A Comparative Study on Brain Stem Evoked Response Audiometry among Pre-school Children with Normal and Delayed Development of Speech Attending Bankura Sammilani Medical College

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ABSTRACT

Introduction: The main consequence of hearing loss, especially in children, is the impact caused by sensory deprivation in the development of auditory and language skills and learning. Any degree of hearing loss can result in significant damage, as it interferes with perception and understanding of speech sounds.This proposed descriptive cross sectional study tries to compare BERA parameters between normal and delayed speech/language impairment children. Study also examines possible abnormalities in BERA in children with speech and language impairment.

Material and Methods: One descriptive study with cross-sectional design was conducted in neurophysiology laboratory in the Department of Physiology, Bankura Sammilani Medical College and Hospital for one year. About106 pre-school children (1 to below 6years) of either sex were selected from those referred from Paediatric and ENT Department with complaint of delayed speech who had been advised BERA test. About 105 children without having delayed speech development were chosen randomly.

Results: Descriptive analysis was done of BERA parameters among all subjects. Mean and standard deviation of both male and female were calculated separately. Independent 't' test was done between the BERA parameters of normal children and children diagnosed with speech impairment. The test showed significant changes (p value <0.05) in waves I, III latency, I-III, I-V, III-V inter peak in study subject.

Conclusion: The brainstem speech evoked auditory responses can serve as an efficient tool in identifying underlying auditory processing difficulties in children with learning disability and can help in early intervention.

Keywords: Brainstem Evoked Response Audiometry (BERA), Pre-school children, Delayed speech/language

INTRODUCTION

Hearing loss is a high-prevalence disease, ranging from one to three per 1000 individuals. This number increases in the presence of risk factors for hearing impairment.[1,2] Its main consequence, especially in children, is the impact caused by sensory deprivation in the development of auditory and language skills and learning. Any degree of hearing loss can result in significant damage, as it interferes with perception and understanding of speech sounds.[3]

The first years of life are considered critical for child development, as the peak of the central auditory system maturation process occurs during childhood and neuronal plasticity is at its maximum.[4] This makes the early detection of hearing impairment crucial to minimize the damaging impact on the development of language and listening skills, as well as on the learning process caused by hearing loss.[6,7,8,9] In addition to an early diagnosis, the literature also points out the importance of interventional speech therapy in the successful rehabilitation of children with hearing impairment.[4,5] The earlier the diagnosis is established and auditory speech therapy is initiated, the closer will be the development of affected children to that of normal hearing children.[7,9]

Brainstem Evoked Response Audiometry (BERA) the screening test measures the summation of action potentials from the eighth cranial nerve (cochlear nerve) to the inferior colliculus of the midbrain in response to a click stimulus. Literature has shown that BERA test is a modern non-invasive, objective neurophysiological method for assessing the auditory pathways from the auditory nerve to the brainstem.[10] It is considered a short latency potential, since it occurs within the first 10 milliseconds after a sound stimulus is presented. The BERA comprises various waves, of which waves I, III and V are the most visible and of more significant clinical value. The currently used classification for the generating site of these waves is: I - distal portion of the auditory nerve relative to the brainstem; II – proximal portion of the auditory nerve relative to the brainstem; III - cochlear nucleus; IV – superior olivary complex; V - lateral lemniscus; VI - inferior colliculus; and VII – medial geniculate body.[11,12]

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This proposed descriptive cross sectional study tried to compare BERA parameters between normal and delayed speech/language impairment children. Study also examined possible abnormalities in BERA in children with speech and language impairment.

MATERIAL AND METHODS

One descriptive study with cross-sectional design was conducted in neurophysiology laboratoryin the department of Physiology, Bankura Sammilani Medical College and Hospital for one year. 106 Pre-school children (1 to below 6years) of either sex were selected from those referred from Paediatric and ENT Department with complaint of delayed speech who had been advised BERA test (as a study group). About 105 children without having delayed speech development were chosen randomly from the paediatric OPD, Bankura Sammilani Medical College and Hospital. Study Subjects were included in the study after getting informed consent from the parents or accompanying caregiver.

Exclusion criteria

Gross developmental anomaly, autism, very low IQ, recent ear infection, head injury, systemic disease or drug toxicity that affects ear were excluded from the study.

Method of study

Written consent was taken from guardian of all participants after explaining purpose and procedure of study. Pre-school children were chosen according to the inclusion and exclusion criteria. The participants were made familiar with the equipment and the test was discontinued if they faced any discomfort. History was taken regarding delayed speech/language impairment followed by General Health check-up was done.Than Brain stem evoked response audiometry test was done.

Recording of BERA

All participants were subjected to BERA testing according to standard techniques on an RMS Portable Aleron EP-Electromyograph machine manufactured by RMS Recorders and Medicare System (Chandigarh, India). Recording of BERA was carried out in a quiet and dimly lit room with the participant in the supine position. Participants were briefly informed about the procedure. Restless, irritable, and apprehensive participants were allowed to relax for 5–10 min before testing.

Since the electrodes used to record BERA should be placed over the scalp, the scalp hair should be oil free. Patient should be instructed to give shampoo bath to the hair on the day of the investigation. The inverting electrode is placed over the both ear lobe (Ai and Ac) and mastoid prominence and non-inverting electrode is placed over the vertex (CZ) of the head. One more electrode known as the earthing electrode is placed over the forehead (ground). This earthing electrode is very important for the proper functioning of preamplifier. Electrodes that are placed over the mastoid process or ear lobe should be symmetrical. All the electrodes should run towards the top of the patient's head.

Monaural auditory stimulus consisting of rarefaction clicks of 100 µs2 pulse were delivered through an electrically shielded earphone at a rate of 11.1/s. The contralateral ear was masked with pure white noise 30 dB below that of the BERA stimulus. A band pass of 10–3000 Hz was used to filter out undesirable frequencies in the surrounding. Responses to 2000 click presentations were live averaged to obtain a single BERA waveform pattern. Waveforms were obtained at 40, 60, 90 and 110 dB in each ear. Data of waveforms obtained at 110 dB were used for analysis. Absolute Peak Latency of waves I, III, V and Inter Peak Latency of I–III, III–V, I–V wave forms were considered for assessment.

STATISTICAL ANALYSIS

Statistical analysis was carried out using statistical software ‘SPSS version 20.0’ (SPSS Corp, Chicago, IL, USA). Descriptive data analysis included the use of Mean with Standard Deviation and range for various parameters. Comparison of various parameters of Brainstem Evoked Response Audiometry were done using independent ‘t’ test.

RESULTS

Descriptive analysis was done of BERA parameters among all subjects. Mean and standard deviation of both male and female were calculated separately (Table 1/Fig. 1). Independent ‘t’ test was done between the BERAparameters ofnormal children and children diagnosed with speech impairment. The test showed significant changes (p value <0.05) inwaves I, III latency, I-III, I-V, III-V interpeak in study subject (Table 2).

DISCUSSION

The experimental aim of this study was to compare between BERA parameters in normal children and children diagnosed with speech impairment to determine if there are

Brainstem Evoked Respond Audiometry parameters of all children	Normal children(n=105)		Delayed speech children(n=106)	
	Male (n=68)	Female (n=37)	Male (n=69)	Female (n=37)
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
APL-I	1.71 ± 0.12	1.64 ± 0.10	1.64 ± 0.16	1.59 ± 0.19
APL-III	3.78 ± 0.12	3.74 ± 0.18	3.63 ± 0.24	3.61 ± 0.27
APL-V	5.64 ± 0.14	5.62 ± 0.14	5.65 ± 0.28	5.60 ± 0.23
I-III IPL difference	2.08 ± 0.15	2.09 ± 0.18	2.00 ± 0.28	2.02 ± 0.32
I-V IPL difference	3.93 ± 0.19	3.98 ± 0.17	4.02 ± 0.30	4.02 ± 0.31
III-V IPL difference	1.86 ± 0.16	1.88 ± 0.24	2.01 ± 0.34	2.00 ± 0.29
APL- absolute peak latency, IPL- inter peak latency				

Table-1: Mean and standard deviationof Brainstem Evoked Response Audiometry parameters of all subjects (n=211)

Brainstem Evoked Respond Audiometry parameters of all children	Normal children (n=105)	Delayed speech children (n=106)	't' value	p value
	Mean ± SD	Mean ± SD		
APL-I	1.69 ± 0.12	1.62 ± 0.17	3.101	<0.05
APL-III	3.77 ± 0.15	3.63 ± 0.25	4.910	<0.05
APL-V	5.63 ± 0.14	5.63 ± 0.26	.102	>0.05
I-III IPL difference	2.08 ± 0.16	2.01 ± 0.29	2.319	<0.05
I-V IPL difference	3.95 ± 0.18	4.02 ± 0.30	2.134	<0.05
III-V IPL difference	1.87 ± 0.19	2.00 ± 0.32	3.751	<0.05
APL- absolute peak latency, IPL- inter peak latency				

Table-2: BERA parameters of children having delayed speech development and normal children

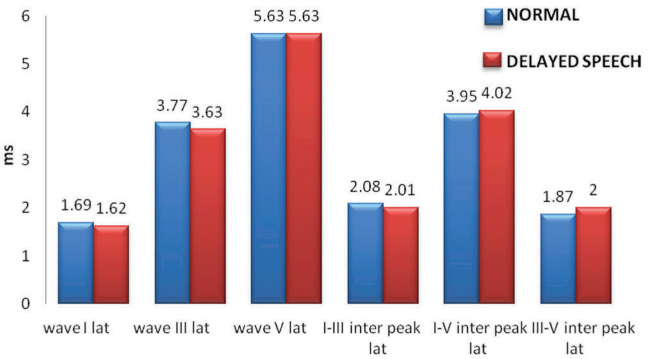

Figure-1: Bar diagram showing mean value of BERA test parameters both normal children and children having delayed speech development.

neurophysiologic differences between these two populations. Measures of sound perception and evoked potential features from the cortex were used to interpret differences in BERA seen between normal and learning-impaired subjects.

In our study with children in delayed speech as compared to the normal children, we found that wave I latency showed significant ($p < 0.05$) changes (Table 2).This finding of the speech and click-evoked results could be due to the difference in the acoustic character between click and speech stimuli. Click stimuli are characterized by rapid onset, brief duration, and flat broadband spectral components. However, speech stimulus is a complex signal with gradual onset and longer duration than click stimuli. Moreover, there is a difference in mechanism of encoding signal at the level of brainstem. Because of backward masking effect (effect of a vowel on brief consonant), the speech stimuli may be considered more challenging to the central auditory system.[13,14]

Present study found that wave III latency was significant ($p < 0.05$) in child with delayed speech when compared to the normal children (Table 2).The lack of a group difference on the cortical measure when compared to brainstem measure further supports that most language-impaired children share similar mechanisms with normal children, that link brainstem and cortical auditory processing. Abnormal cortical processing in most delayed speech children may primarily be a result of corrupted 'input' to the thalamo-cortical circuitry—possibly a result of degraded processing and/or transmission at the lateral lemniscus and/or inferior colliculus. Study done by Sachin et al revealed a considerable prolongation of the Wave III latency in the right ear of the study group (p<0.05).

Present study found that I-III interpeak latencies were significantly ($p < 0.05$) decreased in delayed speech child when compared to the normal children (Table 2). Moreover, Ghannoumet al.[15] studied the BERA in learning disabled children and they found that brain stem evoked responses were affected in those children, suggesting abnormalities in brainstem encoding of auditory signals.

Present study found that I-V interpeak latencies were significantly ($p < 0.05$) increased in delayed speech child when compared to the normal children (Table 2). This finding is consistent with the study of Tallal and Piercy 1974 in which it was suggested that abnormal neural encoding of auditory information (verbal or nonverbal) appears to play a major role in the disruption of normal language skills.[16] The results of these subjects were compared to the responses for normal children (referred here as control group) already established by Munish et al in 2008.[17]

Present study found that III-V interpeak latencies were significantly ($p < 0.05$) increased in delayed speech children when compared to the normal children (Table 2). Song et al in 2008 tried to prove that brainstem timing deficits in children with learning disability may result from corticofugal origins. He described the early brainstem responses to speech typically developing in 8-12 year old children and children with delayed speech. In various study the researcher found that children with delayed speech showed abnormal components of the rostral speech-evoked auditory brainstem response (ABR). The data were consistent with the view that the auditory deficits in the majority of the delayed speech children with abnormal speech-evoked ABR, originated from the corticofugal modulation of the subcortical acitivity.[13]

These data may indicate a specific relationship between temporal acuity in the auditory brainstem and cerebral asymmetry for speech sounds associated with auditory processing and learning ability. This may further correspond to the representation of the speech in the left hemisphere and may help us in unfolding the mechanisms responsible for language deficits. Our mentioned conclusions are in agreement with those of Wible et al who in 2004 demonstrated that speech ABR had a significantly shallower slope in learning problem children, suggesting longer duration.[18]

As the auditory brainstemreceives efferent inputs from the cortex, the abnormal cortical function results in impairedcortical feedback to the brainstem, that affects the brainstem timing.[19] Moreover, the descending pathway has a role in gating the sensory information to the cortex by its influence onselective attention.[20]

This poor representation of significant components of speech sounds could be due to synaptic efficacy distortion and poor synaptic transmission. Another reason may be activation of fewer auditory nerve fibers in the auditory brainstem in response to speech stimulus. Therefore, error in encoding of speech at brainstem level as depicted by the current findings could be the possible reason for the language based problems of children of the study group. These deficits may be attributed to poor neural recovery time in the children with learning based problems.

CONCLUSION

The brainstem speech evoked auditory responses can serve as an efficient tool in identifying underlying auditory processing difficulties in children with learning disability and can help in early intervention. Thus speech evoked auditory brainstem responses may help to determine when to refer a child to training and reduce the frustration of parents and educators from the uncertainty of outcomes.

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