted back to normal by the end of the 3<sup>rd</sup> month, only 7 had persistent ABR abnormalities. A propensity for rapid reversibility of disturbances was noted; most probably the

observed aberrant brainstem function was due to an acute toxic encephalopathy caused by bilirubin, as the jaundiced babies were free of pathological process other than the hyperbilirubinemia such as asphyxia and polycythaemia. The rapid reversibility of the changes of ABR with resolution of the jaundice reinforces this contention. This was consistent with the study by Max Perlman et al.<sup>7</sup>

Although the rapid reversibility of the observed changes in ABR in jaundiced infants in present study is encouraging, the possibility of subtle damage to the auditory or other brainstem pathways cannot be excluded. A targeted approach for hearing screening may be more feasible in resource limited settings.

## CONCLUSION

From present study, we concluded that,

1. Hyperbilirubinemia is one of the most common problems seen in the newborn period and contributes significantly to the neonatal morbidity and mortality.
2. Hearing loss is one of the most important morbidity following hyperbilirubinemia.
3. Brainstem Evoked Response Audiometry is one of the non –invasive methods to detect the hearing loss at the earliest.
4. BERA test was done in all the babies included for the study at the peak of jaundice was later followed the 1<sup>st</sup> month and 3<sup>rd</sup> month.
5. Majority of the babies (51.9%) showed BERA abnormalities at the time of appearance of jaundice and by the end of 3<sup>rd</sup> month, only 7 (13%) babies had persisted abnormality.
6. Hearing loss due to hyperbilirubinemia is a transient phenomenon, which reverts back to normal

gradually, with only a small percentage going for permanent damage.

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