

ORIGINAL RESEARCH ARTICLE

POTENTIALITY OF BERA AS ESSENTIAL DIAGNOSTIC MARKER FOR EARLY DIAGNOSIS OF HEARING LOSS IN HIGH RISK GROUP IN PAEDIATRIC POPULATION; AN INSTITUTIONAL STUDY

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DOI URL- <https://doi.org/10.21176/ojohns.2018.12.1.3>**ABSTRACT:**

Introduction: Development of auditory function in newborn infants is revealed by auditory brainstem potentials. Effects of brainstem and cochlear disorders on auditory brainstem potentials were noted in abnormal infants. BERA is established method of testing hearing of newborns, neonates and infants. It is used as method of screening for deafness in this age group particularly for at risk patients. It is Non invasive modality to assess neural integrity of auditory pathway. In this study we focus on early identification of infants with high risk of impaired hearing and also observe pattern of maturation of auditory pathways as age advances in high risk infants so that rehabilitation can be initiated when brain is sensitive to development of speech and language.

Objectives

1. To study neural maturity in neonatal auditory pathway by absolute latencies, Inter wave latency delay by BERA
2. To study progression /regression of myelination by observing wave morphology at periodical intervals at birth, 3months, 6month in high risk infants.

Materials and Methods:

Observations and Results: An observational study was conducted from December 2013 to may 2015 in Department of ENT where Study group comprised of 30 babies with more than one high risk factor for hearing loss. 25 full term normal neonates taken as control group were included in study. In majority of the infants when BERA was performed only wave I, III & V could be definitely identified. In group comprising of 30 high risk neonates BERA was performed and no response was obtained from 10 neonates. Remaining 20 neonates showed abnormal BERA. Response parameters were prolonged absolute latencies of wave I, II, III, V at 90db, wave IV not found in any case. Prolonged inter peak latencies of I-III, III-V, V-I were obtained at higher frequencies. Time interval of wave I-III, III-V, V-I were obtained by subtracting latency of peak I from III, V & wave III from V of BERA response derived at higher intensities.

Discussion and Conclusion: Early diagnosis and timely intervention for deaf and hard of hearing in newborns provides proper path for normal development of hearing impaired. All normal newborns and high risk infants should undergo hearing evaluation within first 6 months followed by thorough diagnostic evaluation and follow-up for infants who fail their initial testing.

Key Words: Auditory Brainstem Responses, Deafness, Neural, Developmental delay.

INTRODUCTION:

Development of auditory function in newborn infants is revealed by auditory brainstem potentials¹. The developing child must pass through critical periods of language acquisition and even a mild hearing loss can interfere with this natural growth. The effects of brainstem and cochlear disorders on auditory brainstem potentials were noted in several abnormal infants.

The harmful effects of hearing loss on the development of a child's ability to learn, to communicate and to socialize

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have stimulated efforts to initiate rehabilitative procedures early in life².

Brainstem evoked response audiometry referred from here onwards as BERA which are auditory brain stem responses are now an established method of testing the hearing of newborns, neonates and infants. It is being used as a method of screening for deafness in this age group particularly for at risk patients. It is a Non invasive modality to assess neural integrity of the auditory pathway³.

In this study we tried to focus and observe on early identification of infants with high risk of impaired hearing and also observe the pattern of maturation of auditory pathways as age advances in high risk infants so that rehabilitation can be initiated when brain is sensitive to development of speech and language.

OBJECTIVES:

1. To study neural maturity in neonatal auditory pathway by absolute latencies, Inter wave latency delay by BERA
2. To study progression/regression of myelination by observing wave morphology at periodical intervals at birth, 3months, 6month in high risk infants.

MATERIALS AND METHODS:

An observational study was conducted from December 2013 to may 2015 in Department of ENT where Data regarding the antenatal, birth history and detailed examination of the newborn were collected in a predesigned Proforma.

Study group comprised of 30 babies with more than one high risk factor for hearing loss. 25 full term normal neonates taken as control group were included in the study. Initial evaluation of BERA was performed within 3days of hospitalization after obtaining informed consent from parents. 1st follow up was performed at 3 months and 2nd follow up was performed at 6months in all these babies who included both high risk and normal neonates.

Data regarding the antenatal, birth history and detailed examination of the newborn were collected in a predesigned Proforma. Neonates with following high risk factors of prematurity, hyperbilirubinaemia, Delayed birth cry, consanguinity, family h/o deafness, family h/o congenital anomalies, high risk pregnancies, h/o miscarriages, meningitis, low birth weight, septic shock were included in the study comprising of study group. Another group of babies were considered as a control group consisting of Full term Neonates without risk factors.

Audiological testing was performed in a sound proof room with electrical isolation and with good ambience. Equipment used for testing is GSI audera with insert ear phones. BERA testing was performed by qualified

Audiological professional who had adequate experience in performing and analysis of BERA. Patient is placed in supine position over soft cushioned couch and mother/ care giver was present during testing, all neonates were given sedation for carrying out BERA.

For BERA recording, a filter setting of 30-3000Hz is recommended to enhance the BERA when testing infants. Electrical activity picked up by the recording electrodes within the specified window must be processed through several stages to visualise the BERA wave form. This is because the BERA peaks are of extremely small voltage ($> 1\mu v$) and are buried in a back ground of interference, which includes ongoing electroencephalogram activity, muscle potentials caused by movement or tension, and 50Hz power-line radiation. The stages of processing include amplification, filtering, and signal averaging.

A standard Protocol was followed for performing the procedure where Click acoustic stimuli with rate of 11.1/sec was administered to all the babies. A Rarefaction in polarity was presented by insert ear phone to each ear at varying intensities from 90-30dbnHL. A Time window was 15 milliseconds was maintained with a Filter setting of 30-3000Hz. The presence of wave V at the intensity of 30dBnHL was taken as the normal threshold. BERA measures considered for diagnosis were absolute latencies of wave I, III, V, Inter peak latencies of I-III, III-V, I-V and Progression and regression of wave morphology.

After obtaining BERA recording detailed analysis was carried out with the help of audiologist. Auditory brainstem evoked potentials are used to observe the pattern of maturation of the auditory pathways in terms of absolute latency, Interaural latency delay at the time of birth at 0-3 days, 3 months, 6 months and documented. The response latencies in milliseconds were obtained by establishing peak of the wave and reading out the digitally displayed time.

OBSERVATIONS AND RESULTS:

A total 55 neonates were included in the study, among them 30 children were high risk neonates and 25 were normal neonates forming the control group tested at 0-3days, at 3 months, and at 6months of age. In the majority of the infants when BERA was performed only wave I, III & V could be definitely identified.

In the group comprising of 30 high risk neonates BERA was performed and no response was obtained from 10 neonates. Remaining 20 neonates showed abnormal BERA. Response parameters in this study were prolonged absolute latencies of wave I, II, III, V at 90db, wave IV not found in any case. Prolonged inter peak latencies of I-III, III-V, V-I were obtained at higher frequencies. The time interval of wave I-

III, III-V, V-I were obtained by subtracting the latency of peak I from III, V & wave III from V of BERA response derived at higher intensities.

The following high risk factors were documented in the neonates comprising the high risk group of 30 where prematurity was observed in maximum 20.0% and craniofacial anomalies form the least in 3.33% of neonates. These findings were documented in the Table I mentioned below.

Table- I : High Risk Factors Distribution in Neonates with Delayed BERA Responses & Absent BERA Responses (n=30)

High Risk Factor	Distribution	Percentage
prematurity	6	20.0
hyperbilirubinaemia	5	16.67
h/o consanguinity	2	6.67
Delayed birth cry	3	10.0
Low birth weight	4	13.33
Family h/o deafness	3	10.0
meningitis	3	10.0
Birth asphyxia with hypoxic encephalopathy	3	10.0
Craniofacial anomalies	1	3.33

BERA responses in 25 normal neonates show that as age advances absolute latencies from age 0-3 days to 6 months of wave I, III, V have decreased. Also it was observed that Inter Peak Latencies of wave I-III, III-V, and V-I also decreased. These results were tabulated in the Table II mentioned below. Absolute Latencies of 20 High Risk Infants from age 0-3days to 6months of age show marked decrease in absolute latencies of wave I ranges from 2.7-3.0ms to 1.3-1.5ms, wave II from 3.6-

Table- II: Range of Responses of BERA in normal neonates (n=25)

AGE	Absolute Latency			Inter Peak Latency delay		
	WA VE-I	WA VE-III	WA VE-V	I-III	III-V	V-I
0-3DA YS	2.0-2.2m sec	4.2-4.4m sec	6.6-6.8m sec	2.1-2.3 msec	2.3-2.5 msec	4.5-4.7 msec
3 MON THS	1.5-1.7m sec	3.9-4.1m sec	6.3-6.5m sec	2.3-2.5 msec	2.3-2.5 msec	4.7-4.9 msec
6 MON THS	1.9-2.1m sec	4.0-4.2m sec	6.0-6.2m sec	2.0-2.2 msec	1.9-2.1 msec	4.0-4.2 msec

Table-III: Range of Responses of BERA in 25 High Risk Infants

AGE	ABSOLUTE LATENCY			IPL		
	WA VE-I	WA VE-III	WA VE-V	I-III	III-V	V-I
0-3DA YS	2.7-3.0m sec	4.6-5.0m sec	7.0-7.5m sec	1.9-2.0 msec	2.4-2.5 msec	4.3-4.5 msec
3 MON THS	1.4-1.6m sec	4.0-4.3m sec	6.2-6.6m sec	2.6-2.7 msec	2.2-2.3 msec	4.8-5.0 msec
6 MON THS	1.3-1.5m sec	3.8-4.2m sec	6.0-6.3m sec	2.5-2.7 msec	2.2-2.1 msec	4.7-4.8 msec

3.8ms to 2.2-2.5ms, wave III from 4.6-5.0ms to 3.8-4.2ms, wave V from 7-7.5ms to 6-6.3ms were observed from 0-3 days to 6 months. Inter Peak Latencies are prolonged in these children from 0-3 days to 6 months. There is no decrease in I-III and V-I. Wave morphology in 20 high risk neonates ranges from average to poor. These results were tabulated in the Table III mentioned below.

When the average difference of BERA responses between high risk and normal neonates was compared it was observed that the difference is decreased in absolute latencies of wave I, III, V from 0-3 days to 6 months. The difference in Inter Peak Latencies between high risk and normal neonates is more from 0-3 days to 6 months.

It is observed that in present study wave morphology in 20 high risk neonates ranges from average to poor. In 10 neonates who have absent BERA wave morphology was very poor, not repeatable and peaks could not identify from 0-3 days to 6 months. In neonates who had delayed BERA

Table -IV: Difference of BERA Responses in High Risk & Normal Neonates (Average)

AGE	ABSOLUTE LATENCIES			INTER PEAK LATENCIES		
	WA VE-I	WA VE-III	WA VE-V	I-III	III-V	V-I
0-3DAY S	0.8m sec	0.5m sec	0.6m sec	0.2m sec	0.1m sec	0.2m sec
3MON THS	0.1m sec	0.2m sec	0.1m sec	0.2m sec	0.1m sec	0.1m sec
6MON THS	0.6 msec	0.2m sec	0.1m sec	0.5m sec	0.3m sec	0.6m sec

response, the wave morphology was average with fail repeatability.

Response for average to poor morphology can be attributed to inadequate myelination of auditory pathway from cochlear level to brain stem level. In normal neonates there is good peak to peak repeatability & good wave morphology.

DISCUSSION:

Congenital hearing loss is one of the most common congenital anomalies which can be identified early in life. Its early recognition and intervention helps in the overall development of the child⁴. The aim of hearing screening is to early detection and early intervention of hearing loss. BERA is a very valuable Audiological investigation for neonates and the otherwise difficult to test child as one of the most reliable measures of neural integrity in the cochlear and caudal brainstem pathway⁵. Long term follow-up is needed to study the correlation between early ABR morphology and the effects on hearing function, speech and language development later in life.

In our study among 30 high risk infants who underwent BERA, 20 neonates (66.6%) got abnormal BERA response in the form of prolonged absolute latencies. These prolonged absolute latencies of wave I, II, III, V decreases as age advances from 0-3 days to 6 months. These prolonged absolute latencies of wave I, II, III, V during 0-3 days of birth are due to delayed maturation and myelination of auditory pathway due to high risk factors. It is also observed that wave IV was absent in all these neonates. This absence of wave IV is because of incomplete myelination of auditory pathway.

The inverse correlation between gestational age and absolute latencies shows that as gestational age increases - and the brainstem in the central nervous system matures - there is a continuous decrease in absolute wave latencies in term and preterm newborn⁶. Such decrease relates to the progressive myelination of central nervous structures, increased axon diameter, improved neural activity synchronism, effective structural connections, and improved synaptic function; all of these factors derive from the maturation process of the central auditory system.

Similarly Absolute latencies of wave I, III, V in normal neonates were decreased as age advances and the difference between absolute latencies of high risk neonates and normal neonates also decreased as age advanced. This delayed absolute latency in high risk neonates as compared to normal

neonates is due to delayed maturation process of auditory pathway in high risk neonates.

The latency increase was even more marked in premature newborn, as the maturity level in this group is at an earlier stage compared to term neonates, since this process depends on the gestational age. An increased absolute latency in premature compared to term newborn may be related to electrical conduction delays because of myelination of developing auditory pathway structures up to the brainstem; this suggests that the degree of nerve fiber myelination and immature auditory pathways affects wave latency⁷.

From the literature available it was observed that four variables were found to be important for predicting hearing loss. They were length of stay in the NICU, gestational age, craniofacial anomalies and TORCH infections⁸. Our study found prematurity as the most common risk factor for hearing impairment. These possibilities is confirmed by the global delay in absolute and inter peak latencies in the study sample compared to the adult population, as well as the inverse correlation between gestational age and absolute latencies.

In present study 20 high risk neonates showed abnormal prolonged Inter Peak Latencies of wave I-III, III-V, V-I from 0-3 days to 6 months. In high risk neonates Prolonged Inter Peak Latencies of wave III-V decreased as age advances, ranges from 2.4-2.5ms in 0-3 days to 2.2-2.1ms in 6 months, but Inter Peak Latencies of wave I-III and V-I prolonged from 0-3 days to 6 months.

There is no improvement in average difference of Inter Peak Latencies between high risk and normal neonates from 0-3 days to 6 months. This could be because of difference in maturation of auditory pathway in high risk neonates as compared to normal neonates and improper myelination of higher order neurons in auditory pathway in high risk neonates which gives impression that maturation of auditory pathway is not yet complete⁹.

It is observed that in present study wave morphology in 20 high risk neonates ranges from average to poor. In 10 neonates who have absent BERA, wave morphology was very poor, not repeatable and peaks could not identify from 0-3days to 6months. In neonates who had delayed BERA response, the wave morphology was average with fail repeatability. Response for average to poor morphology can be attributed to inadequate myelination of auditory pathway from cochlear level to brain stem level. In normal neonates there is good peak to peak repeatability & good wave morphology.¹⁰.

The primary objective of this study was to analyse the maturation and myelination of auditory pathway by using BERA results in terms of absolute latencies and Inter Peak Latencies in high risk neonates & normal neonates. This has provided us with new insights in the normal development and the risks that can compromise the immature auditory system of high risk neonates. Researches to be taken up to establish population based, cost effective hearing screening modalities and guidelines.

CONCLUSION:

Early diagnosis and timely intervention for deaf and hard of hearing in newborns provides a proper path for normal development of the hearing impaired¹¹. All the normal newborns and especially the high risk infants should undergo hearing evaluation with in the first 6 months followed by thorough diagnostic evaluation and follow-up for infants who fail their initial testing. No Aggressive treatment decision for the management of the child should be made until repeated BERA measurement confirms the diagnosis of hearing improvement.

DISCLOSURES:

- a) Competing interests/Interests of Conflict- None
- b) Sponsorships – None
- c) Funding - None
- d) Written consent of patient- taken
- e) Animal rights- Not applicable

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