Original Article

Neurophysiological and Audiological Assessment in At-risk Infants by Brainstem Evoked Response Audiometry in Haryana

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Abstract

Background and Aim: Sensorineural hearing loss is a serious neurodevelopmental sequel among high-risk neonates and is one of the most common congenital disorders. To assess the neurophysiological and audiological impairment in at-risk infants in Haryana. **Methods:** This was a time-bound study of 12 months duration during which 101 at-risk infants visiting SGT Hospital, Haryana, were enrolled for the study. Brainstem evoked response audiometry (BERA) findings in these children were analyzed. Methodology standardized by IFCN Committee and instrument Neurostim NS-2 of Medicaid firm were employed. 10–20 International System of EEG Electrode Placement was used for scalp electrode placement. The data were analyzed using the Statistical Software Package for the Social Sciences version 20. **Results:** Highly significant prolongation of various latencies and interpeak latencies (IPLs) was observed in the cases. **Conclusion:** Risk factors known to cause hearing loss affect BERA parameters causing highly significant prolongation of latencies and IPLs, suggesting that at-risk infants are prone to sensorineural hearing loss. Universal newborn hearing screening by BERA can be carried out in children, especially when they come for routine immunization. BERA is the only test that gives precise information about hearing sensitivity in children, especially <1 year of age.

Keywords: At-risk infants, brainstem evoked response audiometry, sensorineural hearing loss

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Introduction

Hearing impairment is a concealed handicap and child's faulty response to aural stimulus gets overlooked and is discerned only after concealed disease such as suppurative otitis media erupts. Deafness is a global issue with a major chunk of such people being in the developing countries. Even though hearing impairment is relatively common in neonates and infants, it may not be easily detected behaviorally at a very young age.

To maximize the outcome for infants who are deaf or hard of hearing, the hearing of all infants should be screened at no later than 1 month of age.[1] Growth of the auditory nervous system can be impaired when auditory input is reduced. Plasticity of developing sensory system in critical period 0–3 years can occur if hearing loss is not detected early and the child is not audiologically rehabilitated at the earliest. According to the Position Statement,[2] high-risk factors have role in sensorineural and/or conductive hearing loss in newborns and infants including delayed-onset hearing loss, and once the child is identified as having a risk for hearing loss, hearing assessment should be done immediately.

A study in Belgium showed that the auditory brainstem response (ABR) allowed for an earlier diagnosis and intervention for auditory dysfunction than behavioral tests.[3] The early intervention allowed 85.4% of the children who presented with moderate, severe, or profound hearing impairment without any additional disabilities to enter mainstream education.[3]

There has been no single-unified study which has analyzed all the risk factors causing subclinical hearing deficit and their impact on subsequent brainstem deterioration in children in Haryana state in India. Hence, the present study aims to fulfill

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this gap. Therefore, in the present study, we have planned to assess the neurophysiological and auditory impairment in at-risk infants in Haryana by brainstem evoked response audiometry (BERA).

Table 1: Neurophysiological parameters of the study group

	Right latency I (ms)	Right latency II (ms)	Right latency III (ms)	Right latency IV (ms)	Right latency V (ms)
Mean	2.2190	3.7479	5.3109	6.8010	8.3218
SD	0.69026	1.00610	1.08306	1.21304	1.31056

SD: Standard deviation

Table 2: Neurophysiological parameters of the study group

	Right IPL I-III (ms)	Right IPL I-V (ms)	Right IPL III-V (ms)	Right amplitude I (μV)	Right amplitude V (μV)	Right amplitude V/I
Mean	3.0921	6.1028	3.0109	0.3784	0.3320	23.9595
SD	0.87288	1.19272	0.80610	1.01965±	0.47757	96.31034

IPL: Interpeak latency, SD: Standard deviation

Table 3: Neurophysiological parameters of the study group

	Left latency I (ms)	Left latency II (ms)	Left latency III (ms)	Left latency IV (ms)	Left latency V (ms)
Mean	2.2782	3.9435	5.6054	7.0121	8.5701
SD	0.76075	0.88904	1.08673	1.11173	1.27471

SD: Standard deviation

Table 4: Neurophysiological parameters of the study group

	Left IPL I-III (ms)	Left IPL I-V (ms)	Left IPL III-V (ms)	Left amplitude I (μV)	Left amplitude V (μV)	Left amplitude V/I
Mean	3.3272	6.2920	2.9647	0.5830	0.5330	44.7510
SD	0.86696	1.13266	0.79412	2.10970	2.04485	306.84695

SD: Standard deviation, IPL: Interpeak latency

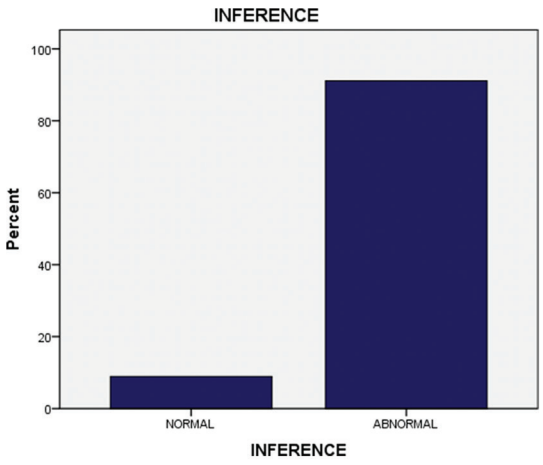

Figure 1: Inference

Materials and Methods

This study was conducted in the Department of Physiology, Electrophysiology Research Laboratory, SGT Medical College Hospital and Research Institute, SGT University, Haryana. Permission was obtained from the ethical committee of our institute before conduction of the study. At-risk 101 infants referred from the Paediatrics Department to Physiology Department of SGT Hospital and University during those 12 months were selected for the study, conforming to the inclusion and exclusion criteria. BERA findings in these children at risk were analyzed. Correct procedure of the test was explained to all children's parents/guardian, and their consent was taken.

Inclusion criteria

1. Neonatal pathological jaundice
2. Children having manifestations of congenital infections, neonatal sepsis
3. Cerebral palsy, mental retardation, or seizures in the neonatal or postneonatal period
4. Neonatal hypoglycemia
5. Neonatal Intensive Care Unit admission >2 days
6. Low birth weight and very low birth weight babies, preterm babies
7. History of birth asphyxia
8. Exposure to ototoxic drugs.

Exclusion criteria

1. Craniofacial anomalies, atresia or stenosis of external ear canal anomalies, ocular hypertelorism, flat nose
2. Middle ear infection: Chronic or acute suppurative otitis media
3. Congenital disease and syndromes: down's syndrome, Turner's syndrome, Edward syndrome, Patau syndrome.

Electrode placement

Standard EEG electrodes were placed on the scalp areas after preparing the skin by cleaning and abrading with a conducting electrode paste. Each infant was either fast asleep or sedated

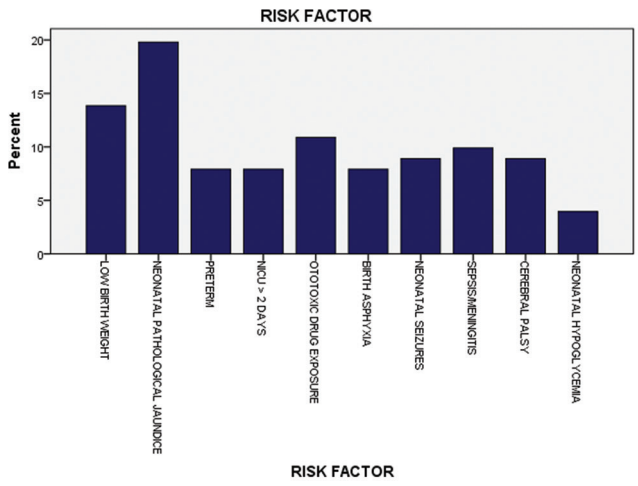

Figure 2: Risk factor distribution

with syrup pedicloryl 30–50 mg/kg body weight. The scalp electrodes were placed according to the 10–20 International System of EEG Electrode Placement as mentioned below.

a. The ground electrode (fz) at forehead
b. The reference electrode (Cz) at the vertex
c. Active electrodes at both mastoids (Ai and Ac).

Acoustically shielded earphones were placed on the ear and headbands were adjusted. Monoaural auditory stimulus consisting of rarefaction clicks with intensities starting from 90 dB till 20 dB was delivered through electrically shielded earphones.

Sweep speed was 1 ms. Low cutoff frequency was 100 Hz and high cutoff frequency was 10 Hz. Pulse/s was 11. Pulse width was 0.1 ms. Filter level 3 was used.

Contralateral ear was masked at 40 dB. The polarity used was alternate, the analysis time was 10 ms, and the stimulus rate was 11/s. About 2000 responses were averaged.

Statistical analysis of data

The data collected were entered into the MS Excel Sheet/ Statistical Software Package for the Social Sciences (SPSS). The results were analyzed using software SPSS Version 20 (SPSS Software Inc., Chicago, IL, USA). The mean and standard deviation (SD) for latencies of BERA waves and their interpeak latencies (IPLs) were calculated and *P* value was obtained. $P < 0.05$ was considered significant and <0.01 was considered highly significant.

Table 5: Highly significant prolongation of bilateral latency I values in study group

	Test value=2		
	t	df	Significant (two-tailed)
Right latency I (ms)	3.189	100	0.002
Left latency I (ms)	3.675	100	0.000

Table 6: Highly significant prolongation of bilateral latency II values in study group

	Test value=3					
	t	df	Significant (two-tailed)	Mean difference	95% CI of the difference	
					Lower	Upper
Right latency II (ms)	7.471	100	0.000	0.74792	0.5493	0.9465
Left latency II (ms)	10.665	100	0.000	0.94347	0.7680	1.1190

CI: Confidence interval

Table 7: Highly significant prolongation of bilateral latency III values in study group

	Test value=4.5					
	t	df	Significant (two-tailed)	Mean difference	95% CI of the difference	
					Lower	Upper
Right latency III (ms)	7.524	100	0.000	0.81089	0.5971	1.0247
Left latency III (ms)	10.223	100	0.000	1.10545	0.8909	1.3200

CI: Confidence interval

Table 8: Highly significant prolongation of bilateral latency V values in study group

	Test value=7					
	t	df	Significant (two-tailed)	Mean difference	95% CI of the difference	
					Lower	Upper
Right latency V (ms)	10.136	100	0.000	1.32178	1.0631	1.5805
Left latency V (ms)	12.379	100	0.000	1.57010	1.3185	1.8217

CI: Confidence interval

Table 9: Highly significant prolongation of bilateral interpeak latency I-III in study group

	Test value=3.5					
	t	df	Significant (two-tailed)	Mean difference	95% CI of the difference	
					Lower	Upper
Right IPL I-III (ms)	−4.697	100	0.000	−0.40792	−0.5802	−0.2356
Left IPL I-III (ms)	−2.003	100	0.048	−0.17277	−0.3439	−0.0016

CI: Confidence interval, IPL: Interpeak latency

Table 10: Highly significant prolongation of bilateral interpeak latency III-V in study group

	Test value=3.2					
	t	df	Significant (two-tailed)	Mean difference	95% CI of the difference	
					Lower	Upper
Right IPL III-V (ms)	−2.358	100	0.020	−0.18911	−0.3482	−0.0300
Left IPL III-V (ms)	−2.978	100	0.004	−0.23535	−0.3921	−0.0786

IPL: Interpeak latency, CI: Confidence interval

Table 11: Highly significant prolongation of bilateral interpeak latency I-V in study group

	Test value=5.5					
	t	df	Significant (two-tailed)	Mean difference	95% CI of the difference	
					Lower	Upper
Right I-PL I-V (ms)	5.079	100	0.000	0.60277	0.3673	0.8382
Left IPL I-V (ms)	7.027	100	0.000	0.79198	0.5684	1.0156

IPL: Interpeak latency, CI: Confidence interval

Results

A total of 110 children were screened, out of which nine were excluded as they were conforming to the exclusion criteria. Thus, 101 children complying with the inclusion criteria were enrolled for the study. The results were expressed as mean and SD. Mean latencies and IPLs were increased, and the magnitude of change was highly significant in at risk cases as indicated by Tables 1-11 and figures 1 and 2. Increased latency V values were found in preterm babies, which reflect the immaturity of the auditory system.

Discussion

Recent evidence shows that the prevalence of newborn and infant hearing loss is estimated to be 1.5–6/1000 live births.[2] Neonatal screening for deafness has been neglected in India.

Misra *et al*. found that prevalence of BERA abnormalities was 43.3% on initial testing and that in 43.3% neonates having birth asphyxia, mean latencies of various BERA waves were higher, and there was no significant change in IPLs as compared to controls and abnormally reduced V/I amplitude ratio has been regarded as bad predictor of anoxic brain damage.[4] Such neonates are highly vulnerable to hypoxia with brainstem nuclei and inferior colliculi being worst affected. It was found that 71.73% of the cases diagnosed to have deafness were below 5 years.[5] Prolonged absolute latencies of wave V with normal IPLs would suggest involvement of cochlear nerve or cochlea which may be due to depression of endocochlear potential as a result of hypoxia and acidosis.[6] Involvement of cochlea in asphyxia has also been observed clinically.[7] Histopathological studies show that human neonates brainstem is highly vulnerable to anoxia with predominantly damaging effect on brainstem nuclei and inferior colliculi which participate in the formation of ABR.[8] A study in Belgium showed that the ABR allowed for an earlier diagnosis and intervention for auditory dysfunction than behavioral tests.[3]

In the present study, latencies I, II, III, and V and IPLs I–III, I–V, and III–V were prolonged bilaterally in the cases, and the prolongation was highly significant with $P < 0.01$. Hearing loss affects child's ability to speak and communicate, so early detection of hearing impairment is essential so that interventions such as sign language, hearing aid, infant stimulation, or cochlear implantation can be instituted early and satisfactorily.

Limitations of the study

The limitation of our study was that no follow-up of infants and children could be done and sample size was less.

Conclusion

BERA is a reliable method to determine hearing sensitivity. Thus, all high-risk cases should be screened by BERA as a routine measure for earliest detection of subclinical hearing impairment. There should be regular follow-up of such children, and rehabilitative measures should be initiated as soon as possible.

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Conflicts of interest

There are no conflicts of interest.

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