Brainstem Auditory Evoked Potentials in Patients with Type 2 Diabetes Mellitus

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INTRODUCTION

In the literature, although there are few studies on neuropathology, it has been known since the 19th century that in diabetics disorders caused by vascular and metabolic involvements take place in many organs (1).

Central diabetic neuropathy is a never concept and it can be detected by simple and noninvasive methods. One of these methods is brainstem auditory evoked potentials (BAEP) and interpretations of them (2,3). By this method, functional and autonomic pathologies from the acoustic nerve to the upper part of the brainstem can be demonstrated at an early stage (3). Lesions on these levels result in changes in BAEP amplitudes and latencies. Evaluation of these changes might help to determine early subclinic injuries restricted to the afore mentioned regions (4).

MATERIALS AND METHODS

This study was performed in the electrophysiology laboratories of the Neurology Department of Selçuk University Medical Faculty on 126 type 2 diabetic patients (54 female and 72 male) aged 18-72 years, who were followed up by the Endocrinology and Metabolic Disorders Department. The illness interval of the diabetic patients was between 1-10 years. A control group was formed from 30 people with similar sex and age distribution. Neither group showed any central neuropathy. There was no subjective symptom which showed an auditory pathology in either the diabetics patients or the control groups. Also, neurological examination including Weber and Rinne tests was normal.

In the brainstem auditory evoked potentials (BAEP) study, subjects were in a supine position on the examination desk. Active electrodes were attached to A1 and A2 points, reference electrode to Cz, soil electrode into Fz points (Figure 1). Recordings were done by monoaural stimulation by giving 90 dB stimulation to both ears and 40 dB masking.
rumbling sound to the contralateral ear. The duration of analysis was 10 msc and frequency range was 300-3000Hz. 2000 stimulations were applied to both ears and the average of them was accepted as BAEP response (Figure 2). The results of the patients and control groups were analysed statistically by using student’s t-test.

There was no significant correlation between the duration of diabetes, blood glucose levels and the latencies (Table 3a,b).

**Table 1.** The distribution of the cases according to age and sex, blood glucose levels and HbA1C.

<table>
<thead>
<tr>
<th></th>
<th>Patient group</th>
<th>Control group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age distribution</td>
<td>18-72</td>
<td>21-69</td>
</tr>
<tr>
<td>Age average</td>
<td>40.20±15.82</td>
<td>39.41±10.36</td>
</tr>
<tr>
<td>Sex (F,M)</td>
<td>54/72</td>
<td>13/17</td>
</tr>
<tr>
<td>Blood glucose levels</td>
<td>186±62</td>
<td>104±12</td>
</tr>
<tr>
<td>HbA1C</td>
<td>8.1±0.8</td>
<td>6±1.2</td>
</tr>
<tr>
<td>Blood pres. diastolic systolic</td>
<td>140±14-92±10</td>
<td>135±16-90±88</td>
</tr>
</tbody>
</table>

**Table 2a.** The statistical analysis of BAEP values obtained by a 90 dB stimulation of diabetic and control groups.

<table>
<thead>
<tr>
<th>Latence (mm./sc.)</th>
<th>Waves</th>
<th>Patients (n: 126)</th>
<th>Controls (n: 30)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>1.7075±0.190</td>
<td>3.8833±0.1750</td>
<td>5.8712±0.333</td>
<td>&gt;0.01</td>
</tr>
<tr>
<td>III</td>
<td>3.8520±0.1708</td>
<td>5.565±0.2259</td>
<td>&lt;0.01</td>
<td></td>
</tr>
<tr>
<td>V</td>
<td>5.8600±0.124</td>
<td>6.01±1.2</td>
<td>&gt;0.05</td>
<td></td>
</tr>
</tbody>
</table>

**Table 2b.** The statistical analysis of the duration of diabetes and latencies of BAEP waves in diabetics.

<table>
<thead>
<tr>
<th>Latence (mm./sc.)</th>
<th>Waves</th>
<th>Patients (n: 126)</th>
<th>Controls (n: 30)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>2.2133±0.2245</td>
<td>2.04±0.2059</td>
<td>4.2373±0.310</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>III</td>
<td>2.1382±0.1729</td>
<td>1.9041±0.2076</td>
<td>4.0252±0.220</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>V</td>
<td>4.2373±0.1645</td>
<td>5.7424±0.240</td>
<td>&gt;0.05</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 1.** Electrode placement. Active (+): Vertex ‘Cz’ of the international “10-20” system, Reference (-): Earlobe, A1 left, A2 right, Ground: Forehead.

**Figure 2.** The BAEP found in a diabetic patient.

**Results**

Table 1 and 2a, 2b show statistical analysis of age, sex, blood glucose levels, HbA1C and blood pressure (mm Hg) of the patients and control group and BAEP latency averages. The amplitude was a changeable parameter, so it was not taken into consideration.

As seen in Table 2a, in diabetics, especially in the first wave latency (p>0.01), IIIrd (p<0.05) and Vth (0.01) wave latencies are longer than in the control group. In addition, we found that interpeak latencies of I-III, III-V and I-V (Table-2b) were longer than those of the control group (p<0.05).
Central and peripheral nerve damage in diabetes may be related to the microangiopathy of diabetes. In diabetes small precapillaries and capillaries develop thickened basement membranes which may interfere with their function (5). The second major metabolic derangement that may be involved in the development of diabetic neuropathy is the accumulation of alcohol sugars sorbitol and fructose. Conceivably, an excessive accumulation of alcohol sugar in the nerves might similarly damage nerve structures (5,6). Diabetic neuropathy may be due to a deficiency of myoinositol in the nerve. Nerve myoinositol levels are decreased by galactose feeding and in Wallerian degeneration (5,7).

That metabolic and vascular complications of diabetes causing multi-organ failure is a well known feature of the disease but the central nervous system changes were not mentioned in the literature until the second half of the 19th century. De Jung was first to make the description of diabetic encephalopathy. Later on, postmortem examination by Reske et al. disclosed leptomeningeal thickening, cortical gliosis, degenerative changes of the brainstem and cerebellum with axonal degeneration and demyelination of cranial nerves.

The functions of the 6th nerve are relevant to hearing and equilibrium. Makashima and Tonoka have also observed cochlear atrophy and demyelination of the 8th cranial nerve (7). Kan and Surenson reported vascular changes in the cochlear and vestibular nucleus in the postmortem experiments on a diabetic patient who had vertigo and deafness (8).

There is little information about the vestibular function and central neuropathy in diabetics. In addition, it is thought that microangiopathy, orthostatic hypotension, complications of diabetes, sorbitol accumulation or electrolyte imbalance may cause central neuronal ischemia. As an addition the peripheral part of the vestibular system may be affected directly by acustic internal arter microangiopathy (6-9).

In past clinical studies, electroencephalography was used to explore the changes in electrocortical activity. But, by applying this method, it is impossible to obtain information on deep brain structure. In evoked potential studies used in recent years, it becomes possible to have detailed and adequate information on the central nervous system. Brain auditory evoked potential is a useful investigation method in order to explore the early subclinical neurologic dysfunctions in metabolic disorders.

In order to evaluate acoustic nerve function clinically, Weber and Rinne tests are used. In laboratory conditions, audiogram and brain auditory evoked potential can be used. In audiogram, cooperation of the subject and external conditions effect the results and may give false results (10). That audiogram cannot give information about brainstem pathology is its further disadvantage. But in brain auditory evoked potential the cooperation of the subject and it has a simple technique to apply even subject is not needed and it is a simple technique to apply even to subjects who are asleep or in a coma. It is not affected by external conditions (2,4).

BAEP study relies on the measurement of latencies and amplitude of waves arising after giving a sound higher than the hearing threshold (3). An auditory stimulus delivered to the ear evokes consecutive stimulation of brainstem structures such as the cochlear nucleus and tracts of the lateral lemniscus and inferior colliculus. Localizations and latencies from which waves originate are seen in Table 4. Consecutive waves on a BAEP pattern from I to V reflect the electrical activity of the acoustic nerve, cochlea, superior olives, lateral lemniscus, and inferior colliculus respectively (3,11). Patologies on this pathway from the
acoustic nerve to the mesencephalic may result in decreasing amplitude, lengthening of the latency or absence of the wave. Amplitudes were not taken into consideration because of their wide range of variability (11).

In this study, we found a lengthening in I, III and V wave latencies and I-III and I-V interpeak latencies in patients compared to the control group (p<0.05). In III-V interpeak latency, there was minimal lengthening and this was not significant statistically. Lengthening in the first wave latency indicates that the disorder is peripheral (distal to the nucleus), whereas, lengthening in the Vth wave latency is specific for brainstem involvement (3,9). If the lengthening in I-III interpeak latency occurs together with I-V interpeak latency, this indicates upper or lower brainstem pathology. Lengthening in I-III interpeak latency with normal III-V interpeak latency indicates that the pathology is in the lower brainstem or pons (3,9).

According to our results, lengthening in waves and interpeak latencies indicate that the pathology affected both the peripheral and the central nervous system structures. Some previous studies indicate similar results, and the main affected item is reported as BAEP interpeak latencies (12).

In our comparisons, there was no correlation between the lengthening in BAEP latency and metabolic control and this was compatible with the literature (13). There was a positive correlation between the duration of illness and lengthening of latency. This condition can be explained by subclinical ischemia which can develop during diabetic process (atherosclerosis, hypotension, sorbitol accumulation) (14,15).

According to these results and information in the literature, it can be suggested that BAEP can demonstrate electrophysiologically any lesions from the acoustic nerve to the brainstem and can be used in diabetics to show subclinical variances and central neuropathy.

References


