

Original Research Article

A study of brainstem evoked response audiometry in children with severe hearing loss

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ABSTRACT

Background: Brainstem evoked response audiometry (BERA) is a non-invasive diagnostic tool which can be used to assess the early hearing loss. The objectives of the study were to find out the risk factors for severe hearing loss in children and to evaluate the role of BERA in early diagnosis of severe hearing loss in children.

Methods: The present hospital based cross sectional study was conducted on 105 children suffering from severe hearing loss. Risk factors of hearing loss was assessed in these children and brainstem evoked response audiometry was performed.

Results: Out of 105 children studied risk factors for hearing loss were present in 69 cases (65.71%) in which several cases had multiple risk factors. History of prolonged stay at NICU was present in 23 cases (21.9%). 11 (10.5%) cases had suffered from meningitis while history of cerebral malaria was present in 2 cases (1.9%). History of cerebral palsy was present in 5.7% cases. The family history of hearing loss was present in 15 patients (14.3%). Bilateral severe hearing loss was present in 76 cases (72.4%) while in 13 cases (12.4%) there was bilateral severe to profound hearing loss assessed using BERA test.

Conclusions: Early detection and timely intervention can not only help prevent this silent handicap of deafness but also contribute to social and economic productivity of a community.

Keywords: Severe hearing loss, Brainstem evoked response audiometry, Children

INTRODUCTION

Hearing is the deepest, most humanizing philosophical sense man possesses. The sense of hearing is important during the early years of life for the development of speech, language, and cognition. Losses in either partial or total hearing may lead to poor language and speech development and thereby affects the comprehensive development of the individual and his productivity. Hearing loss and deafness are global issues that affect at least 278 million people worldwide. Two-thirds of these people live in developing countries.¹

Hearing loss is one of the commonest childhood handicap and with a large quantum of its burden in developing countries like India; there is a need to address this issue.

Hearing loss in infants should be recognized in time and appropriate otological and audiological interventions and rehabilitation should be instituted early, to take advantage of the plasticity of developing sensory system. So, early detection of hearing loss in children and providing hearing devices helps to develop speech, language, and listening skills needed for oral communication. Because

of this reason, early detection of a possible hearing loss in children is crucial.²

With the advent of brainstem evoked response audiometry (BERA), detection and quantification of hearing impairment has been easier in pediatric patients who are unable to cooperate with routine testing. The best predictor of permanent hearing loss is bilateral failure in auditory brainstem response (ABR) possibly because of its ability to detect both cochlear and brainstem lesions. Hearing loss of 40 dB or more at any frequency in the range of 0.5–4 kHz in the better ear is defined as sensorineural deafness with or without associated conductive loss. An infant is considered to have passed the ABR test if a replicable wave V response is present at 30 dB hearing level in both ears or in one ear at 30 dB hearing level and the other ear at 45 dB hearing level.³

With taking all these considerations the present study was undertaken with following objectives:

- To find out the risk factors for severe hearing loss in children.
- To evaluate the role of BERA in early diagnosis of severe hearing loss in children.

METHODS

The present study was conducted in the department of otorhinolaryngology, institute of medical sciences, Banaras Hindu University from January 2014 to July 2015.

Selection of cases

The study population comprised of children below twelve years of age with severe hearing loss who came to the department of otorhinolaryngology, institute of medical sciences, Banaras Hindu University and whose parents have given consent regarding participation in this study.

One hundred and five subjects were registered in the study who fulfilled the eligibility criteria. All these children had complaint of difficulty in hearing and/or speech.

A careful history was taken and full clinical examination was carried out and points were noted in performa. After proper history and clinical examination patients were subjected to brainstem evoked response audiometry test (BERA).

Past history of prolonged medical illness, ototoxic drug intake, seizure, meningitis, head trauma, fever with rashes, noise exposure were taken. Antenatal history like maternal health during pregnancy, previous history of abortion, maternal age, drug intake during pregnancy, radiation on exposure, any illness were asked. Perinatal history regarding term or preterm birth, mode of delivery,

birth trauma, asphyxia, weight of child, cry at birth, neonatal intensive care unit admission, Neonatal jaundice, seizure, congenital anomaly, immunisation history were asked. Postnatal history regarding any relevant findings was also assessed. History of deafness in family members and relatives were asked.

Brainstem evoked response audiometry

Before the test all patients underwent through ENT examination. If any wax or any foreign body found it was removed. Any ear discharge was treated. This test was performed in the department of ENT, Institute of medical sciences, BHU in a dust free, sound free and air conditioned room free from electromagnetic disturbances. Syrup Trichlofos (25 mg/kg body wt.) was given to sedate the baby half an hour before procedure. The patients laid on a flat couch and were allowed to relax before testing. After cleaning the forehead, vertex and both mastoid regions with spirit, surface electrodes were applied and subject tested in sleeping state with neck slightly flexed to minimise any myogenic activity. External auditory canals were cleaned and head phones were held against the ear of baby taking care that external auditory canal did not collapse. The BERA test was performed using a portable computerised system EP15-25 (ABR neuroscreening) interacoustics and graph was obtained. The software used was Ia base 2000 software. The electrodes used were pre gelled kendall (Tyco health care, H92SG, 48×34 mm). The transducer used was TDS39. Filter setting was 3000 Hz (low pass). Electrode impedance was checked for each individual and was maintained at <5 for all electrodes. Auditory click stimuli delivered monoaurally at the rate of 19.1/sec varying from 105 dBL-40 dBL using 2000 clicks failing which 4000 clicks were given. The test takes between 30-45 minutes with optimal testing conditions.

This procedure was performed for both ears separately. Hearing threshold was taken as normal if wave V was present at 40dB intensity of stimulus in BERA graph. If no wave V was found in BERA graph patient was diagnosed as hearing impaired. The morphology of the graph was noted until wave V is no longer identifiable. The minimum intensity at which wave V is identifiable is taken as the hearing threshold for that individual.

Data analysis

The data thus collected was coded and entered into Microsoft office excel worksheet. Frequency table and percentage of required variables were made.

Ethical consideration

The study was approved by the ethical committee of the Institute of Medical Sciences, Banaras Hindu University. Informed consent was taken from the parents.

RESULTS

Out of 105 children studied most of them (80.9%) belonged to 1-5 years age group. Among infants 5 cases (83.3%) were male while 1 case (16.7%) was female. In 1-5 years age group 51 cases (60.0%) were male and 34 cases were female (40.0%). In 6-12 years age group 6 cases (42.9%) were male while 8 cases were female (57.1%) (Table 1).

Table 1: Distribution of patients according to sex and their age group.

Age group (in years)	Male		Female		Total (n=105)
	No. of cases	%	No. of cases	%	
Less than 1	05	83.3	01	16.7	06 (5.7)
1-5	51	60.0	34	40.0	85 (80.9)
6-12	6	42.9	8	57.1	14 (13.4)

Table 2: Frequency of various risk factors for hearing loss present in study group.

Risk factors	No. of cases	%
Pre-term birth (<36 weeks of gestation)	9	8.6
Very low birth weight	10	9.5
Hyperbilirubinemia at birth requiring phototherapy	10	9.5
Meningitis	11	10.5
Cerebral palsy	6	5.7
Cerebral malaria	2	1.9
History of seizures	7	6.7
Ototoxic drugs	3	2.9
Recurrent diarrhoea	11	10.5
Recurrent Pneumonia	17	16.2
Delayed crying at birth	37	35.2
History of NICU administration for more than 48 hours	23	21.9
Family history of hearing loss in siblings	15	14.3

Table 2 shows presence of various risk factors related to hearing loss in study subjects. In present study risk factors for hearing loss were present in 69 cases (65.7%) in which several cases had multiple risk factors. In 9 cases there was history of preterm birth. Hyperbilirubinemia at birth leading to phototherapy was present in 10 cases (9.5%). History of prolonged stay at NICU was present in 23 cases (21.9%). 11 (10.5%) cases had suffered from meningitis while history of cerebral malaria was present in 2 cases (1.9%). History of cerebral palsy was present in 5.7% cases.

History of seizures was present in 7 cases (6.7%). In 3 cases (2.9%) there was history of ototoxic drug intake. History of recurrent diarrhoea was present in 11 cases

(10.5%) while history of recurrent pneumonia was present in 17 cases (16.2%). The family history of hearing loss was present in 15 patients (14.3%). 9 children (8.6%) had preterm birth (less than 36 weeks of gestation) while 10 children (9.5) had very low birth weight (less than 1.5 Kg).

Table 3: Frequency of hearing impairment in both ear in study group based on BERA threshold.

Threshold	No of right ear	%	No of left ear	%
≥105 dB	43	40.9	41	39.1
95 dB	58	55.2	58	55.2
85 dB	4	3.8	6	5.7

Table 3 shows hearing threshold of both the ear separately. In right ear the maximum hearing threshold was obtained at 95 dB for 58 ears (55.2%) followed by at or above 105 dB and 85 dB which was 40.9% and 3.8% respectively. In left ear the maximum hearing threshold was obtained at 95 dB for 58 ears (55.2%) followed by at or above 105 dB and 85 dB which was 39.1% and 5.7% respectively.

Table 4: Distribution of cases according to interaural difference of wave V latency in BERA test.

Increased interaural difference of wave V latency >0.3 ms	No. of cases	%
		66
Increased interaural difference of wave V latency < 0.3 ms	39	37.1

An increased inter aural difference of wave V latency of more than 0.3 ms was present in 66 cases (62.9%) while an increased inter aural difference of wave V latency of less than 0.3 ms was present in 39 cases (37.1%) (Table 4).

Table 5: Interpretation of BERA finding in study subjects.

BERA interpretation	No. of cases	%
Bilateral moderately severe hearing loss	2	1.9
Bilateral moderately severe to severe hearing loss	3	2.9
Bilateral severe hearing loss	76	72.4
Bilateral severe to profound hearing loss	13	12.4
Rt severe Lt moderately severe to severe hearing loss	4	3.8
Lt severe Rt moderately severe to severe hearing loss	7	6.7

Bilateral severe hearing loss was present in 76 cases (72.4%). In 13 cases (12.4%) there was bilateral severe to

profound hearing loss. In 4 cases (3.8%) there was right sided severe and left sided moderately severe to severe hearing loss. In 7 (6.7%) cases there was left sided severe hearing loss and right sided moderately severe to severe hearing loss (Table 5).

DISCUSSION

In this study, majority of children with hearing loss belong to age group 1–5 years (81%). Similar findings of delayed reporting were also found in different studies across India.^{4,5} Much of the speech and language development occurs during this period. Hence, hearing loss is identified when the child presents with delayed speech.

Only 6% of children belonged to infant category in present study. This shows that the early referral was poor. Neonatal screening can identify such children at an earlier stage which helps in early rehabilitation. Early identification of hearing loss offers children the opportunity to develop significantly improved language skills compared with those children who are diagnosed later. Therefore, internationally recommended age for the diagnosis of hearing loss in children is 3 months of age. If hearing loss is confirmed, intervention should start as soon as possible, preferably before 6 months of age.⁶

Severe deafness in children is usually due to sensorineural hearing loss rather than conductive loss or auditory processing disorders. Sensorineural deafness can be due to causes such as: (1) Hereditary (genetic), (2) prenatal (rubella), (3) perinatal (kernicterus, birth asphyxia, etc.) and (4) childhood acquired deafness (following meningitis, trauma).³

In present study the family history of hearing loss was present in 15 patients (14.29%). Bansal et al in their study on severe hearing loss found that family history of hearing loss was present in 15.6% and 16.6% cases respectively.⁷

In present study multiple risk factors for hearing loss were present in 69 cases (65.7%) in which several cases had multiple risk factors. Gupta in his study found that risk factors for hearing loss were present in 54.3% cases.⁸

In present study there were 9 cases with history of preterm birth. Hyperbilirubinemia at birth leading to phototherapy was present in 10 cases (9.5%), history of prolonged stay at NICU was present in 23 cases (21.9%), 11 (10.5%) cases had suffered from meningitis while history of cerebral malaria was present in 2 cases (1.9%), history of cerebral palsy was present in 5.7% cases, history of seizures was present in 7 cases (6.7%) and in 3 cases (2.9%) there was history of ototoxic drug intake. Several other risk factors in the history during antenatal, perinatal and postnatal period were also studied.

In a study by Lachowaska et al (2014), among the infants with particular risk factors of having hearing loss, the ones with hyperbilirubinemia, low birth weight, intensive therapy for at least 7 days, low Apgar scores, and craniofacial abnormalities proved to correlate with confirmation of hearing loss.⁹

Bhagya et al in their study found similar risk factors like present study. In their study out of 18 patients with severe hearing impairment 3 had hyperbilirubinemia, 8 had neonatal convulsions and 7 had birth asphyxia. Out of 50 patients with profound hearing loss, 10 patients were preterm, 18 had hyperbilirubinemia, 6 had neonatal convulsions, 12 birth asphyxia, 4 LBW.¹⁰

Bansal et al in their study also reported meningitis, birth asphyxia, ototoxicity, respiratory distress and hyperbilirubinemia as risk factors for hearing loss.⁷

Hearing assessment in children is one of the dark areas in spite of the fact that two out of every 1,000 children have permanent bilateral hearing loss above 60 dB. Four to six out of every 1,000 children born in India are found to have severe to profound hearing loss.^{3,11}

BERA is the only tool which can confirm the normal sensitivity of hearing whenever required & is very useful in early detection of hearing loss and planning rehabilitative procedures. In case of multiple handicaps, BERA is the only test which can give accurate picture of hearing sensitivity.¹² In case of high risk babies who are exposed to multiple risk factors like preterm babies, neonatal jaundice, neonatal convulsions, birth asphyxia & LBW & even other multiple risk factors which have chances of impairing hearing ability, BERA should be carried out as a routine procedure to detect the hearing loss in such babies. In present study bilateral severe hearing loss was present in 76 cases (72.4%). In 13 cases (12.4%) there was bilateral severe to profound hearing loss. In 4 cases (3.8%) there was right sided severe and left sided moderately severe to severe hearing loss. In 7 (6.7%) cases there was left sided severe hearing loss and right sided moderately severe to severe hearing loss. So, BERA test not only able to assess the threshold of hearing but also helped in planning of management in these cases.

BERA test although a more time consuming process is an accurate test for early detection of neural conduction irregularities in the auditory pathway. It can be reliably recorded even in premature infants of 30 weeks gestational age. It gives an estimate of degree and type of hearing impairment. It is used to localize the site of lesion in patients with hearing loss and vertigo. Threshold estimation by BERA is used to identify hearing impairment in neonates thus facilitating early rehabilitation. The existence of peak V is considered as sound stimulus perceived by the ear.⁴

CONCLUSION

Hearing loss commonly goes undetected until it affects the child's communication in the form of speech and language. This emphasizes the need for newborn screening. Screening programs should not only include newborn screening but screening in later periods also based on the risk factors. BERA gives an accurate picture of hearing sensitivity. Hence, in all high risk babies, BERA should be carried out as a routine procedure to detect hearing impairment.

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