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Type-2 Diabetes Mellitus and Auditory Brainstem Response - A Hospital Based Study

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Abstract

Aim: To detect early changes involving central auditory pathway in patients with diabetes mellitus using BERA

Objective:

1. To find out central auditory pathway involvement in patients with diabetes mellitus.
2. To find out whether any correlation exists between the observed abnormality in BERA, blood glucose level and duration of diabetes.
3. To quantify the characteristic of auditory brainstem response and detecting the type, site as well as nature of lesion in patients with long standing diabetes mellitus using BERA.

Methodology: The study group consist of 30 patients aged more than 35 years with type 2 diabetes mellitus of more than 5 years duration on treatment attending diabetic OPD. Brainstem auditory evoked potentials were recorded and the results were statistically analysed using unpaired t-test. Absolute latencies of wave I, III, V and Interpeak latencies between waves I-III, III-V, I-V were recorded at intensity of 70 dB, 80 dB and 90 dB. The difference in latencies of wave I, III, V and interpeak latencies between I-III, III-V, I-V were calculated and compared with control group.

Result: There is a positive correlation between the delay evoked potential latencies with duration of DM and HbA1C. There was significant differences found in wave III (superior olivary complex level) and V (inferior colliculus level), interpeak latencies wave I-III, III-V and I-V between control and study group at 70 dB and 80 dB.

Conclusion: The study suggests that BERA helps in the early detection of central neuronal axis involvement at level of brain stem and midbrain in patients with long standing type-2 diabetes mellitus.

Keywords: BERA – Brainstem auditory evoked response, DM - Diabetes Mellitus, HbA1c –Glycosylated hemoglobin

Introduction

Diabetes mellitus type 2 a chronic metabolic disorder characterized by hyperglycemia has become a global epidemic. Since there is a long asymptomatic period of hyperglycemia, many individuals with type 2 diabetes, have complication at the time of diagnosis, neuropathy being the most frequent [(1)]. Diabetic neuropathy occurs in 50% of individuals with long standing diabetes mellitus. Risk of developing diabetic neuropathy increases with duration of diabetes and hyperglycemia. A part from peripheral and autonomic neuropathy patients with type 2 diabetes mellitus may also suffer from sensory neural hearing loss, which is more severe at higher frequencies. Brainstem auditory evoked response [BERA] evaluates the electrophysiological activity of the auditory pathway in response to externally

applied acoustic stimulation. This technique is non invasive and provides objective measurements of the function and integrity of the auditory system. It consists of upto 7 waves recorded during first 10ms after acoustic stimulation. The waves represent summated neuronal activity at different sites in the brainstem.

Wave I - Acoustic nerve

Wave II - Cochlear nucleus

Wave III - Superior olivary complex

Wave IV - Nucleus of the lateral leminiscus

Wave V - Inferior colliculus

Wave VI - Medical geniculate body

Wave VII - Originate between medical geniculate body to auditory complex[3]

Study Design: Prospective study to detect the early changes involving central auditory pathway among diabetic patients

Source of Data: Study was conducted among the Diabetic patients attending diabetic outpatient department and medicine outpatient department at Rajah Muthiah Medical college hospital, Chidambaram.

Study Period: October 2019 to September 2021.

Study Population: The patients attending diabetic outpatient and medicine outpatient department on treatment for diabetes mellitus of more than five years duration.

Equipment: BERA: RMS [Recorders and medicare systems (P)] EMG.EP MARK-II.

Inclusion Criteria

30 patients attending diabetic OPD and medicine OPD for treatment of diabetes mellitus and with duration of disease of more than 5 years.

Exclusion criteria

1. Patient with history of ear disease due to prolonged exposure to loud sound.
2. Patients with history of intake of ototoxic drugs.
3. Patients with family history of deafness.
4. Patients on any medication that might affect normal functioning of the central nervous system{eg. Methyldopa, reserpine, phenytoin, antipsychotics, etc}
5. Patient with any systemic illness that might affect the nervous system[uremia, stroke, hepatic encephalopathy, multiple sclerosis, thyroid disorder, meningitis, etc]

METHOD OF STUDY

After obtaining clearance from the ethical committee, study was started in department of ENT and department of Medicine at Rajah Muthiah Medical College and Hospital. The study group consisted of 30 patients with type 2 diabetes mellitus on treatment for a duration of more than 5years. A total of 30 adult healthy volunteers were taken as control. BERA test was performed in 30 diabetic patients and in 30 healthy volunteers. The equipment used for recording evoked response audiometry was RMS [Recorders and medicare systems (P)] EMG.EP MARK-II. Absolute latencies of I, III, V were recorded at intensity of 70 dB, 80 dBand 90 dB. Interpeak latencies between I-III, III-V, I-V were recorded. The difference in latencies of wave I, III,V and interpeak I-III, III-V, I-V were calculated and compared with the control group. The results were statistically analysed using unpaired t-test.

Statistical analysis

The data collected was entered into Microsoft excel 2019 and the master chart created was then loaded into SPSS version 23. All the outcome variables were quantitative variables in the present study. The variables were expressed with mean and standard deviation.

In order to compare the mean between two groups, unpaired t test was used. To find out the correlation between two quantitative variables following normal distribution, Pearson correlation test was applied. A ‘p’ value of less than 0.05 was considered to be statistically significant.

RESULTS:

Among the participants in the DM group, (13) 43.3% were in the age group 50 -59 years and (10) 33.3% were in the age group 60-69 years. Among the participants in the control group, (13) 43.3% were in

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the age group 50 to 59 years and (10) 33.3% were in the age group 60 to 69 years.

The mean latencies at 70 dB and 80 db in both ears were found to be prolonged in the diabetic group than in the control group in waves III and V and also the interpeak latencies I-III, III-V and I-V at 70 dB, 80 dB were also delayed. The above differences were found to be statistically significant with p value of less than 0.05 (Table 1,2,3,4).

The mean latency at 90 dB in both ears was found to be more in the diabetic group than in the control group in wave III. The above differences were found to be statistically significant with p value of less than 0.05 (Table 5,6).

The duration of diabetes and HbA1C was positively correlated with delay in latencies of III and V wave and also in I – III, III-V and I – V interpeak latencies. With increase in duration of diabetes, there was delay in latencies at III, V, I-III, III-V and I-V at 70 dB, 80 dB and 90 dB. With increase in HbA1c levels, there was delay in latencies at III, V, I-III, III-V and I-V at 70 dB, 80 dB and 90 dB (Table 7, 8, 9).

Table 1: Comparison of BERA wave latencies at 70 dB in the right ear between diabetics and the control group

BERA wave latencies (70 dB)	Diabetes		Control		't'	p value
	Mean	SD	Mean	SD		
I	1.61	0.05	1.58	0.05	1.90	0.062
III	3.96	0.35	3.46	0.04	7.57	0.001
V	6.10	0.54	5.43	0.06	6.82	0.001
I-III	2.34	0.34	1.87	0.08	7.22	0.001
III-V	2.14	0.24	1.96	0.06	3.98	0.001
I-V	4.49	0.52	3.84	0.07	6.68	0.001

Table 2: Comparison of BERA wave latencies at 70 dB in the left ear between diabetics and the control group

BERA wave latencies (70 dB)	Diabetes		Control		't'	p value
	Mean	SD	Mean	SD		
I	1.61	0.05	1.59	0.05	1.67	0.099
III	3.96	0.35	3.47	0.04	7.55	0.001
V	6.11	0.54	5.43	0.06	6.83	0.001
I-III	2.34	0.34	1.87	0.08	7.22	0.001

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III-V	2.14	0.24	1.96	0.07	4.01	0.001
I-V	4.49	0.52	3.84	0.07	6.73	0.001

Table 3: Comparison of BERA wave latencies at 80 dB in the right ear between diabetics and the control group

BERA wave latencies (80 dB)	Diabetes		Control		't'	P value
	Mean	SD	Mean	SD		
I	1.61	0.05	1.58	0.05	1.65	0.104
III	3.81	0.35	3.48	0.04	4.96	0.001
V	5.81	0.54	5.45	0.06	3.68	0.001
I-III	2.19	0.34	1.89	0.08	4.70	0.001
III-V	2.01	0.24	1.96	0.06	0.87	0.387
I-V	4.21	0.52	3.86	0.07	3.55	0.001

Table 4: Comparison of BERA wave latencies at 80 dB in the left ear between diabetics and the control group

BERA wave latencies (80 dB)	Diabetes		Control		't'	P value
	Mean	SD	Mean	SD		
I	1.61	0.05	1.59	0.05	1.67	0.099
III	3.96	0.35	3.47	0.04	7.55	0.001
V	6.11	0.54	5.43	0.06	6.83	0.001
I-III	2.34	0.34	1.87	0.08	7.22	0.001
III-V	2.14	0.24	1.96	0.07	4.01	0.001
I-V	4.49	0.52	3.84	0.07	6.73	0.001

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Table 5: Comparison of BERA wave latencies at 90 dB in the right ear between diabetics and the control group

BERA wave latencies (90 dB)	Diabetes		Control		't'	P value
	Mean	SD	Mean	SD		
I	1.61	0.05	1.59	0.05	1.23	0.221
III	3.65	0.35	3.51	0.03	2.21	0.035
V	5.57	0.54	5.47	0.05	1.01	0.314
I-III	2.04	0.33	1.91	0.07	2.01	0.052
III-V	1.93	0.24	1.93	0.04	0.96	0.337
I-V	3.97	0.52	3.89	0.65	0.87	0.384

Table 6: Comparison of BERA wave latencies at 90 dB in the left ear between diabetics and the control group

BERA wave latencies (90 dB)	Diabetes		Control		't'	P value
	Mean	SD	Mean	SD		
I	1.61	0.05	1.59	0.05	1.08	0.283
III	3.65	0.35	3.51	0.03	2.09	0.045
V	5.58	0.54	5.48	0.05	0.92	0.358
I-III	2.04	0.33	1.92	0.06	1.93	0.058
III-V	1.92	0.24	1.97	0.49	0.98	0.331
I-V	3.97	0.52	3.89	0.67	0.80	0.421

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Table 7: Correlation between BERA at 70 dB with duration of diabetes mellitus and HbA1c

		Right		Left	
		Duration of diabetes	**HBA1c**	**Duration of diabetes**	**HBA1c**
I	Pearson Correlation	0.15	0.13	0.33	0.34
	P value	0.420	0.463	0.074	0.066
III	Pearson Correlation	0.63	0.63	0.84	0.85
	P value	0.001	0.001	0.001	0.001
V	Pearson Correlation	0.74	0.74	0.91	0.91
	P value	0.001	0.001	0.001	0.001
I - III	Pearson Correlation	0.62	0.63	0.81	0.82
	P value	0.001	0.001	0.001	0.001
III - V	Pearson Correlation	0.74	0.73	0.79	0.80
	P value	0.001	0.001	0.001	0.001
I - V	Pearson Correlation	0.74	0.75	0.90	0.90
	P value	0.001	0.001	0.001	0.001

Table 8: Correlation between BERA at 80 dB with duration of diabetes mellitus and HbA1c

		Right		Left	
		Duration of diabetes	**HBA1c**	**Duration of diabetes**	**HBA1c**
I	Pearson Correlation	0.22	0.31	0.51	0.41
	P value	0.239	0.098	0.004	0.025
III	Pearson Correlation	0.63	0.63	0.85	0.85
	P value	0.001	0.001	0.001	0.001
V	Pearson Correlation	0.74	0.71	0.91	0.91

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	P value	0.001	0.001	0.001	0.001
I - III	Pearson Correlation	0.62	0.62	0.82	0.82
	P value	0.001	0.001	0.001	0.001
III - V	Pearson Correlation	0.74	0.67	0.79	0.80
	P value	0.001	0.001	0.001	0.001
I - V	Pearson Correlation	0.74	0.71	0.89	0.91
	P value	0.001	0.001	0.001	0.001

Table 9: Correlation between BERA at 90 dB with duration of diabetes mellitus and HBA1c

		Right		**Left**	
		Duration of diabetes	**HBA1c**	**Duration of diabetes**	**HBA1c**
I	Pearson Correlation	0.29	0.28	0.51	0.53
	P value	0.120	0.139	0.004	0.003
III	Pearson Correlation	0.63	0.63	0.85	0.85
	P value	0.001	0.001	0.001	0.001
V	Pearson Correlation	0.74	0.75	0.92	0.91
	P value	0.001	0.001	0.001	0.001
I - III	Pearson Correlation	0.62	0.62	0.82	0.82
	P value	0.001	0.001	0.001	0.001
III - V	Pearson Correlation	0.74	0.75	0.81	0.80
	P value	0.001	0.001	0.001	0.001
I - V	Pearson Correlation	0.74	0.75	0.9	0.90
	P value	0.001	0.001	0.001	0.001

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DISCUSSION:

The result of our study shows a positive correlation between the delay in evoked potential latencies with duration of DM and HbA1c. There were a statistical significant delay in latency of wave III (superior olivary complex level) at 70 dB, at 80 dB, at 90 dB and wave V (inferior colliculus level) at 70 dB and 80 dB. There was a significant difference found in interpeak latency I-III, III-V and I-V between control and study group at 70 dB, 80 dB in both ears. The latency in wave I was found to be equal in both groups. This suggests that transmission from 8th nerve till the level of cochlear nucleus may not be altered. This evaluation of the extent and mechanism of damage of central nervous system in diabetes is of high value in current neurological research.

Our finding supported the result obtained by Siddharth Suresh et al (2018)[2] they compared Diabetic group (n=15) and Control group (n=15), The wave I latency was found non significant and there were delay in latencies III and V and interpeak latencies I-III, III-V and I-V in diabetic patients compared to the controls. This suggests brainstem and midbrain involvement. So the study suggests that BERA helps in early detection of central neuronal axis involvement in type-2 diabetes mellitus.

In a study by Sharat Gupta el al [4] there was delay in wave III, V. Interpeak latencies I-III, I-V showed significant delays 70dB, 80dB, 90dB bilaterally. However in our study wave III, V and interpeak wave latencies I-III, I-V, III-V were delayed at 70dB and 80dB.

Siddiqui et al[3] in their study compared 25 diabetic and healthy individuals. There was delay in latency of wave III representing superior olivary complex and absolute latency of wave V representing inferior colliculus at 70 dB, 80 dB, 90 dB and Interlatencies I-III, I-V at 70 dB, 80 dB, and 90 dB.

M.Vijayalakshmi et al[1] detected early impairment of acoustic nerve and CNS pathway even in absence of specific symptoms. In our study we observed delay only in CNS pathway. The Acoustic nerve remained unaffected.

Donald et al[7] conducted BERA on 20 insulin-dependent diabetes patients and concluded that the latency of wave III ($p < 0.05$) wave V ($p < 0.001$) was significant at 70, 80, and 90 dB. The interpeak latency wave I-III ($p < 0.01$) and I-V ($p < 0.05$) is delayed. In the present study there is delay in wave III ($p < 0.001$), wave V ($p < 0.001$) and inter peak latency of waveI-III ($p<0.001$) and wave I-V, III-V ($p<0.001$) .In a study by Jorgensen et al[8] the histological findings in the inner ear of diabetic patients show characteristic microangiopathy with Periodic Acid Schiff positive substance in the vessel wall of striavascularis

Vaughan et al (2007)[5] conducted 5 year prospective study in 416 non diabetes and 375 diabetes veterans. Patients with diabetes had significantly delayed latencies of wave III and V in the right ear and significantly prolonged interpeak I-III and I-V latencies in both ears.

Durmus et al[6] measured the delay in neural conductance along the auditory pathway in 43 diabetes patients. Their auditory brainstem response (ABR) recording revealed that absolute latencies of wave I, III, and V were prolonged significantly in the diabetes group when compared with the control group ($p < 0.05$).

Due to the constant global rise in incidence of diabetes mellitus and its deleterious effect over the peripheral and central auditory system BERA may be considered as a mandatory screening procedure in all diabetic patients for assessing early central auditory neuropathy.

CONCLUSION:

BERA is a simple and noninvasive procedure to detect the early impairment of central auditory pathway. Latency of wave I was found to be equal in DM and control group suggesting 8th nerve transmission till the level of cochlear nucleus was not altered in diabetes. The delay in the latency of waves III, V and the interpeak latency in I-III, III-V,I-V in diabetic group suggests brainstem and midbrain involvement. BERA may be considered as a mandatory screening procedure for assessing early changes in central auditory pathway.

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