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Investigation of Auditory Brainstem Function in Diabetic Patients

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Abstract: We performed brainstem auditory evoked potential (BAEP) examinations in 15 patients with long-standing type 1 diabetes mellitus. We applied cardiovascular reflex tests for assessment of autonomic neuropathy. The aim of our investigation was to compare the BAEP results of this patient group with those of controls and to look for the possible correlation between alteration of the auditory brainstem function and cardiovascular autonomic neuropathy. Analysis of the latencies (waves I, II, III, and V) and the interpeak latencies (I–III and I–V) of BAEP revealed a significant difference between those of diabetics and those of healthy controls. The amplitudes of waves I, III, and V were definitely lower in comparison with amplitudes of healthy controls. We observed a positive correlation between the overall autonomic score and the latencies (waves III and V) and interpeak latencies (I–III, I–V). These data support the hypothesis that long-standing diabetes mellitus and diabetic neuropathy might be revealed as a cause of certain dysfunctions of the central auditory pathways.

Key Words: brainstem auditory evoked potentials; long-standing type 1 diabetes mellitus

Diabetic complications are well-known factors in the pathogenesis of several functional and morphological disorders. Neuropathy is one of the most frequent late complications of diabetes mellitus (DM). Diabetic neuropathy can be detected usually as autonomic and peripheral nerve impairment in the early period of DM [1]; however, data demonstrate the involvement of the central nervous system in diabetic neuropathy [2]. The evaluation of brainstem auditory evoked potentials (BAEP) is a very simple, noninvasive procedure to detect impairment of the auditory pathway and to analyze the influence of diabetic neuropathy.

The aim of our study was to evaluate the hearing function of a homogeneous group of diabetic patients with cardiovascular autonomic neuropathy, to compare the BAEP of normally hearing diabetic patients with the BAEP of controls, and to look for a possible correlation between alteration of the auditory brainstem function and cardiovascular autonomic neuropathy.

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PATIENTS AND METHODS

We performed our audiological investigations in 15 patients with long-standing type 1 DM. These insulin-treated patients were middle-aged (42.8 ± 4.3 years) and nonobese (body mass index, 26.7 ± 1.3). The duration of DM was 23.0 ± 2.6 years. None of these patients had a subjective hearing complaint. The control group included 15 age-matched, normally hearing subjects.

We investigated the presence of cardiovascular autonomic neuropathy by five standard cardiovascular reflex tests [3]: heart rate response to deep breathing, the Valsalva ratio, the 30/15 ratio, systolic blood pressure response to standing, and diastolic blood pressure response to hand grip. A score (0–10) was applied to express the severity of the autonomic disorder.

All subjects underwent a thorough audiological evaluation, including pure-tone audiometry, tympanometry, stapedial reflex, distortion product otoacoustic emission, and BAEP investigations. The latency and

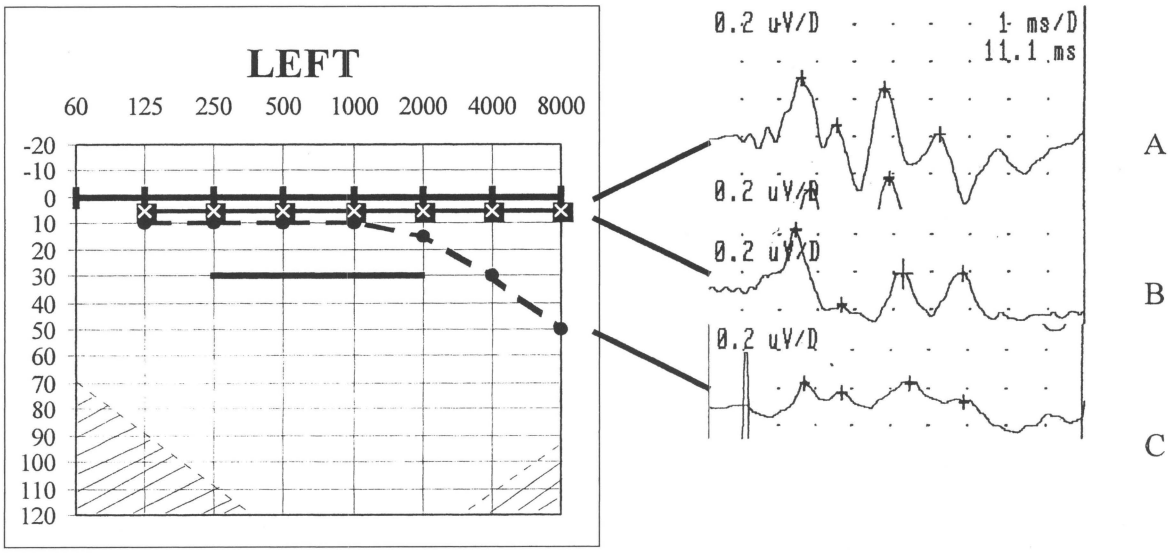

Figure 1. Pure-tone audiogram and the brainstem auditory evoked potential recording of a normally hearing control subject (A), a diabetic patient with normal hearing (B), and a diabetic patient with sensorineural hearing loss (C).

the amplitude values of waves I, II, III, and V and the interpeak latencies (IPL III–I, IPL V–I) were calculated. For statistical analysis, the Student's *t*-test and the Pearson correlation coefficient were used.

RESULTS

The results of our audiological evaluation show that 3 of 15 diabetic patients had sensorineural hearing loss and 12 patients had normal hearing (pure-tone thresholds between 0 and 10 dB in the 125- to 8,000-Hz frequency range). Figure 1 shows the BAEP results recorded from a normally hearing subject, a diabetic patient with normal hearing, and a diabetic patient with sensorineural hearing loss (pure-tone threshold elevation at high-frequency area). The wave latencies increased and amplitudes decreased in the patients with normal hearing. The latency growth and the amplitude deficit were more definite in patients with hearing loss.

The 12 diabetic patients with normal hearing were compared with age-matched controls. Our results of BAEP investigations are summarized in Table 1. There were significant latency differences in all BAEP waves. The latency values were significantly higher in diabetic patients than in those in the control group. The amplitudes of all BAEP waves in diabetic patients were definitely lower in comparison with those of healthy controls. Analysis of the IPLs of BAEP revealed a

Table 1. Mean Values of the Parameters of Brainstem Auditory Evoked Potentials and Standard Deviations

	Latencies (msec)					
	Wave I	**Wave II**	**Wave III**	**Wave IV/V**	**IPL I–III**	**IPL I–V**
Controls	1.48 ± 0.10	2.51 ± 0.09	3.74 ± 0.07	5.29 ± 0.10	2.26 ± 0.10	3.81 ± 0.11
Diabetics	1.58 ± 0.13	2.60 ± 0.12	4.02 ± 0.16	5.61 ± 0.18	2.42 ± 0.25	4.02 ± 0.25
Significance	$p < .01$	$p < .05$	$p < 10^{-7}$	$p < 10^{-7}$	$p < .05$	$p < .005$
	Amplitudes (μV)					
	Wave I	**Wave II**	**Wave III**	**Wave V**		
Controls	0.24 ± 0.05	0.12 ± 0.04	0.35 ± 0.09	0.24 ± 0.08		
Diabetics	0.19 ± 0.07	0.09 ± 0.03	0.24 ± 0.09	0.14 ± 0.06		
Significance	$p < .05$	$p < .05$	$p < .005$	$p < 10^{-4}$		

IPL = interpeak latency.

significant difference between those of diabetics and those of healthy controls.

Looking for a relation between the alteration of auditory brainstem function and degree of cardiovascular autonomic neuropathy, we observed a positive correlation between the overall autonomic score and the latencies of wave III ($r = 0.62$; $p < .05$) and wave V ($r = 0.61$; $p < .05$). The latency intervals I–III ($r = 0.54$; $p < .05$) and I–V ($r = 0.49$; $p < .05$) were positively correlated with the autonomic score.

DISCUSSION

BAEP represents the electrical events generated along the auditory pathway. Thus, BAEP evaluation is able to detect the early impairment of brainstem function. Delay of BAEP waves in diabetic patients has been reported previously. Khardori et al. [4] and Parving at al. [5] found deviations in latency interval I–V but not in the latency of wave I. Other authors demonstrated that diabetic patients are characterized by an impairment in latency values of all major components of BAEP [6,7]. The amplitude values were generally, but not significantly, reduced. The results of our study show that all parameters of BAEP components measured in normally hearing diabetic patients were impaired in comparison with those in healthy controls. Our subjects experienced significant latency increases and amplitude decreases, particularly in the cases of waves III and V.

Very few data exist about the relation between the alteration of auditory brainstem function and cardiovascular autonomic neuropathy. Martini et al. [8] found a high incidence of BAEP impairment (53% in diabetics with cardiovascular autonomic failure). Kondo et al. [9] could not show significant correlations between IPLs and autonomic nervous dysfunction as determined by orthostatic hypotension. Our results demonstrate that the overall autonomic score (including five standard cardiovascular reflex tests) significantly correlate with latencies and IPLs [10].

CONCLUSION

Cardiovascular autonomic neuropathy is a frequent complication of DM. However, the BAEP abnormalities point toward the presence of neuropathy in the acoustic nerve. The parameters of autonomic neuropathy consequently worsen along with several abnormalities of brainstem function. Our data support the hypothesis that diabetic neuropathy might be revealed as a cause of certain dysfunctions of the peripheral and the central auditory pathways.

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