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Evoked Auditory Response in Preterm Infants

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Abstract :

Hearing is the means by which the newborn comes into contact with the world of sound and with language. The survival of preterm infants has increased substantially over last few decades because of improvements in obstetric and neonatal care. However, the newborn experience many perinatal complications including peripheral or central hearing loss. The prevalence of hearing loss is reported to be 1.5–6 per 1000 newborn in the well-baby nursery population. Brainstem evoked response audiometry (BERA) is a simple, non-invasive way of evaluating the hearing function and has been widely used for early detection of hearimg loss and neural conduction irregularities in the auditory pathway.

Aims & Objective: To analyze the BERA responses in preterm infants.

Materials and Methods: Thirty preterm infants attending Pediatric OPD of Bapuji Hospital and Chigateri General Hospital satisfying the inclusion criteria were subjected to BERA. Parameters such as absolute latencies of waves I, III, and V, and interpeak latencies (IPLs) I–III, I–V, and III–V were assessed and analyzed by using unpaired t-test. Results: Preterm babies had highly significant increased wave V threshold, Waves III and V were delayed in preterm babies, IPLs of wave III–V were increased in the preterm group, and statistically significant increase was observed in IPL of wave I–V.

Conclusion : This study indicates that preterm infants have prolonged latency of wave V, which reflects immaturity of the auditory system. Therefore, it is essential to screen all preterm infants at the earliest to prevent adverse effect on the developing auditory pathway.

Key Words : Auditory immaturity, BERA, Preterm, Term infants

Introduction

Auditory Brainstem Response (ABR) is a far – field recording of the synchronized response of numerous neurons in the auditory pathways within the brainstem. ABR was first described by Sohmer and Feinmesser1. ABR is generated with 100 μs rectangular pulse or clicks and recorded with surface electrodes placed on the forehead and mastoid or ear lobes. Recording consists of a series of vertex positive peaks traditionally labelled with Roman numerals I to V. Primary application of ABR is as a tool for estimating audiometric thresholds, assessing integrity of auditory pathway till the level of brainstem, newborn hearing screening, monitoring eighth nerve and auditory brainstem function during certain neurotologic operations[2]. As per WHO report, there are about 250 million deaf people in the world and is the second most common cause of disability. WHO estimates that every year 38,000 deaf children are born in South – East Asia. India has 6.3% prevalence rate of moderate to severe hearing impairment[3].

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Hearing impairment has a devastating detrimental and invariable adverse impact on the development of children. Late detection causes irreversible stunting of the language development potential of the child. Joint Committee on Infant Hearing (JCIH)4 promulgated a list of specific risk factors to identify infants at risk for hearing impairment for careful follow – up and assessment. Later the consensus recommended screening of all newborns. According to Centre for Disease Control (CDC), Hearing screening and follow – up survey 2009, 1.4 per 1000 babies screened (Range 0 – 4.6 per 1000 babies screened) have hearing impairment. Prevalence and incidence rate of hearing loss in India is quiet alarming. Studies show varying prevalence rates from 1% to as high as 40% 5. Hecox and Galambos6 first reported about successful application of ABR in the audiological evaluation in children. JCIH recommends the use of ABR and Oto Acoustic Emission (OAE) for screening of newborns. These electrophysiological methods are efficient, cost effective and accurate for identifying the degree of hearing loss.In pediatric practice, BERA has two main uses: a)Assessment of auditory function in a child whose hearing cannot be tested behaviorally. b)Evaluation of auditory pathways of the brainstem.

In children BAEP recording is more difficult than in adults, but provides valuable clinical information. BAEP response is smaller and background electrical noise from the ECG and scalp muscles often higher compared to adults. Recording during sleep can reduce these artifacts. Since ABR is not affected by sedation, infants can be sedated to avoid problems related to muscle activity. Infants BAEP response is slower than that of adults, therefore the recording sweep should be slower with low frequency filter at 20-30 Hz. Clicks presented preferably rarefaction clicks. In newborns BAEP can be recorded with stimulus intensity as low as 30 dB. The lowest click intensity at which the BAEP potentials are apparent is considered as BAEP threshold. The ear phone should be comfortably placed and should not slip off the ear to occlude the ear canal. Complete maturation of auditory processing capabilities takes place over the first year of life and to a lesser extent, perhaps for the first several years[7]. There are developmental changes in the response morphology, wave amplitude, and wave latencies of the ABR. Attempts have been made to define the maturation of BAEP in infants. In general, the waveform and its amplitude depend on chronological age, threshold for BAEP for infants is higher than that in adults and BAEP waveforms are better elicited in lower click rates.

Preterm is defined as birth on or before the end of the last day of the 37th completed week (i.e., 36 6/7 weeks' gestation) after the onset of the mother's last menstrual period, which equates to 259 days in common medical terminology [8].

Advances in the perinatal and neonatal medicine in the past 2 decades have resulted in improved survival rates for premature and very low birth weight (VLBW) infants. The vast literature reporting the outcome of preterm babies can be a minefield for the unwary reader. The results of outcome studies show a huge variation and there has been little improvement in methodology over time. Severe neurodevelopmental disability remains the worst adverse long term outcome associated with prematurity. The major neonatal complications which influence later development remain preterm brain injury (intraventricular hemorrhage or periventricular leukomalacia), chronic lung disease, neurotizing enterocolitis and sepsis. Preterm and Low Birth Weight (LBW) infants are more susceptible to Hypoxic-ischemic brain injury, and bilirubin brain toxicity9. Deafness afflicts fewer children but is still a problem in about 1-2%. Early diagnosis by screening can help limit the handicap resulting from deafness10.The purpose of the study was to analyse and compare the BERA parameters with the term babies.

Methodology

In this study, 30 preterm infants and 30 age-matched controls (term infants) were selected from Bapuji Hospital and Chigateri General Hospital, attached to J.J.M. Medical College, Davangere, Karnataka, India. Controls were selected randomly from the immunization center and pediatric OPD. Babies less than 1 year old, babies less than 37 weeks gestational age, and normal age-matched term babies with birth weight >2500 g were included in the study. Babies with severe multiple anomalies, incompatible with life, atresia or stenosis of external ear canal, untreated otitis externa, and more than 1 year of age were excluded from the study. Written informed consent was taken from the parents after explaining them the procedure and its significance in their vernacular language. Detailed information regarding medical history was obtained and thorough ENT examination was carried out before the procedure. The infants were subjected to BERA testing on RMS EMG EP MARK-II machine (RMS Recorders & Medicare Systems, Chandigarh, India). The infants were sedated with syrup triclofos (Pedicloryl) 20 mg/kg body weight. Before the placement of electrodes, the skin was cleaned with abrasive strip. Recording of BERA was carried out in a quiet and semidarkened room. Surface electrodes were placed at the vertex (CZ), both mastoids (Ai and Ac), and forehead (ground). The resistance was kept below 5 K. Monoaural auditory stimulus comprising rarefaction clicks of 100 ms was delivered through electrically shielded earphones at the rate of 11.1 per second. Contralateral ear was masked with pure white noise of 40 dB. A band pass of 150–3000 Hz was used to filter out undesirable frequencies in the surroundings. Responses to 2000 click presentations were averaged. BERA threshold for each ear with absolute latencies of waves I, III, and V, and interpeak latencies (IPL) of waves I–III, I–V, and III–V were considered from the recording for comparison among high-risk infants and controls.

Statistical Analysis: The results were expressed as mean and standard deviation. Unpaired t-test was used for intergroup comparisons, and p-value of <0.05 was considered to be statistically significant.

Results

Of 30 preterm babies, no response was obtained from 4 babies. Mean wave V threshold for 26 preterm babies was 49.94 + 21 dB which was statistically highly significant when compared to controls (i.e., 30 dB) (Figure 1). Absolute latencies of waves III and V were delayed in preterm babies; the delay being statistically significant in wave V. IPLs of III–V were increased in preterm group, and statistically significant increase was seen in IPLs of I–V ($p < 0.05$) (Figure 2 & Table 1).

Figure 1: Comparison of wave V threshold in controls (term) and preterm

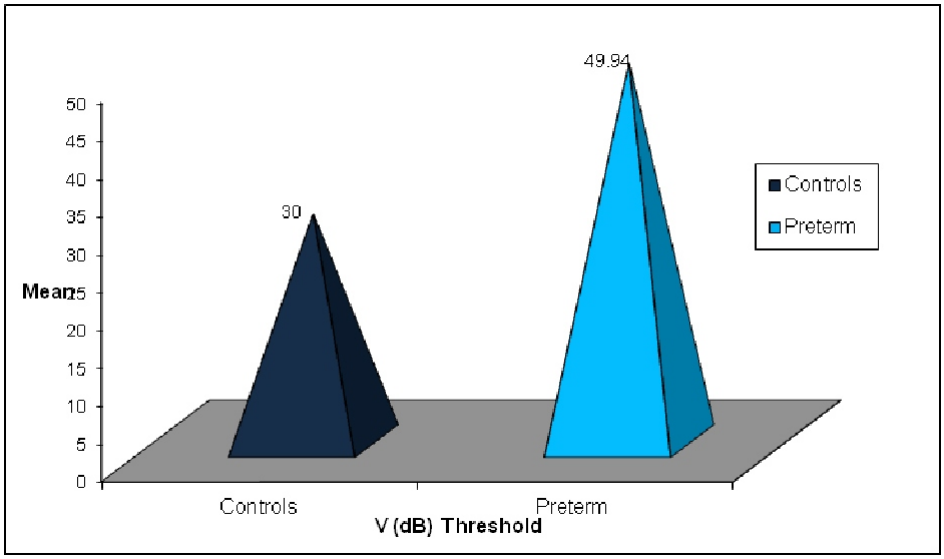
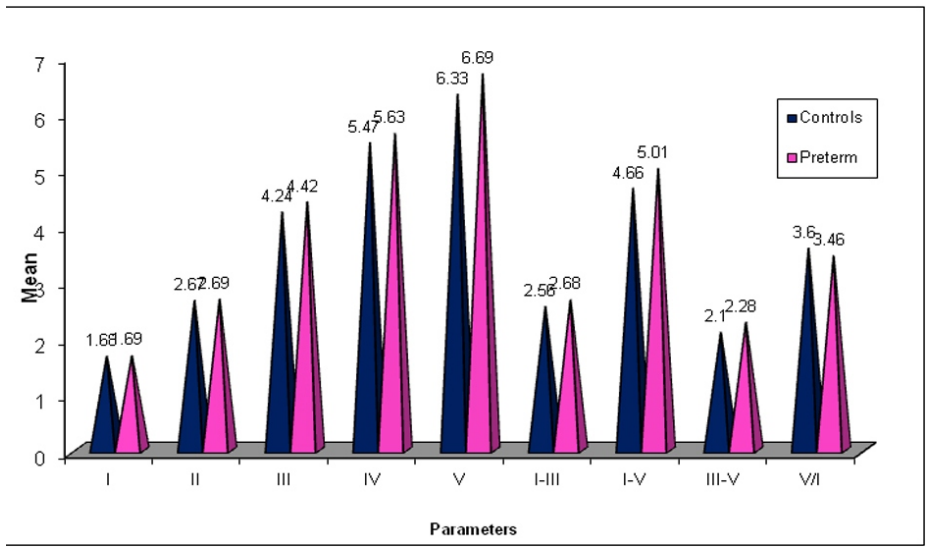


Table No -1 Comparison of BERA parameters in preterm and normal term infants

	Term (N=30)		Preterm (N=26)		Preterm v/s Term	
	Mean	SD	Mean	SD	t value	P value
V (dB) Threshold	30	0	49.94	21	-5.15	< 0.001 **
I	1.68	0.2	1.69	0.23	-0.37	0.71
III	4.24	0.26	4.42	0.56	-1.48	0.14
V	6.33	0.35	6.69	0.79	-2.26	<0.05*
I-III	2.56	0.27	2.68	0.52	-1.1	0.27
I-V	4.66	0.35	5.01	0.78	-2.15	<0.05*
III-V	2.1	0.33	2.28	0.55	-1.51	0.14

Unpaired t test * Significant ** Highly significant

Figure 2: Comparison of BERA parameters between controls (term) and preterm



Discussion

Preterm babies had prolonged absolute latency of wave V (6.69 ± 0.79 ms) and IPL of I–V (2.28 ± 0.55 ms) compared to normal term babies. These observations reflect a delayed maturation of central auditory pathway and support the earlier findings[11,12] that brainstem auditory evoked potential waveform latencies are delayed in preterm infants due to prematurity itself.

Increase in absolute latency observed in premature infants compared with that in term infants may be related to delay in electrical conduction through the process of myelination of the structures of the auditory pathway to the brainstem that is still under development, suggesting that the degree of myelination and immaturity of nerve fibers of auditory pathways affect the latencies of waves. Similar findings were observed by Roopkala et al.[13], Jiang et al.[14], and Pasman et al.[15]. In the study by Casali and Santos[16], absolute latencies of waves I, III, and V of preterm infants were also prolonged. However, in the study by Kilic et al.[17], there was no difference in absolute latencies and interpeak latencies between term and preterm babies. In the study by Marlow et al.[18], preterm infants with sensorineural hearing loss had longer periods of intubation, ventilation, oxygen treatment, and acidosis, and more frequent treatment with dopamine or furosemide. According to the review by Cristobal and Oghalai[19], VLBW may not have a severe impact on hearing and is commonly associated with multiple other risk factors that may experience increase risk of progressive or delayed onset hearing loss.

Interpeak intervals in relation to the delay in central conduction time compared to adult population may also be related to changes in neural conduction velocity associated with myelination and/or changes in synaptic efficiency of various nuclei of auditory pathway. Prolonged I–V IPL is in accordance with other studies[14,15,16]. However, the values of interpeak intervals become smaller as the routes get longer because they continue to specialize in their function after birth, increasing the speed of a driving rhythm that exactly compensates for the physical growth of auditory pathway.

There is an inverse correlation between gestational age and absolute latencies with increasing gestational age, and hence the maturation of central auditory system to the level of the brainstem is a continuous decrease of absolute latencies of all the waves in term and preterm infants. This decrease is related to the progressive myelination of central nervous system structure, increase in axonal diameter, the improvement in synchrony of neural activity, establishment of effective structural connections, and increased functionality of the synapses. Studies report a systematic decrease in latency as a function of increasing age[11].We could not see similar findings as sequential study of preterm babies was not done. It is also possible, however, that auditory sequelae are more frequently associated with increased survival of preterm births exposed to multiple potentially ototoxic factors.

Conclusion

Considering preterm as the risk factor, significant delay was seen in absolute latency of wave V and IPL of III–V. In addition, the threshold of hearing was increased in preterm with respect to control term babies, all of these reflect the immaturity of auditory pathway. We believe that a larger sample and the follow-up of these infants at risk by means of the study of BERA potentials offer valuable information on the state of maturation of the acoustic pathways achieved by these children.

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