International Journal of Research in Medical Sciences
Kumari R et al. Int J Res Med Sci. 2016 Jul;4(7):2870-2873
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012

DOI: http://dx.doi.org/10.18203/2320-6012.ijrms20161967

Research Article

Auditory assessment of children with severe hearing loss using behavioural observation audiometry and brainstem evoked response audiometry

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Received: 17 May 2016
Accepted: 09 June 2016

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ABSTRACT

Background: Early detection of hearing loss has been a long-standing priority in the field of audiology. Currently available auditory testing methods include both behavioural and non-behavioural or objective tests of hearing. This study was planned with an objective to assess hearing loss in children using behavioural observation audiometry and brain stem evoked response audiometry.
Methods: A total of 105 cases suffering from severe to profound hearing loss were registered. After proper history and clinical examination patients were subjected to behavioural observation audiometry (BOA) and brainstem evoked response audiometry test (BERA).
Results: Out of 105 cases in 62 cases (59.05%) the findings of both BOA and BERA tests were similar but in 43 cases the findings of both tests were not similar. In total 18 cases (17.14%) diagnosis of severe hearing loss could be made by BERA test only because of in 10 cases there was inconclusive BOA finding and in 8 cases there was no response in BOA test.
Conclusions: Behavioural observation audiometry can detect hearing loss but in developmentally retardrd children in whom responses are difficult to elicited, this test is not so conclusive. BERA is the tool which can confirm the normal sensitivity of hearing in such persons whenever required and is very useful in early detection of hearing loss and planning rehabilitative procedures.

Key words: Severe hearing loss, Behavioural observation audiometry, Brainstem evoked response audiometry

INTRODUCTION

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] The prevalence of hearing loss is two to five of every 100 newborns in high risk groups which is much higher than that of the low-risk population whose prevalence is 0.5-6/1000 healthy new born across the globe in different studies.[2-6]

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

Early detection of hearing loss has been a long-standing priority in the field of audiology. However, owing to the

fact that hearing loss is an invisible disability, it may often go undetected until school age, especially in children with no additional disabilities. The identification of hearing loss in developing countries like India is often passive, and poor reactions of a child to acoustic stimuli are ignored or only identified following an underlying disease, such as suppurative otitis media.

A hearing loss occurring early in life can have a major impact on speech and language development. Even a mild hearing loss during the first 3 years of life can adversely affect a child's development in areas that rely on auditory input.[7]

Currently available auditory testing methods include both behavioural and non-behavioural or objective tests of hearing. Although widely used and fairly reliable in normal children, behavioural tests have their limitations when administered to a developmentally retarded paediatric population. Appropriate examiner skills in handling children and a good sense of timing are imperative. Despite the best of intentions, efforts at determining responses using these tests are frustrated by factors like lack of cooperation and poor psychomotor skills in the child being tested. Further, behavioural tests, while measuring the lowest stimulus intensity to which response occurs, often do not provide an accurate picture of auditory threshold.[8]

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 co-operate with routine testing. Taking all these into account this study was planned with an objective to assess Hearing loss in children with severe hearing loss using behavioural observation audiometry and brain stem evoked response audiometry.

METHODS

The present study was carried out from January 2014 to July 2015 in the department of otorhinolaryngology, institute of medical sciences, Banaras Hindu University. The study population comprised of the all those children below twelve years of age with severe hearing loss. One hundred and five subjects were registered in the study. All these children had complaint of difficulty in hearing and/or speech. A careful history was taken and full clinical examination was carried out. After proper history and clinical examination patients were subjected to behavioural observation audiometry (BOA) and brainstem evoked response audiometry test (BERA).

Testing methods

- *Behavioural observation audiometry (BOA)*

Hearing was assessed either by distraction tests, play audiometry or pure tone audiometry based on the mental age of the patient. The stimuli used included the following: calibrated rattles, drums, bells and clacker, warble tones of 0.5, 1, 2 and 4 kHz, narrow band noise and speech. The quietest intensity level at which a response was obtained was noted. Responses from both ears separately could be assessed correctly only when headphones were used. Children whose test results were declared inconclusive were assessed no less than three times before arriving at this conclusion.

- *Brainstem evoked response audiometry test (BERA)*

This procedure was performed for both ears separately. Hearing threshold was taken as normal if wave V was present at 40 dB 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.

Ethical consideration

Ethical clearance was obtained from the institutional ethical committee of Institute of Medical Sciences, BHU. Informed consent was obtained from the parents of children enrolled for the study.

Data were entered and analysed in Microsoft office excel. Frequency table and percentage were used for analysing the data.

RESULTS

There was a male predominance over the female accounting for 59.05% of total number of cases. Majority of cases in present study were below three years of age i.e. 69.52%. Most of the cases (94.28%) were from middle and lower socio-economic class. Cerebral palsy, birth asphyxia, microcephaly, hydrocephalous and other associated conditions were present (Table 1).

On behavior observation audiometry at 500 Hz sound, major response was localization of sound source which was present in 70 cases (66.67%). At 1000 Hz, 2000 Hz, 4000 Hz most of the patients were unable to give any response. In 10 cases (9.52%) inconclusive BOA report was present while in 8 cases (7.63%) no response could be elicited (Table 2).

On BERA most of the study subjects (59.05%) hearing threshold of wave V in better ear was found to be at 95 dB. In 35 subjects (33.33%) the hearing threshold was at or above 105 dB and in 8 cases (7.62%) the hearing threshold was at 85 dB (Table 3).

In 62 cases the findings of both BOA and BERA tests were similar but in 43 cases the findings of both tests were not similar. In total 18 cases (17.14%) diagnosis of severe hearing loss could be made by BERA test only because of in 10 cases there was inconclusive BOA

finding and in 8 cases there was no response in BOA test (Table 4).

Table 1: General characteristic of study subjects (N=105).

Variables	No. of cases	Percentage
Gender		
Male	62	59.05
Female	43	40.95
Age group		
Less than 3 years	73	69.52
3-5 years	18	17.15
6-12 years	14	13.33
Socio-economic status		
Lower class	47	44.76
Middle class	52	49.52
Upper class	6	5.72
Family history in siblings	15	14.29
Associated conditions in children		
Cerebral palsy	6	5.71
Birth asphyxia	7	6.66
Microcephaly	3	2.86
Hydrocephalous	3	2.86
History of seizures	7	6.66
Congenital cataract	4	3.81
Hyperbilirubinemia at birth requiring phototherapy	10	9.52

Table 2: Behavioural responses of children at 100 dB sound (N=105).

Sound frequency	No response	Head turn	Localisation of sound source
500 Hz	8 (7.62%)	27 (25.71%)	70 (66.67%)
1000 Hz	60 (57.14%)	25 (23.81%)	20 (19.05%)
2000 Hz	78 (74.29%)	20 (19.04%)	7 (6.67%)
4000 Hz	83 (79.05%)	17 (16.19%)	5 (4.76%)

Table 3: Distribution of study subjects according to hearing threshold of wave V in better ear as obtained by brain stem evoked response audiometry (N=105).

Hearing threshold	No. of cases	Percentage
≥105 db	35	33.33
95 db	62	59.05
85 db	8	7.62

Table 4: Agreement between finding of BOA and BERA.

Results of auditory assessment	No. of cases	Percentage
Children in whom results of BOA and BERA agreed	62	59.05
Children in whom results of BOA and BERA not agreed	43	40.95
Children in whom diagnosis was made only by BERA due to:		
Inconclusive BOA	10	9.52
No response by BOA	8	7.62
Unilateral hearing loss	3	2.86

DISCUSSION

The majority of cases in present study were below three years of age i.e. 69.52%. Five years and below in this study were 86.67%. In study by Gupta (2008) below five years cases were 71.73%.[9] In study by Thirunavukarasu et al, majority of children with hearing loss belong to age group 1-5 years. Much of the speech and language development occurs during this period. Hence, hearing loss is identified when the child presents with delayed speech. This indicates that neonatal screening can identify such children at an earlier stage which helps in early rehabilitation.[10]

In 62 cases (59.05%) the findings of both BOA and BERA tests were similar. This finding was similar to study by Rupa in which agreement between the results of both testing methods resulting in a clear-cut diagnosis regarding hearing sensitivity was present in 54 children (57.5 per cent).

In present study total 18 cases (17.14%) diagnosis of severe hearing loss was made only by BERA because in 10 cases there was inconclusive BOA finding and in 8 cases there was no response in BOA test.

In study by Rupa out of 94 cases 15 children had either inconclusive (n = 9) or not elicitable (n = 6) BOA finding and hence threshold determination was possible only by the results of BERA.[11]

McCormick stated that under ideal conditions children aged six to 18 months respond only 70 per cent of the time to stimuli used in BOA. In a developmentally retarded child, sustaining the child's attention is even more challenging. Response assessment is further hampered by concomitant motor disability like spasticity and involuntary movements. When results using these tests are inconsistent after two or three trials, it may become necessary to abandon further testing in favor of BERA. Further, behavioral tests, while measuring the lowest stimulus intensity to which response occurs, often do not provide an accurate picture of auditory threshold.

In many children the results of BOA were inconclusive and hence threshold determination was possible only by the results of BERA.[8]

Discrepancies between threshold estimation by BOA and BERA may also be because the pathway followed by the auditory brain stem response is different from the pathway sub serving hearing as tested by behavioral methods.

CONCLUSION

Early identification of hearing loss offers children the opportunity to develop significantly improved language skills compared with those children who are diagnosed later. Thus neonatal screening can identify such children at an earlier stage which helps in early rehabilitation.

Behavioural observation audiometry can detect hearing loss but in developmentally retarded children in whom responses are difficult to elicited, this test is not so conclusive.

BERA is the tool which can confirm the normal sensitivity of hearing in such persons whenever required and 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.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Kumari R, Chakraborty P, Jain RK, Kumar D. Auditory assessment of children with severe hearing loss using Behavioural Observation Audiometry (BOA) and Brainstem Evoked Response Audiometry (BERA). Int J Res Med Sci 2016;4: 2870-3.