Research Article

Evoked response audiometry in high risk infants

Lakshmi T.[1*], Zaheera Sultana S.[2], S. V. Brid[3]

[1,2]Assistant Professor, Department of Physiology, Chamrajnagar Institute of Medical Sciences, Chamarajanagar- 571313, Karnataka, INDIA.
[3]Professor and HOD, Department of Physiology, Sri Nijalingappa Medical College Bagalkote-587102, Karnataka, INDIA.
Email: jenydrlaks@gmail.com, dranjumshaik786@gmail.com

Abstract

Background: Hearing is the means by which the newborn comes into contact with the world of sound and with language. The first three years of life are the most important period for speech and language acquisition. Reduced hearing acuity of any severity in infancy or early childhood may prevent the child from receiving adequate auditory, linguistic and social stimulation required for speech and language development. Hearing loss is one of the most common abnormalities present since birth. The prevalence of hearing loss is reported to be 1.5 to 6 per 1000 newborn in the well baby nursery population. Several risk factors associated with hearing loss during early infancy have been described by Joint Committee on Infant Hearing which includes hereditary cause, inutero infection, prematurity, asphyxia, hyperbilirubinemia and ototoxic medications. **Objectives:** To assess the degree of hearing impairment in high risk infants by using BERA and to analyse and compare BERA responses in high risk infants with age matched controls. **Methods:** 100 high risk infants having one or more risk factors attending Pediatric OPD of Bapuji hospital and Chigateri General Hospital and 30 age matched controls satisfying the inclusion criteria were randomly selected from immunization centre were subjected to BERA. Parameters such as absolute latencies of waves I, III, and V, Interpeak latencies I-III, I-V and III-V were assessed and analysed by using unpaired t-test. **Results:** The high risk infants had increased wave V threshold when compared to the control group. Absolute latencies of wave III, V, interpeak latencies of I-III and I-V were prolonged in the cases. The incidence of hearing impairment was 64.9% in the high risk infants.

Keywords: Brainstem Evoked Response Audiometry (BERA), hearing impairment, high risk infants, hyperbilirubinemia, preterm.

[*]**Address for Correspondence:**
Dr Laxmi T. Assistant Professor, #1705/B, 2nd cross, Christian colony, Mandya-571401, Karnataka, INDIA.

Email: jenydrlaks@gmail.com
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INTRODUCTION

Auditory evoked responses are electrophysiologic recordings of responses from within the auditory system that are activated by sounds. The evoked transient responses can be recorded up to 500 milliseconds from time of onset of the sound stimulus. The evoked potentials of the first 10 milliseconds i.e. Short Latency Response (SLR) is popularity known as Brain Stem Evoked Response Audiometry (BERA)[1] Auditory Brainstem Response (ABR) is a far – field recording of the synchronized response of numerous neurons in the auditory pathways within the brainstem. 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[2]. 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)[3] 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. Most of the neonatal facilities in the United States and European Union have enforced mandatory screening of all newborns. In a developing country like India, newborn hearing screening is yet to be implemented. 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

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in India is qui*et al*arming. Studies show varying prevalence rates from 1% to as high as 40%[4]. He cox and Galambos[5] first reported about successful application of ABR in the audio logical evaluation in children. JCIH recommends the use of ABR and O to Acoustic Emission (OAE) for screening of newborns. These electrophysiological methods are efficient, cost effective and accurate for identifying the degree of hearing loss. The objective of the present study was: to determine the threshold of hearing in high risk infants by observing wave 'V' at the minimum intensity of click stimulus and to compare the auditory brainstem parameters between controls and high risk infants.

METODOLOGY

In this study 100 high risk infants having one or more risk factors, according to the criteria stated by American Academy of Pediatrics, JCIH 2007 were selected from Bapuji Hospital and Chigateri General Hospital, attached to J.J.M. Medical College, Davangere and 30 age matched controls were selected randomly from the immunization centre and pediatric OPD. Inclusion Criteria includes: Babies < 1 year, Family history of permanent childhood hearing loss, Neonatal intensive care of more than 5 days or any of the following regardless of length of stay. Extracorporeal membrane oxygenation (ECMO), assisted ventilation, exposure to ototoxic drugs or loop diuretics (furosemide) and hyperbilirubinemia that requires exchange transfusion, In utero infection such as cytomegalovirus, herpes, rubella, syphilis and toxoplasmosis, Craniofacial anomalies, Birth weight < 1500g, Bacterial meningitis, Gestational age < 37 weeks, Apgar scores < 4 at 1 minute or < 6 at 5 minutes, Normal age matched term babies with birth weight > 2500gm. Exclusion Criteria: Severe multiple anomalies, Incompatible with life, Atresia or stenosis of external ear canal, Untreated otitis externa, Babies more than one year of age. 100 high risk infants and 30 age matched controls satisfying the inclusion criteria were included in the study. Written informed consent was taken from the parents after explaining them the procedure and its significance in their vernacular language. Detailed history and thorough ENT examination was done before the procedure. The infants were subjected to BERA testing on RMS EMG EP MARK-II machine manufactured by the RMS RECORDERS and MEDICARE SYSTEM, CHANDIGARH. Infants were sedated with syrup Trichlofos (pedichoryl) 20mg/kg body weight. The skin at the point of placement of electrodes were cleaned with 'abrasive strip. Recording of BERA was carried out in a quiet and semi-darkened room. Surface electrodes were placed at the vertex (C_Z), both mastoids (Ai and Ac) and forehead (ground). The resistance was kept below 5K. Monoaural auditory stimulus consisting of rarefaction clicks of 100 microseconds were delivered through electrically shielded earphones at the rate of 11.1/sec. Contralateral ear was masked with pure white noise of 40dB. A band pass of 150-3000Hz 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 wave I, III, and V waves inter peak latencies (IPL) of I-III, I-V and III-V were considered from the recording for comparison among high risk infants and controls.

STATISTICAL ANALYSIS

The results are expressed as mean and standard deviation. Unpaired t-test was used for intergroup comparisons, p-value of 0.05 or less has considered as statistical significance.

RESULTS

The present study was conducted in Department of Physiology, J.J.M. Medical College, Davangere. 30 control and 100 high risk infants were analyzed for the study. The results were expressed in mean $\pm$ standard deviation. Mean age of babies was 4.29 $\pm$ 1.28 months and mean birth weight of 2.42 $\pm$ 0.7kgs.Of the 100 high risk infants, BERA response was not obtained from 23 babies. Wave V threshold, Mean absolute latencies (in Ms) of Wave I, Wave III, Wave V, Interpeak latencies(in Ms) of I – III, I – V and III – V in left and right ear of controls in table 1, of cases in table 2 and comparison between cases and controls in table 3.

Table 1: Comparison of BERA parameters in left and right ears of controls

Measurement	Left Ear			Right Ear			Right V/s Left ear		
	N	Mean	SD	N	Mean	SD	T value	P value	Significance
V (dB) Threshold	30	30.0	0.0	30	30.0	0.0	0.00	1.00	NS
I	30	1.63	0.27	30	1.72	0.25	-1.32	0.19	NS
III	30	4.12	0.47	30	4.26	0.26	1.96	0.07	NS
V	30	6.32	0.44	30	6.34	0.32	-0.21	0.83	NS
I-III	30	2.49	0.37	30	2.64	0.34	-1.57	0.12	NS
I-V	30	4.69	0.43	30	4.62	0.43	0.61	0.54	NS
III-V	30	2.22	0.54	30	2.12	0.25	1.31	0.21	NS

Unpaired t – test: NS - Non Significant

Table 2: Comparison of BERA parameters in left and right ears of cases

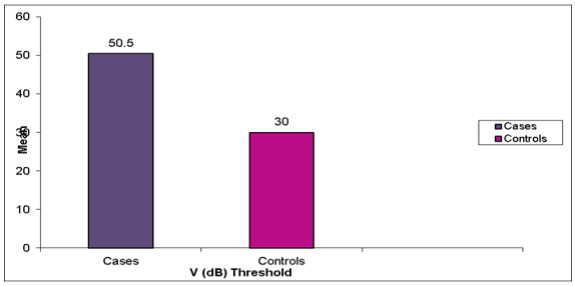
Measurement	Left Ear			Right Ear			Right V/s Left ear		
	N	Mean	SD	N	Mean	SD	T value	P value	Significance
V (dB) Threshold	72	49.4	22.8	70	52.3	21.4	0.81	0.42	NS
I	72	1.70	0.34	70	1.67	0.31	0.55	0.58	NS
III	72	4.37	0.64	70	4.57	0.58	1.94	0.06	NS
V	72	6.55	0.51	70	6.62	0.56	0.80	0.42	NS
I-III	72	2.72	0.66	70	2.92	0.77	1.68	0.09	NS
I-V	72	4.85	0.54	70	4.95	0.63	1.02	0.35	NS
III-V	72	2.19	0.51	70	2.05	0.64	1.44	0.15	NS

Unpaired t – test: NS - Non Significant

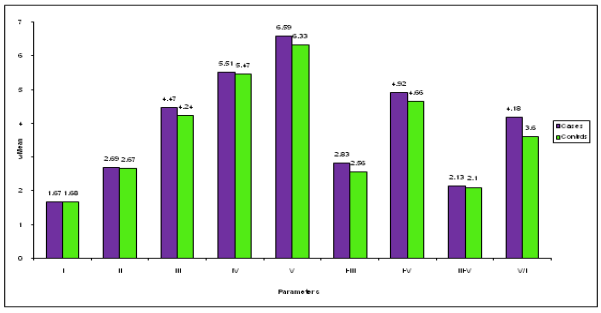
Table 3: Comparison of BERA parameters in high risk infants (cases) and controls

Measurement	Cases			Controls			Cases v/s Controls		
	N	Mean	SD	N	Mean	SD	t* value	P value	Significance
V (dB) Threshold	77	50.5	21.6	30	30	0	5.18	< 0.001	HS
I	77	1.67	0.29	30	1.68	0.2	0.07	0.95	NS
III	77	4.47	0.41	30	4.24	0.26	2.85	<0.05	S
V	77	6.59	0.51	30	6.33	0.35	2.46	<0.05	S
I-III	77	2.83	0.51	30	2.56	0.27	2.64	<0.05	S
I-V	77	4.92	0.6	30	4.66	0.35	2.22	<0.05	S
B	77	2.13	0.55	30	2.1	0.33	0.19	0.85	NS

*Unpaired t test: HS – Highly significant, NS – Non significant, S-Significant



Graph 1: Comparison of wave V threshold between cases and controls



Graph 2: Comparison of BERA parameters between cases and controls

DISCUSSION

The incidence of hearing impairment in high risk infants according to different statistics[4,6,7] varies from 1% to 40%. There are several risk factors which are important as precipitatory events, causing hearing impairment in newborn and young infants. The following are among these risk factors- prematurity, low birth weight, asphyxia, use of aminoglycosides, hyperbilirubinemia, prolonged mechanical ventilation, bacterial meningitis, intrauterine infection and craniofacial anomalies[3]. In this study the incidence of hearing impairment in the infants who had at least one risk factor was 64.9%. These results are comparable with Aiyer[8] but very high in comparison to other studies[9,10,11,12]. This difference was perhaps due to referral nature which provides care to highly complex cases. Other factors which might have been significant in this difference were lack of good prenatal care and delay in referral of sick and high risk babies to our hospital. We have used BERA for assessing hearing impairment which

has important characteristics- it gives the electrophysiological response of hearing without any need for assessment of the newborn behaviour, the result of this study are not affected by anaesthetics or sedatives, which may be used during the test, BERA is rapid, easy and relatively cheap test. The reported sensitivity of BERA for hearing assessment was 100% and specificity around 97%[13]. Absolute latencies of wave III, wave V and IPL of I-III and I-V were increased among the high risk group compared to the control group. Absolute latency of wave V is a consistent and stable parameter which has received primary attention as a valuable factor in response evaluation. It is suggested that all the risk factors which bring the neonate under intensive care induce a certain amount of hypoxia of the cochlea and brainstem which leads to various cellular changes such as edema, degeneration and necrosis. Hence they predispose to hearing impairment which may be reversible following reversal of hypoxic changes. The I-V IPL is a reflection of neural conduction time between the auditory nerve and brainstem nuclei and reflects upon the efficiency of the auditory pathway. Prolonged I-V IPL is a feature of neurological impairment and is an indication of delay in neural conduction within the brainstem. Our findings are in accordance with Parikh[8]. From the multiple analysis, a subset of variables was obtained, which better characterizes the group at risk of hearing impairment, only hyperbilirubinemia found to be significantly correlated with hearing impairment unlike Taghdiri[9] and Hans raj[14] where low birth weight and caesarean section also contributed for hearing loss. However, four variables were found to be important for predicting hearing loss-length of stay in the NICU, gestational age, craniofacial anomalies and TORCH infections in study by Aiyer[8]. These results suggest that it is necessary to implement protocols with strict control of jaundice, including objective measures for assessing the serum level of bilirubin and highly efficient phototherapy, which represent measures to prevent hearing impairment resulting from hyperbilirubinemia. Although we cannot make a definite conclusion concerning the outcome of the present study, it seems that all high risk infants will benefit from hearing assessment by using BERA at an early age. No child is too young for hearing evaluation. Screening programme should be performed in the nursery and well baby clinic during immunization in the first year or better in the first 6 months of age to avoid harmful effect on speech and language development. The true value of screening may lie in identification of mild to moderate hearing losses that are amenable to treatment and if untreated may manifest like a severe impairment. High risk infants have substantially higher incidence of hearing. So at least all high risk infants must be screened for hearing impairment prior to discharge from hospital using BERA. Retesting of infants with abnormal initial ABR within 3 months and several times within the first year if abnormal responses persists, is important. However the above findings need to be confirmed with a larger sample size.

CONCLUSION

The present study indicates that hyperbilirubinemia contributes significantly for hearing impairment. The most common risk factors for hearing loss being prematurity, hyperbilirubinemia, birth asphyxia, parental consanguinity and convulsions which may have synergistic effect. Therefore it is essential to screen all the infants at the earliest, to prevent adverse effect on the developing auditory pathway.

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