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Original Article

Physiology Section

ABER Assessment in Pre-school Children with Developmental Speech and Language Impairment

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ABSTRACT

Introduction: Developmental speech and language disorders (DLD) constitute a group of disorders when children with normal intelligence and hearing fail to develop language in an age-appropriate manner. There is no definite or surrogate neurophysiologic laboratory marker to quantitate the extent of speech and language impairment. The current study was designed to evaluate the abnormalities in Auditory Brainstem Evoked Responses (ABER) in children with speech and language impairment who do not have a hearing deficit or autism.

Materials and Methods: ABER recording was done in a cohort of 94 children (age 2-8 y) with DLD without overt hearing deficit or autism. The mean latencies for waves I, II, III, IV and V along with inter peak latencies for I-III, I-V, III-V and amplitude ratio of wave V/I was measured after click stimulus with intensities 110 db until 40 db and compared to age appropriate normograms.

Results: The peak latencies for waves I, III & V, inter-peak latencies I-III & I-V, III-V and wave amplitude ratio V/I was found within normal limits in both ears of all the children when compared to age appropriate normograms.

Conclusion: The current study therefore emphasizes the fact that ABER may not be used/recommended as diagnostic or prognostic tool in children with speech and language impairment without autism or hearing deficit. The results and the recommendations of this study will definitely reduce the burden on electrophysiologist, laboratories and also save time and financial resources.

Keywords: Autism, Brainstem, Hearing deficit, Speech and language delay

INTRODUCTION

Language is one of the fundamental basis of human intelligence and a key part of human culture. Children with developmental speech and language impairment constitute a large group of patients attending the paediatric neurology clinic. The exact prevalence and incidence of developmental speech and language delay/abnormality is not known but various studies have reported that approximately 15-50% of children attending Pediatric Neurology clinics have developmental speech and language delay/impairment/abnormality [1,2]. Developmental speech and language impairment is a common concurrence with a number of neurodevelopmental disorders including brain malformations, cerebral palsy, genetic leukodystrophies, severe epileptic encephalopathies including Landau Kleffner's syndrome, Electrical status epileptics in sleep (ESES) & Lennox Gestaut Syndrome [3-5]. It may also be associated with many inborn errors of metabolism, autism, severe malnutrition and hearing abnormalities. In many other children with DLD, no structural or metabolic abnormality can be found possibly due to gaps in literature and these cases are labeled idiopathic. Despite extensive research to unravel the pathophysiologic basis of speech and language impairment/ delay, the exact mechanism and pathophysiology still remain unclear [6]. This is further complicated by the fact that there is no definite or surrogate neurophysiologic laboratory marker to quantitate the extent of speech and language impairment.

Literature has shown that ABER (also called BERA Brainstem Evoked Response Audiometry) is a modern non-invasive, objective neurophysiological method for evaluation of hearing threshold and also helps in prognostication of neurological disorders like brain malformations, cerebral palsy, genetic leukodystrophies and abnormalities in the hearing pathway in the brainstem [7]. Many researchers have in the past used ABER to assess hearing deficit in children with speech and language impairment but there is a paucity of research specifically evaluating the abnormalities in ABER in children of DLD without hearing deficit [8].

With the aforementioned background we hypothesized that auditory evoked potentials are abnormal in children with speech and language impairment/delay who do not have any hearing deficit and these should help in understanding the pathophysiology of the same. The current study was therefore designed to evaluate the abnormalities, if any, in ABER in children with speech and language impairment without frank hearing deficit or autism.

MATERIALS AND METHODS

The current study was a clinical observational study. All children attending the Paediatric Neurology Clinic between 2011 and 2014 were screened for developmental speech and language impairment/delay. For the purpose of the current study, DLD was defined as a condition in which a child failed to develop age appropriate speech and language skills and had dysfunction in speech (comprehension, naming, repetition, fluency) and/or language (morphology, semantic, syntax, phonology and pragmatics). Permission from the institutional ethical committee was taken prior to the commencement of the study. Parental consent was obtained in all the selected children and their epidemiological data and detailed clinical history was recorded. Clinical examination was then performed by a Pediatric Neurologist. Clinical history included neurologic history, prenatal, perinatal, postnatal, family history and history of previous hospitalizations. All children less than 24 months, more than 8 years, having associated gross motor developmental delay, major cognitive deficit, traumatic brain injury, hearing impairment, cleft lip or palate and autism (using Childhood autism rating scale) were excluded from the study [9]. The final cohort constituted 94 children in the age group of 2 to 8 y, out of which 18 were girls and 76 were boys. In all these children any previous neuroimaging was reviewed. ABER were then performed in all these children in a silent, dark, sound and electric-

proof room to confirm and rule out hearing impairment. The peak latencies for waves I, III & V, inter-peak latencies I-III & I-V and wave amplitude ratio V/I was recorded. All the information was registered in a predesigned proforma.

RESULTS

A total of 1641 patients attended neurology clinic from 2011 to 2014. After using the exclusion criteria the final cohort constituted 94 (5.72 %) children in the age group of 2 to 8 years, out of which 18 (19.14 %) were females and 76 (80.86%) were males. The mean age of the whole cohort was 50.3 ± 19.7 months and was 49.3 ± 19.5 months in female children and 51.3 ± 20.0 months in male children. Fifteen out of 94 children were born of LSCS; indication of LSCS in seven of them being oligohydroamnios and in 6 history suggestive of difficult labour. Gestational diabetes and Hyperemesis gravidarum was present in the mother of one child each. The perinatal history of our cohort revealed that six babies were resuscitated at the time of birth and 19 had associated epilepsy. Postnatal history of 39 children was suggestive of delayed developmental milestones whereas 37 children were found hyperactive on neurological examination.

Despite best efforts, neuroimaging could be performed in only 19 children and abnormalities were seen in 6 of these. The major findings on neuroimaging included symmetrical gliosis in bilateral parietal region (n=1), gliotic areas in deep white matter periventricular region of bilateral parieto-occipital lobes (n=3), microcephaly (n=1), supratentorial hydrocephalous (n=1), diffuse white matter hypodensities seen bilaterally in white matter with specks of calcification in both lentifrom nucleus (n=1) and prominence of sulcal spaces mainly in bilateral fronto-temporo-parietal configuration (n=1).

ABER was performed in each of the 94 children and the mean latencies for wave I, II, III, IV and V along with inter peak latencies for I-III, I-V, III-V and amplitude ratio of wave V/I was measured after click stimulus with intensities 110 db until 40 db and compared to age appropriate normograms [10-12].The results of the auditory evoked responses on the right and left side are given in [Table/Fig-1,2] respectively.

The ABER mean latencies for waves I, II, III, IV and V along with inter peak latencies for I-III, I-V and amplitude ratio of wave V/I were within normal limits in all the 94 children when compared to age appropriate normograms.

DISCUSSION

Many authors in the past have conducted BERA in children with speech and language impairment and demonstrated that it can be used as a screening tool for hearing deficits. Some studies have also demonstrated that BERA can be abnormal in children with DLD without hearing deficit. Therefore BERA is recommended as a part of work up to prognosticate neurologic disorders including speech and language impairment [13-17]. However, this observation was mostly a byproduct rather than being primary objective of a well-planned study with a concrete research question. The current study was therefore planned to find out BERA abnormalities in children with speech and language impairment without having hearing deficit or autism. It was hypothesized that auditory evoked potentials are abnormal in children with DLD and that these abnormalities may provide some clue to the severity and prognosis of the speech and language impairment.

Olsén and co-authors examined click evoked ABERs in 42 children (mean age of 8 y) with history of premature birth. Neurological examination and neuroimaging revealed minor developmental dysfunction (31%) and periventricular leukomalacia (32%) respectively. No significant ABER abnormalities were detected in these children when compared to normal age-matched controls who were born at full term [13]. In another study Tharpe et al., found no significant delays in absolute or interpeak latencies in ABER in normal hearing autistic children, compared to age and gender matched controls [16]. Similarly no delays for click evoked ABERs were found for a group of children with language based learning impairments [14]. Filippini and Schochat also found no differences in a click evoked ABER for individuals with an auditory processing disorder when compared to a control group [17].

However, a few other studies reported click evoked ABER abnormalities in children with autism [15,18,19]. Subtle neural dysfunction at the brainstem level may not be detected by click

Montage	Intensity	I	II	III	IV	V	I-III	I-V	III-V	AR
Cz-A1	110 db	1.56±0.45	3.08±0.22	3.420. ±54	4.83±0.67	5.70±0.45	2.20±0.44	3.63±0.87	1.79±0.22	0.65
Cz-A1	100db	1.52±0.36	3.08±0.25	3.43±0.22	4.82±0.56	5.65±0.45	2.04±0.56	3.96±0.65	1.92±0.56	0.36
Cz-A1	90 db	1.48±0.86	3.08±0.15	3.4±0.23	4.76±0.67	5.67±0.55	2.1±0.45	4.08±0.34	1.98±0.56	0.42
Cz-A1	80 db	1.44±0.54	3.08±0.56	3.39±0.45	4.74±0.56	5.58±0.87	2.5±0.35	4.17±0.55	1.67±0.53	0.45
Cz-A1	70 db	1.42±0.35	2.5±0.56	3.38±0.45	4.67±0.69	5.63±0.55	2.52±0.79	4.21±0.67	1.69±0.29	0.39
Cz-A1	60 db	1.40±0.36	2.58±0.54	3.37±0.33	4.66±0.8	5.21±0.59	2.27±0.54	4.67±0.45	1.75±0.45	0.58
Cz-A1	50 db	1.41±0.19	2.88±0.34	3.36±0.67	4.58±0.35	5.49±0.52	2.26±0.54	4.27±0.66	1.81±0.67	0.29
Cz-A1	40 db	1.39±0.22	3±0.45	3.3±0.56	4.68±0.45	5.48±0.55	2.36±0.56	4.00±0.10	1.80±0.50	0.5

[Table/Fig-1]: Mean latencies (millisecond) for wave I, II, III, IV and V along with inter peak latencies for I-III, I-V, III-V(millisecond) and amplitude ratio (AR) of wave V/I measured after click stimulus with intensities 110 db until 40 db (right side) of all 94 children

Montage	Intensity	I	II	III	IV	V	I-III	I-V	III-V	AR
Cz-A1	110 db	1.54±0.44	3.08±0.14	3.47 ±0.67	4.82±0.67	5.70±0.45	2.20±0.44	3.63±0.85	1.79±0.22	0.7
Cz-A1	100db	1.52±0.36	3.15±0.25	3.43±0.22	4.81±0.56	5.65±0.45	2.14±0.56	3.96±0.64	1.89±0.56	0.5
Cz-A1	90 db	1.47±0.76	3.08±0.15	3.47±0.25	4.76±0.87	5.67±0.55	2.10±0.45	4.09±0.34	1.88±0.56	0.42
Cz-A1	80 db	1.44±0.54	2.78±0.56	3.30±0.49	4.74±0.56	5.58±0.87	2.45±0.37	4.18±0.55	1.67±0.53	0.35
Cz-A1	70 db	1.42±0.45	2.5±0.56	3.38±0.45	4.67±0.69	5.63±0.55	2.52±0.79	4.21±0.65	1.69±0.29	0.29
Cz-A1	60 db	1.41±0.36	2.58±0.54	3.37±0.33	4.66±0.8	5.21±0.59	2.25±0.55	4.67±0.48	1.75±0.45	0.58
Cz-A1	50 db	1.41±0.14	2.84±0.39	3.36±0.67	4.58±0.35	5.49±0.52	2.26±0.54	4.25±0.66	1.79±0.67	0.39
Cz-A1	40 db	1.39±0.89	3.05±0.67	3.34±0.50	4.68±0.45	5.48±0.55	2.36±0.59	4.00±0.18	1.81±0.60	0.5

[Table/Fig-2]: Mean latencies (millisecond) for wave I, II, III, IV and V along with inter peak latencies for I-III, I-V, III-V(millisecond) and amplitude ratio (AR) of wave V/I measured after click stimulus with intensities 110 db until 40 db (left side) of all 94 children

evoked ABER using a slow presentation rate. However, more recent studies have found that ABERs recorded using clicks presented at a fast rate or speech stimuli may indicate neural dysfunction at the brainstem level for some language-impaired children [14,17,20,21].

In a study by Al-Kandari, ABER was performed in a cohort of children with hearing loss and delayed speech and 37% of these children were found to have normal ABER [22]. In another study hearing was assessed in 76 children aged 1-5 y with speech delay using tympanometry, free field testing, otoacoustic emission recordings and auditory brainstem evoked responses (ABERs). Despite the fact that this cohort also included children with gross hearing abnormalities, ABER was normal in 68.4% of children [23].

The cohort in the current study was bigger as compared to the aforementioned studies and more specifically excluded children having autism and hearing deficit which may have confided the observations. This was a major limitation in the other similar studies conducted in the past. As stated in the observations of our study, none of the 94 children with speech and language impairment who do not have any hearing deficit or autism, had any abnormalities in the auditory evoked responses. This observation emphasizes the fact that in majority of such children, ABER does not show any abnormality even if structural lesions are present in the brain and inadequate verbal communication is proposed to be responsible for the delayed and abnormal language acquisition and speech development.

CONCLUSION

The results of the current study therefore become very important despite the fact that hypothesis in this study was "ABER is abnormal in children with speech and language impairment or delay". Based on the results of the current study and the aforementioned discussion it is amply clear that ABER does not show any abnormality in majority of children who have a speech and language impairment/delay with or without a hearing deficit. Further, ABER is mostly normal even when there is a structural abnormality in the brain. The current study therefore emphasizes the fact that ABER may not be used/recommended as diagnostic or prognostic tool in children with speech and language impairment without autism or hearing deficit. The results and the recommendations of this study will definitely reduce the burden on electrophysiologists, laboratories and also save time and financial resources. It seems plausible that there is always a functional impairment in speech and language controlling areas of brain and its connecting pathways and we therefore recommend future studies involving use of functional imaging and neurophysiology to find out the exact abnormalities in speech and language processing so that specific diagnostic and prognostic investigations can be performed to help clinicians plan management of these children.

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REFERENCES

[1] Parakh M, Parakh P, Bhansali S, Gurjar AS, Parakh P, Mathur G. A clinico-epidemiologic study of neurologic associations and factors related to speech and language delay. *Natl J Community Med*. 2012;3:518-22.
[2] Luthra S. Language Regression in Indoor Cases. *Global Journal of Medical Research*. 2010;10:12–17.
[3] Alexander KC. Leung CPK. Evaluation and Management of the Child with Speech Delay. *Am Fam Physician*. 1999;(59):3121–28.
[4] McVicar KA, Shinnar S. Landau-Kleffner syndrome, electrical status epilepticus in slow wave sleep, and language regression in children. *Ment Retard Dev Disabil Res Rev*. 2004;10:144–49.
[5] Shetty P. Speech and language delay in children: A review and the role of a pediatric dentist. *J Indian Soc Pedod Prev Dent*. 2012;30:103.
[6] Billard C, Duvelleroy-Hommet C, de Becque B, Gillet P. Developmental dysphasia. *Arch Pédiatrie Organe Off Sociéte Fr Pédiatrie*. 1996;3(6):580–87.
[7] BAER - brainstem auditory evoked response: MedlinePlus Medical Encyclopedia [Internet]. Available from: http://www.nlm.nih.gov/medlineplus/ency/article/003926.htm [Date of citation 24/12/2014].
[8] Savic L, Milosevic D, Komazec Z. Diagnosis of hearing disorders in children with early evoked auditory brainstem potentials. *Med Pregl*. 1999;52(3-5):146–50.
[9] Nagarajan R, Savitha VH, Subramaniyan B. Communication disorders in individuals with cleft lip and palate: An overview. *Indian J Plast Surg*. 2009;42:S137–43.
[10] Debruyne F, Hombergen G, Hoekstra M. (Normal values in brain stem electric response audiometry (BERA). *Acta Otorhinolaryngol Belg*. 1980;34:238–45.
[11] Jacobson JT. Normative aspects of the pediatric auditory brainstem response. *J Otolaryngol Suppl*. 1985;14:7–11.
[12] Durieux-Smith A, Picton TW, Edwards CG, MacMurray B, Goodman JT. Brainstem electric-response audiometry in infants of a neonatal intensive care unit. *Audiol Off Organ Int Soc Audiol*. 1987;26:284–97.
[13] Olsén P, Yliherva A, Pääkkö E, Järvelin MR, Tolonen U. Brainstem auditory-evoked potentials of 8-year-old preterm children in relation to their psycholinguistic abilities and MRI findings. *Early Hum Dev*. 2002;70:25–34.
[14] King C, Warrier CM, Hayes E, Kraus N. Deficits in auditory brainstem pathway encoding of speech sounds in children with learning problems. *Neurosci Lett*. 2002;319:111–15.
[15] Student M, Sohmer H. Evidence from auditory nerve and brainstem evoked responses for an organic brain lesion in children with autistic traits. *J Autism Child Schizophr*. 1978; 8:13–20.
[16] Tharpe AM, Bess FH, Sladen DP, Schissel H, Couch S, Schery T. Auditory characteristics of children with autism. *Ear Hear*. 2006;27:430–41.
[17] Filippini R, Schochat E. Brainstem evoked auditory potentials with speech stimulus in the auditory processing disorder. *Braz J Otorhinolaryngol*. 2009;75:449–55.
[18] Tanguay PE, Edwards RM, Buchwald J, Schwafel J, Allen V. Auditory brainstem evoked responses in autistic children. *Arch Gen Psychiatry*. 1982;39:174–80.
[19] Taylor MJ, Rosenblatt B, Linschoten L. Auditory brainstem response abnormalities in autistic children. *Can J Neurol Sci J Can Sci Neurol*. 1982;9:429–33.
[20] Bauch CD, Rose DE, Harner SG. Brainstem responses to tone pip and click stimuli. *Ear Hear*. 1980;1:181–84.
[21] Cunningham J, Nicol T, Zecker SG, Bradlow A, Kraus N. Neurobiologic responses to speech in noise in children with learning problems: deficits and strategies for improvement. *Clin Neurophysiol*. 2001;112:758–67.
[22] Al-Kandari JM, Alshuaib WB, Joe M. BERA in children with hearing loss and delayed speech. *Electromyogr Clin Neurophysiol*. 2006;46:43–49.
[23] Psillas G, Psifidis A, Antoniadou-Hitoglou M, Kouloulas A. Hearing assessment in pre-school children with speech delay. *Auris Nasus Larynx*. 2006;33:259–63.

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