A Comparative Study of Brainstem Evoked Response in Patients with Diabetic and Nondiabetic Subjects

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ABSTRACT

Introduction: Diabetes mellitus (DM) causes pathophysiological changes at multiple organ system. With evoked potential techniques, the brain stem auditory response represents a simple procedure to detect both acoustic nerve and central nervous system pathway damage. Aim: This study was undertaken to evaluate auditory function and incidence of hearing impairment in patients with diabetes.

Material and Methods: The study was carried out on 28 diabetic patients both insulin requiring and oral hypoglycemic agents and 20 age matched controls. Parameters such as, absolute latencies of wave I, II, III, IV, and V, interpeak latencies I-III, I-V and III-V, were assessed separately for both the ears

Results: The amplitude of the BAER wave I of both ears showed a significant reduction in the diabetic groups. Except in wave I in NIDDM group absolute latency was significantly prolonged in both the diabetic groups. Interpeak latencies of I-III (31) and I-V (11) were found to be prolonged in both groups and I-III (11), I-V (31) in NIDDM was also prolonged. In diabetic patients with elevated glycosylated hemoglobin there was a decrease in amplitude in wave I (11).

Conclusion: BERA is a simple, non-invasive procedure to detect early impairment of acoustic nerve, and CNS pathways, even in the absence of specific symptoms. This study suggests that if BERA is carried out in diabetic patients; involvement of central neuronal axis can be detected earlier.

Keywords: Diabetes Mellitus; Hearing Impairment; Brainstem Evoked Response Audiometry (BERA).

INTRODUCTION

Diabetes mellitus has become a global epidemic. The chronic hyperglycemia of diabetes is linked to long-term injury, dysfunction, and failure of various organs. Recognizing the earliest alteration of nerves, eyes, kidneys or blood vessels from diabetes may be important information useful for setting diagnostic criteria for diabetes and also to understand the pathophysiologic derangement of diabetes complications and adverse outcomes and to develop preventive treatments. Diabetes affects almost every organ system, and peripheral nerve involvement is common. Depending on the interpretation of neuropathy and the method of detection used, abnormalities in peripheral nerve are present in 20% to 67% of people with diabetes, though the prevalence of symptomatic central neuropathy in people with diabetes is not well established.[1] Brainstem auditory evoked responses (BAER) evaluate the electrophysiologic activity of the auditory pathway in response to externally applied acoustic stimulation. This noninvasive, highly repeatable technique provides objective measurements of the function and integrity of the auditory system. In healthy subjects, it consists of up to 7 waves labeled with Roman numerals recorded during the first 10 ms after acoustic stimulation.[2-5] Waves represent summated neuronal activity at different sites in the brainstem. Wave I is generated by the cochlear nerve, wave II originates from the cochlear nucleus, waves III and IV are generated in the olivary nucleus and the lateral lemniscus, respectively, and wave V in the midbrain (caudal colliculus). Physiologic factors such as age and head size affect BAER.[6-8] Stimulus frequency (clicks/s or Hz) also have clinically relevant effects on tracing.[2] In human infants and premature babies, higher frequencies improve the detection of brainstem abnormalities from hypoxic/ischemic encephalopathy (HIE).[9,10]

This study was undertaken to evaluate auditory function and incidence of hearing impairment in patients with diabetes and to find whether any correlation exists between the observed abnormalities and the blood glucose levels and duration of diabetes or not.

Aim

This study was undertaken to evaluate auditory function and incidence of hearing impairment in patients with diabetes.

MATERIAL AND METHODS

This prospective observational study was conducted in Department of Physiology, Thoothukudi Government Medical College for 6 months. The study was carried out on 48 subjects, among them 28 diabetic patients required both insulin and oral hypoglycemic agents. Informed consent was obtained from all participants. Patients were divided into 3 groups 20 people were with normal hearing without diabetes, noninsulin-dependent diabetics (NIDDM) 14 patients and insulin-dependent diabetics (IDDM) 14 patients.

Inclusion criteria: Patient diagnosed with diabetes and taking oral medication or insulin was included in this study.

Exclusion Criteria: any concurrent disease that affects

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How to cite this article: M. Vijayalakshmi, Heber Anandan. A comparative study of brainstem evoked response in patients with diabetic and nondiabetic subjects. International Journal of Contemporary Medical Research 2018;5(2):B1-B5.

the brain or the nervous system. Such as Uremia due to nephropathy; if they were on hemodialysis, If they showed ketoacidosis or hypoglycemia on the day of assessment, If they were judged at the clinic to be morbidly obese, If they had a positive pregnancy test, The patients in the sample were not on methyldopa, nitrofurantoin, reserpine, or any medication that might be expected to interface with the functioning of the central nervous system or to produce peripheral neuropathy, If the patient was febrile.

STATISTICAL ANALYSIS

The functional correlates of BAER and conduction velocity (Neuropathy) incidence of nephropathy, retinopathy, HbA1 levels and blood glucose values, duration of disease, effect of age and gender were analyzed and tabulated. Independent sample t test were used to check statistical significance of variables.

RESULTS

Diabetic patients ages ranged from 30-60 years. 14 patients were male (Mean age: 45 years) and 14 female (Mean age: 41.2 years). The duration of illness since diagnosis ranged from 5 – 20 years. There is no significant difference in demographic characters of controls and cases. It shows a significant reduction in the amplitude wave I of BAER and III in the diabetic groups and waves III of latency in IDDM. Except in wave I (31, 71) in NIDDM groups the absolute latency was significantly prolonged in both diabetic groups. When compared to age and sex-matched healthy controls, the interpeak latencies of I-III (31) and I-V (11) were found to be significantly prolonged in both IDDM and NIDDM the I-III (11) in IDDM and I-V interpeak latency at 31 stimulus rate in NIDDM also prolonged. The parameters of HbA1 and glucose values (fasting and postprandial) given the table except for the decrease in the amplitude in wave I (11) in the case of elevated glycosylated Hb, all the other parameters didn't show any change. (Table 1 and 2) Duration of the disease and its effects on BAER showed that when the duration of disease was more than 10 years, there was a significant increase in interpeak latency of I-III in NIDDM only. (Table 3) In the subjects more than 45 years of age, there is a delay in latency in wave I in both NIDDM and IDDM patients. Wave in younger age group, a delay in

Wave		IDDM		NIDDM		't' Value
		Mean	SD	Mean	SD	
Amplitude	I	184.72	138.64	85.45	82.30	2.251*
	II	119.98	96.42	106.22	63.77	0.420
	III	234.55	64.00	260.66	109.28	0.555
Latencies	I	1.73	0.28	1.77	0.19	0.447
	III	3.91	0.36	3.89	0.24	0.221
	V	5.93	0.32	5.92	0.30	0.082
IPL	I-III	2.19	0.32	2.18	0.50	0.052
	III-V	2.02	0.35	2.04	0.20	0.152
	I-V	4.21	0.20	4.23	0.52	0.103

Table-1: All diabetics HBA1C (BAER)

Wave		Blood Sugar	IDDM		NIDDM		
			Mean	SD	Mean	SD	T Value
Amplitude	I	>126	97.07	96.11	73.56	77.91	0.601
		>200	54.96	62.03	95.75	91.63	1.123
	III	>126	96.60	73.08	119.77	57.45	0.788
		>200	85.08	72.81	113.15	63.39	0.899
	V	>126	268.52	109.87	248.41	127.12	0.38
		>200	242.26	97.48	247.97	127.30	0.109
Absolute Latency	I	>126	1.82	0.18	1.80	0.24	0.193
		>200	1.82	0.20	1.79	0.24	0.361
	III	>126	3.92	0.26	3.89	0.21	0.218
		>200	3.96	0.27	3.95	0.24	0.097
	V	>126	5.96	0.36	5.97	0.28	0.028
		>200	5.98	0.38	5.98	0.27	0.043
Interpeak Latency	I-III	>126	2.10	0.13	2.22	0.73	0.537
		>200	2.14	0.17	2.30	0.73	0.623
	III-V	>126	2.05	0.23	2.07	0.21	0.252
		>200	2.02	0.27	2.03	0.25	0.023
	I-V	>126	4.14	0.25	4.33	0.73	0.772
		>200	4.16	0.25	4.36	0.72	0.771

*p<0.05,**p<0.01

Table-2: Comparisions between blood sugar > (126) F and > (200) PP (BAER)

Wave		Duration of Diabetes	IDDM		NIDDM		
			Mean	SD	Mean	SD	T Value
Latency	I	>10	1.79	0.21	1.61	0.08	1.408
		<10	1.74	0.22	1.79	0.23	-0.444
	III	>10	3.88	0.27	3.97	0.32	-0.471
		<10	3.95	0.28	3.84	0.26	0.905
	V	>10	5.94	0.42	5.96	0.12	-0.067
		<10	5.93	0.20	5.90	0.32	0.279
Interpeak Latency	I-III	>10	2.09	0.13	2.36	0.25	2.403*
		<10	2.21	0.21	2.17	0.71	0.166
	III-V	>10	2.06	0.27	1.99	0.30	0.402
		<10	1.98	0.28	2.06	0.20	-0.682
	I-V	>10	4.15	0.27	4.35	0.08	1.231
		<10	4.19	0.19	4.26	0.71	-0.230
Amplitude	I	>10	98.31	91.67	210.17	176.23	1.367
		<10	86.99	85.60	96.42	95.81	-0.212
	III	>10	107.03	72.68	142.07	111.11	-0.605
		<10	72.68	54.46	124.90	65.70	1.756
	V	>10	301.39	77.28	255.41	50.93	0.929
		<10	215.10	95.99	250.92	123.19	-0.651

***p<0.05,**p<0.01**

Table-3: Comparison between duration of disease > 10 and < 10 years (BAER) (IDDM VS NIDDM)

Wave			Normal		IDDM		NIDDM		't' Value	
			Mean	SD	Mean	SD	Mean	SD	N vs IDDM	N vs NIDDM
Absolute Latency	I	<45	1.59	0.10	1.68	0.15	1.62	0.05	1.498	0.565
		>45	1.58	0.09	1.86	0.22	1.83	0.24	3.514**	3.083**
	III	<45	3.66	0.10	3.86	0.25	3.66	0.22	2.389*	0.065
		>45	3.70	0.24	3.97	0.30	3.98	0.23	2.029	2.536*
	V	<45	5.60	0.11	5.77	0.19	5.76	0.28	2.339*	1.657
		>45	5.75	0.34	6.11	0.34	5.99	0.27	2.130*	1.688
Interpeak Latency	I-III	<45	2.07	0.18	2.18	0.23	2.05	0.24	1.135	0.210
		>45	2.12	0.27	2.11	0.12	2.30	0.78	0.095	-0.655
	III-V	<45	2.03	0.37	1.90	0.22	2.10	0.08	0.800	-0.385
		>45	2.05	0.25	2.14	0.26	2.01	0.26	-0.768	0.267
	I-V	<45	4.00	0.13	4.09	0.15	4.14	0.29	1.234	1.345
		>45	4.17	0.34	4.26	0.26	4.35	0.76	-0.564	-0.687
Amplitude	I	<45	142.31	88.29	76.00	85.58	196.92	154.39	1.543	-0.884
		>45	89.77	51.98	109.30	88.51	78.50	74.15	-0.575	0.387
	III	<45	92.66	64.85	99.29	63.20	164.40	75.68	-0.209	1.916
		>45	158.29	96.31	80.23	68.82	108.67	66.77	1.834	1.290
	V	<45	316.80	80.76	288.40	7.61	332.70	115.10	0.725	0.313
		>45	314.87	105.49	228.09	106.70	207.00	81.56	1.662	2.472*

*p<0.05,**p<0.01

Table-4: Comparision between age < 45 and > 45 (BAER) (normal VS IDDM and normal VS NIDDM)

latency, was noted in wave III and V in IDDM patients. (Table 4) Regarding gender the interpeak latency of I-III and I-V were significantly higher in males when compared with females. (Table 5)

DISCUSSION

BAEP represents the electrical events formed along the auditory pathway. Thus, BAEP evaluation is able to detect the initial impairment of brainstem function. Delay of BAEP waves in diabetic patients has been reported previously. Khardori et al.11 and Parving at al.[12] 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.[13,14] The amplitude values were generally, but not significantly, reduced. The difference was highly significantly increased in the latencies of waves I, III, V, IPL-I-III, I-V, an amplitude of wave V, of each type of diabetes as compared to control. Comparison of type and duration of diabetes between each other showed no significant defects. An evaluation of the extent and mechanism of damage of the central nervous system in diabetes mellitus is of high value in current neurological research. Electrophysiological abnormalities are frequently present is completely asymptomatic diabetes

Wave		Gender	Normal		IDDM		NIDDM		't' Value	
			Mean	SD	Mean	SD	Mean	SD	N vs IDDM	N vs NIDDM
Absolute Latency	I	M	1.54	0.05	1.79	0.21	1.74	0.20	3.645*	3.072
		F	1.63	0.12	1.75	0.22	1.77	0.25	1.436	1.582
	III	M	3.83	0.12	3.98	0.20	3.86	0.29	2.031	-0.382
		F	3.54	0.09	3.83	0.34	3.87	0.27	2.168*	3.628**
	V	M	5.78	0.33	6.01	0.34	5.86	0.33	1.452	-0.503
		F	5.57	0.11	5.85	0.29	5.96	0.25	2.709*	4.349
Interpeak Latency	I-III	M	2.28	0.08	2.20	0.15	2.31	0.87	1.637	-0.100
		F	1.41	0.16	2.09	0.21	2.10	0.29	1.907	1.768
	III-V	M	2.05	0.43	2.03	0.23	2.00	0.22	0.123	0.312
		F	2.02	0.14	2.01	0.32	2.09	0.21	0.096	-0.775
	I-V	M	4.24	0.28	4.22	0.24	4.36	0.90	0.097	-0.409
		F	3.93	0.14	4.10	0.20	4.19	0.17	2.005	3.495**
Amplitude	I	M	100.66	47.33	93.76	86.22	133.50	103.49	0.216	-0.888
		F	131.42	96.25	91.17	92.41	108.09	140.17	0.821	0.409
	III	M	92.99	90.08	96.84	62.97	140.08	73.59	-0.102	1.139
		F	157.96	73.59	80.32	70.67	117.07	75.51	2.072	1.1156
	V	M	314.80	53.20	227.55	93.87	252.2	85.33	2.492*	1.869
		F	316.87	121.74	299.17	87.08	251.51	137.42	0.310	1.034

*p<0.05,**p<0.01

Table-5: Comparison between males and females (BAER) (N Vs IDDM and N Vs NIDDM)

mellitus (DM) patients. Limited data is available in the use of brainstem auditory evoked potential. Although the latencies of waves III, IV, V of the Right ear and the IPL of I-III, I-V of both ears were prolonged, comparison with the control group was not significant. Similar findings were reported earlier by Abdulkadiroglu et al., Di Leo et al.[13,14] The study was done by Fedele D et al., showed that the absence or the correlation between ABR involvement and metabolic control and glycemic level during the test could be attributed to structure damage of the brainstem tissue.[15] Significant increases in IPL in I-III with disease duration > 10 years, which correlates with the study of Toth. F. These data support the hypothesis that long-standing DM and neuropathy might be related as a cause of certain dysfunction of the central auditory pathway. As far as gender is concerned, our study showed positive correlation in males which in accordance with another study. According to earlier studies, there is no significant correlation with age of the patient, but in our study, there was a definite correlation in older age group.[16]

CONCLUSION

BERA is a simple, non-invasive procedure to detect early impairment of acoustic nerve, and CNS pathways, even in the absence of specific symptoms. This study suggests that if BERA is carried out in diabetic patients; involvement of central neuronal axis can be detected earlier. So we strongly recommend that BERA should be done in all patients with diabetic mellitus.

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Source of Support: Nil; **Conflict of Interest:** None

Submitted: 08-02-2018; **Accepted:** 04-03-2018; **Published:** 14-03-2018