THE IMPACT OF PREMATURITY ON INFANT BRAINSTEM AUDITORY EVOKED RESPONSES

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ABSTRACT

BACKGROUND

Recent advances in perinatology have resulted in increased survival rate of preterm infants over the past two decades. Sensorineural hearing loss represent one of the serious neurodevelopmental sequelae among preterm infants. Brainstem Auditory Evoked Responses (BAER) is a noninvasive electrophysiological method for assessing the maturation of auditory system in newborn.

MATERIALS AND METHODS

Brainstem auditory evoked responses of 70 infants (35 preterm and 35 term) were recorded to analyse the impact of prematurity. Absolute latency and interpeak latencies were recorded using "Intelligent Hearing System Smart-EP". Student's t-test was used for statistical analysis.

RESULTS

The absolute latencies I, III, V and interpeak I-III, I-V were significantly prolonged among preterm babies (P value <0.05). There was a significant increase in absolute latencies I, III, V and IPL I-III among preterm babies with comorbidities (P value <0.05). Such difference in latencies was not seen among term babies with comorbidities.

CONCLUSION

Hence, it may be worthwhile to perform BAER recording in preterm babies and all babies with comorbid conditions to identify hearing abnormities at the earliest.

KEYWORDS

Preterm Infants, Brainstem Auditory Evoked Responses, Comorbid Conditions.

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BACKGROUND

In India, around 8 million Low Birth Weight (LBW) infants are born each year.[1] The LBW infants include both preterm babies and Intrauterine Growth Retardation (IUGR) babies. Recent advances in perinatal care have resulted in increased survival rates of preterm infants. However, the preterm infants are at risk of developing several immaturity related problems. Sensorineural hearing loss represents one of the serious neurodevelopmental disorder among the high-risk newborns. The incidence is ten times higher in preterm babies than the overall incidence of 1 to 3 per 1000 live births in normal babies.[2] This undetected hearing loss can result in serious impairment in language and communication skills, cognitive development, social and emotional development. Number of methods have been evaluated to search for reliable and effective technique for determining auditory functions in the neonates. Brainstem Auditory Evoked Responses (BAER) records potentials from the ear and vertex in response to brief auditory stimulation. BAER is one of the noninvasive electrophysiological method in clinical practice to detect neonatal deafness.[3] The BAER is the best tool available to assess the hearing impairments in infants.

BAER depicts the conduction along the brain stem auditory pathway; hence, comparison of auditory evoked responses of preterm infants with term infants is expected to provide insights about the maturational-related response changes during neonatal period and pathological changes due to associated comorbid conditions.

AIMS AND OBJECTIVES

This study aimed at analysing the impact of prematurity and its comorbid conditions on infant brainstem auditory evoked responses. The objectives were to record brainstem auditory evoked responses of preterm and term infants with or without comorbid conditions.

MATERIALS AND METHODS

This prospective observational study was conducted in a Tertiary Care Teaching Hospital, Coimbatore. A total of 70 infants were included in the study of which 35 were preterm infants and 35 were term infants.

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Inclusion Criteria

All the infants were selected from high-risk infant follow up clinic and Well-Baby Clinic. Preterm infants who have completed the post conceptional age of 40 weeks to 3 months of life and term infants up to 3 months of age were included.

Exclusion Criteria

Babies with family history of hearing loss, ear malformations and syndromic conditions were not included. Both preterm and term group were further divided into two subgroups based on the presence and absence of comorbidities.

The comorbid conditions in preterm included those babies who suffered from Respiratory Distress Syndrome, Neonatal Jaundice, Birth Asphyxia and Sepsis. All babies with comorbid conditions were treated in neonatal intensive care unit at Coimbatore Medical College as per the standard protocols by neonatologists. Similarly, term group babies were further divided into two based on the presence of comorbid conditions such as sepsis, birth asphyxia, neonatal jaundice and meconium aspiration syndrome. The study was carried out after explaining the procedures in detail and getting informed written consent from the parents or caregivers of the babies. The study was approved by the Institutional Ethical Committee. Intelligent Hearing System (Florida) [Smart EP, Universal Smart box Jr.,™ Opti-Amp 8002] equipment was used for recording BAER in infants.

Procedure

The procedure was done while infant sleeping naturally, usually after a feeding. Some of the babies who had difficulty in going to sleep were given the sedative promethazine orally of dose 0.5 mg/kg body weight. The babies were made to lie comfortably on his or her mother's or grandmother's lap while doing the recording. The recording was made in the sound proof BAER recording room. The skin at the site of placement of surface electrode was prepared well. The conducting gel was applied and the surface electrodes were fixed at appropriate sites with the help of adhesive plasters.

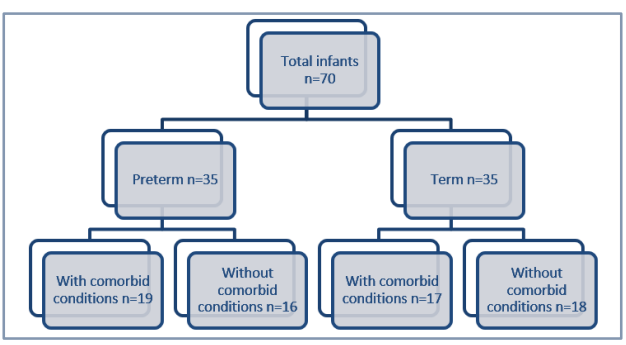
Site of placement of surface electrodes include active electrode on forehead reference electrode over the right (M1) and left (M2) mastoid processes and ground electrode on the cheek. At all the above sites, the impedance was kept below 5W. The earpiece was inserted into the corresponding ear (right or left) of infants while recording. Each ear was tested separately. The acoustic stimuli were given in the form of broadband clicks. The restriction filters were set between 100-3000 Hz. A total of 2000 stimuli were given with the repetition rate of 10 stimuli/seconds. The analysis window was 10 milliseconds. Each recording was made in duplicate to ensure reproducibility. Every time when the acoustic stimuli was given, the auditory system in the infant generated an electrical response. These evoked responses were detected by the surface electrodes. The recordings were analysed by the equipment Intelligent Hearing System and recorded as waveforms. The absolute latencies of the BAER waveforms I, III, V and the interpeak latencies I-III, III-V, I-V were marked and the values were noted down.

Statistical Analysis

Independent t-test has been used for intergroup and subgroup comparison of the BAER parameters. Statistical software SPSS 17 version was used for the analysis of the data.

RESULTS

A total of 70 infants were studied, which had 35 preterm babies and 35 term babies (flowchart-1). The mean birth weight of preterm group is 1.53 (±0.260) kg and 2.84 (±0.360) kg in term babies. The mean age was 2.03 months for preterm, 2.61 months for term (at the time of study) and sex ratio among two groups were comparable.



Flowchart 1. Depicting Study Population

The distribution of comorbid conditions such as HIE, jaundice, respiratory distress, sepsis and multiple risk factors in the study group is depicted in Table 1.

Group With Comorbidities	Comorbid Conditions				
	HIE	Jaundice	Respiratory Distress	Sepsis	Multiple Risk Factors
Term (n=17)	2	3	4	4	4
Preterm (n=19)	4	4	3	2	6

Table 1. The distribution of co-morbid conditions

Absolute latencies and interpeak latencies were compared between the two groups. To find out the impact of comorbidities, subgroup analysis was done in both term and preterm groups. The BAER parameters of preterm and term infants are depicted in Table 2 and 3.

Absolute Latency ms	Preterm Right Ear	Term Right Ear	P-value	Preterm Left Ear	Term Left Ear	P-value
I	2.02±0.35	1.73±0.23	0.000*	1.99±0.37	1.78±0.32	0.017*
III	4.74±0.28	4.53±0.29	0.003*	4.82±0.63	4.54±0.25	0.000*
V	8.16±0.42	6.63±0.31	0.000*	7.99±0.83	6.60±0.30	0.000*

Table 2. Absolute Latency in Preterm and Term Babies

***P - value less than 0.05 is significant**

Interpeak Latency	Preterm Right Ear	Term Right Ear	P-value	Preterm Left Ear	Term Left Ear	P-value
I-III	2.97±0.32	2.61±0.32	0.000*	2.98±0.33	2.55±0.26	0.000*
III-V	2.67±0.27	2.43±0.34	0.303	2.65±0.26	2.50±0.33	0.35
I-V	5.78±0.34	5.05±0.51	0.002*	5.84±0.51	4.75±0.45	0.000*

Table 3. Interpeak Latency in Preterm and Term Babies

*P-value less than 0.05 is significant.

BAER waveform I, III, V latencies were significantly prolonged among preterm babies than term babies. The interpeak latencies I-III, I-V were also significantly increased in preterm infants. The associated comorbid conditions significantly altered the wave latencies in preterm babies. The absolute latencies I, III, V and IPL I-III were significantly prolonged in preterm babies with comorbidities than in those without comorbidities. Though some latencies were prolonged in term babies with comorbid conditions, it had no statistical significance. The wave latencies among preterm group are depicted in Table 4.

Absolute Latency ms	With Comorbid R	Without Comorbid R	P value	With Comorbid L	Without Comorbid L	P-value
I	2.17±0.37	1.84±0.19	0.002*	2.18±0.37	1.75±0.20	0.000*
III	5.17±0.62	4.40±0.56	0.003*	5.13±0.64	4.45±0.37	0.001*
V	8.34±0.31	7.95±0.44	0.004*	8.43±0.37	7.47±0.93	0.000*
Interpeak Latency						
I-III	3.13±0.27	2.78±0.74	0.001*	3.15±0.30	2.77±0.25	0.000*
III-V	2.66±0.29	2.68±0.27	0.858	2.67±0.26	2.63±0.26	0.650
I-V	5.86±0.43	5.72±0.59	0.363	5.91±0.50	5.77±0.54	0.429

Table 4. Preterm With and Without Comorbidities in Both Ears

DISCUSSION

This study was done to compare the BAER parameters between preterm and term infants and also to find out the impact of comorbid conditions on waveforms. A recognisable BAER waveform can be recorded in preterm infants above 28 weeks of gestation.[4] The BAER waveform I arises from peripheral part of cochlear nerve.[4] The wave III originates from superior olivary nucleus in pons whereas wave V from Inferior Colliculus in midbrain.[4] The prolongation of BAER values in this study group was comparable with earlier studies.[5,6] We found that while comparing the BAER parameters among preterm and term babies, there was a significant prolongation of absolute latencies of wave I, III, V, interpeak latencies among preterm infants. Similarly, the interpeak latencies I-III, I-V were also significantly prolonged in preterm babies, which may be due to incomplete myelination of central brainstem auditory pathway in preterm infants.[5] In a similar comparative study done by Roopakala et al have found an increase in wave V latency, which they attributed to delay in maturation of central brainstem pathway in preterm infants.[7] The maturational defects in preterm infants they attributed are incomplete myelination of auditory nerves and pathway, decrease in axonal diameter, immaturity of neuronal synapses.[4] There is no sex difference in values in this present study as seen in many earlier studies except one from Pakistan by Shahid et al,[8] which suggested that high-risk male infants were more prone for auditory defects.[8] There is no significant BAER parameters difference between right and left ears in this study as observed in earlier studies.[5,9]

It has been found in our study that the association with comorbid conditions caused significant increase in all the absolute latencies I, III, V and IPL I-III in preterm infants. This impact of comorbidities on BAER waveforms was not present among term babies. This was probably due to prolonged exposure to extrauterine high-risk environmental conditions in preterm infants.[10,11] Babies who suffered from birth asphyxia and/or respiratory distress are exposed to prolonged periods of hypoxia, which may affect the myelination process. Studies conducted in animals have found that cochlear hair cells are sensitive to hypoxia.[12]

A study done by Agarwal among normal babies and babies with neonatal jaundice have found prolonged

absolute and interpeak latencies among 25% of the study group. The bilirubin specifically causes damage to the cell bodies of auditory nerve in spiral ganglion, brainstem cochlear nuclei.[12] These abnormalities had significant correlation with total bilirubin level.[13]

Neonatal sepsis and its related conditions like meningitis, ototoxic medications [aminoglycosides] may also lead to sensorineural hearing loss. These effects were demonstrated by Sun JH et al in a study among 248 infants using BAER.[14] The cytokines and toxin released during sepsis may cause damage to the developing auditory system.[15] Dowley et al noticed that neonatal sepsis was significantly associated with auditory neuropathy among high-risk newborn babies.[15] This impact of comorbidities is not seen in term infants and much of the changes in them are reversible.[16] Further evaluation of interaction between risk factors and neonatal hearing loss is warranted to implement more time weighted measures.

CONCLUSION

In this study, the brainstem evoked responses were found to be significantly prolonged among the preterm infants when compared to term infants. The associated comorbid conditions had great impact on the BAER latencies among preterm infants, but not in term infants. Regular follow up services should be done to assess the auditory maturation in such high-risk infants.

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