Functional status of auditory pathways in children with borderline intellectual functioning: Evoked potential study

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Abstract

The present study was undertaken to determine whether impairment of sensory conduction in the auditory pathway is one of the contributory factors of performance in children with borderline intelligence. The study was conducted on children having borderline intelligence (IQ 71-84). The functional integrity of the central auditory pathway was assessed using Auditory Evoked Responses i.e. Auditory Brainstem response (ABR), Mid Latency Response (MLR) and Slow Vertex Response (SVR). The recordings were done using a computerized evoked potential recorder by 10–20 electrode placement system. There was no significant difference in the absolute peak latencies, the interpeak latencies and amplitude of ABR in the subjects as compared to controls. There was prolongation of the latency of MLR and SVR waves in subjects though not statistically significant indicating no conduction abnormality in the auditory pathway of the study subjects. Electrophysiological methods reveal underlying immaturity or abnormal brainstem timing and may serve as reliable tool in individuals with learning difficulties.

Introduction

Children with IQ in range of 71-84 are said to have borderline intellectual functioning (slow learners) (1). These children are at risk for learning difficulties and often demonstrate academic failure and underachievement, especially during elementary school (2). Dysfunction in any component of information processing system results in discrepancy between the individual’s potential ability and performance. Difficulty in information processing at the input stage results when the information from the environment is misperceived. These misperceptions do not pertain to visual or auditory acuity. Thus a person with perfect hearing or vision may still have auditory or visual perceptual disabilities (3). Since sensory conduction impairment can be one of the contributory factors of their performance, a thorough sensory examination is mandatory in these children.

Stimulus related potentials (SRPs) are records of the changes in electrical potentials in the nervous system in response to an adequate external stimulus. They reflect the functional integrity of the anatomical sensory/motor pathways in the brain or spinal cord or at periphery (4).

Auditory brainstem response (ABR) obtained within 0-5ms of application of stimulus helps in assessing auditory pathway in brainstem. In addition to it the
Mid Latency Response (MLR) having latency of 8-50 ms and Slow Vertex Response (SVR) with latency > 50 ms can also be studied to scan a wide tract of auditory pathway from auditory nerve to auditory cortex and association areas (4).

We have earlier studied the possibility of deficits in central neural processing of visual pathway in slow learners and observed a weaker VEP response indicative of a deficit early in the visual processing (5). Thorough search of literature reveals very scant data on the status of auditory pathway in children with borderline intelligence. Hence the present study plans to use electrophysiological measures to objectively investigate the auditory sensory process in the brainstem, thalamocortical and cortical areas in these children.

Materials and Methods

The study was conducted in the Electrophysiology Laboratory, Department of Physiology, UCMS, and Delhi. The subjects were selected from a school for special children (i.e. children with borderline intelligence, ADHD, dyslexia etc) in Delhi. These subjects were referred for classroom behavioral or academic problems and they were tested by a psychological evaluation team. All those students having IQ between 71 and 84 and not in the category of specific psychological disorders like learning disability (LD), attention deficit hyperactivity disorder (ADHD), mental retardation etc were selected for the study. Out of 31 children diagnosed as slow learners 5 could not participate in the study due to lack of consent from parents or prolonged absenteeism from school, and 8 had associated ADHD, dyslexia or other psychological problems and were excluded from the study. Hence 18 slow learners, 10 males and 8 females with mean age of 10.55±1.92 yrs participated in the present study. Fifteen age and sex matched controls (9 males and 6 females) with mean age of 10.87±2.94 yrs who had good school performance, were recruited from an elementary school in the vicinity of our institution. All the subjects and controls had a hearing threshold below 20 dB. The clearance from the ethical committee of the institution and an informed written consent was obtained from the parents, after the recording procedure was explained to them. The recording was done in the presence of either one of the parents or teacher.

A detailed history of clinical, academic, physical, psychological and neurological examinations was noted. The clinical psychologist conducted the standard IQ test by using MISC (Malin’s Intelligence Scale for Indian Children) an Indian adaptation of Wechsler intelligence scale for children (WISIC). The evoked potential (EP) recordings were done using Nihon Kohden Neuropack μMEB 9100. Silver-Silver Chloride disk electrodes were placed according to 10-20 International System at Cz (Active electrode), FPz (Grounding electrode), A1 and A2 (Reference electrode). Recording procedure and settings were followed as described previously (6).

Statistical analysis

The data obtained was analyzed using SPSS software (Version 17.0). The average of left and right ear was taken and analyzed. Unpaired ‘t’ test was used to compare between the controls and the subjects. Results were expressed as Mean±SD.

Results

The mean IQ of slow learners was 81.36±4.15 which was significantly lower as compared to that of controls having mean IQ of 99.73±8.63. There was no significant difference in the absolute peak latencies, the interpeak latencies and amplitude (Table I) of ABR in slow learners as compared to that of controls. The mean latencies of MLR waves Na, Pa and Nb are shown in Table II. There was no significant difference between the two groups. The remaining waves No, Po, Pb were not prominent in all the recordings. There was prolongation of the latency of SVR waves P1, N1, P2, and N2 in slow learners though not statistically significant (Table II).

Discussion

In the present study, there was no statistically
significant difference in the absolute peak latencies, the interpeak latencies and amplitude of ABR in children with borderline intelligence as compared to that of controls. ABR serves as a non-invasive clinical tool in characterizing the electrophysiological phenomenon of neural excitation, conduction and transmission across auditory pathway in the brainstem. The ABR waveforms are labeled from I-V and the wave I is believed to reflect activity in the auditory nerve; waves II and III, activity in the cochlea and superior olivary nuclei and waves IV and V, activity in the lateral lemniscus and inferior colliculus (4). The latency of the waveforms denotes the conduction time along the auditory pathway. The amplitude of the ABR waveforms depends on the number of neural elements activated by the sound stimulus and the degree of synchronized activity of these neural elements (7). The interpeak latencies (IPL) reflect neural conduction in the corresponding segments of the central auditory pathway. ABR abnormalities have been reported in children with learning problems (8, 9) speech and learning disorders (10) and auditory processing deficits (11). Puente et al, 2002, found prolonged latencies of waves III and V in ADD children and significant difference between mean interwave intervals I-III and I-V of children with ADD as compared with controls (12). These findings seem to suggest an abnormal brainstem transmission and a deficit in the activation of the central auditory process in these children. While no abnormalities in auditory processing or cognition was observed in children having attention deficit hyperactivity disorder (6, 13).

The mean latencies of MLR waves (Na, Pa, Nb) and SVR (P1, N1, P2, N2) waves are shown in Table 2. These were not significantly different in the two groups. The mid latency response is thought to reflect a combination of muscle reflex activity and neural activity possibly arising in the thalamocortical radiations, the primary auditory cortex and early association cortex (4). MLR abnormalities have been found in children with learning or speech/language disabilities (10).

The long latency responses or SVR consists of P1, N1, P2 and N2 and they are widespread in their distribution over the fronto-central scalp area. Vaughan and Ritter suggested that these potentials arose from primary auditory cortex and temporo-parietal association area and have latency of 50-300msec (14). The primary auditory cortex exerts a control over association cortex response through cortico-cortical and cortico thalamocortical connections. There was prolongation of the latency of SVR waves in children with borderline intelligence but not statistically significant. Our findings could not be compared due to paucity of literature in borderline intelligence group.

### TABLE I: Mean Absolute peak latencies, inter-peak latencies (ms) and Amplitude (μV) of ABR in controls and slow learners, both ears combined.

<table>
<thead>
<tr>
<th>Latencies (ms)</th>
<th>Interpeak intervals (ms)</th>
<th>Amplitudes (μV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>II</td>
<td>III</td>
</tr>
<tr>
<td>Control (n=15)</td>
<td>1.52±0.15</td>
<td>2.59±0.16</td>
</tr>
<tr>
<td>Slow learners (n=18)</td>
<td>1.62±0.29</td>
<td>2.70±0.25</td>
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</tbody>
</table>

### TABLE II: Mean Latencies (ms) of MLR and SVR components in controls and slow learners, both ears combined.

<table>
<thead>
<tr>
<th>MLR latencies (ms)</th>
<th>SVR latencies (ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na</td>
<td>Pa</td>
</tr>
<tr>
<td>Control (n=15)</td>
<td>19.90±4.16</td>
</tr>
<tr>
<td>Slow learners (n=18)</td>
<td>21.22±5.02</td>
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</table>
The findings of the present study do not suggest any conduction abnormality in the auditory pathway of the study subjects. Electrophysiological methods may reveal underlying immaturity or abnormal brainstem timing and may serve as reliable tool in individuals with learning difficulties. Other areas of information processing like central processing needs to be explored in this group to identify them at the earliest so that proper adjustment can be made for them.

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References