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EVALUATION OF AUDITORY BRAIN STEM FUNCTION IN ELDERLY TYPE 2 DIABETES MELLITUS PATIENTS WITH SENILE PRESBYCUSIS.

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Conflicts of Interest: Nil

Abstract:

Objectives: The aim of this study was to evaluate hearing function and possible correlations between alternations of the auditory brain stem function in elderly type 2 DM with presbycusis and to compare the data with elderly healthy non-diabetic controls with presbycusis.

Material and method: All subjects were submitted to full audiological history taking, ontological, basic audiological evaluation and auditory brainstem response audiometry, which were recorded in both ears followed by calculation of the absolute latencies as well as interpeak latencies. This study was done in 35 elderly type 2 DM subjects with presbycusis and 35 non-diabetic presbycusis. Control and experimental group was compared for Speech Recognition threshold and speech Discrimination threshold along with absolute latencies of wave I, III and V, as well as interpeak latencies I-III, III-V, I-V under electrophysiological measure.

Study Design and statistics: Experimental study was used for this study where two groups were compared for different variables.

Results: Elderly type 2 DM with presbycusis patients showed statistical significant both SRT and SDS ($P < 0.05$) as compared with non-diabetic group. The absolute latencies of wave I, III & V are significantly more in diabetic group as compared to non-diabetic group. Interpeak latencies of wave I-III are more in diabetic group as compared to non-diabetic group, but are not significantly different ($P > 0.05$).

Conclusions: It seems that ABR test should be the mandatory test for diagnosis of any auditory alterations and periodic evaluation on diabetic patients for treatment and intervention regarding metabolic regulations.

Keywords: Brainstem-evoked response audiometry. type 2 diabetes mellitus. senile presbycusis. elderly group.

Introduction

DM is the most common endocrine disease. It is a progressive metabolic disorder, characterized by abnormalities in glucose utilization due to absolute or relative insulin deficiency [1]. Its prevalence has been estimated to be more than 285 million people worldwide and 51 million people in India [2]. Over time, diabetes can damage the heart, eyes, kidneys, blood vessels, and nerves. Nephropathy, retinopathy and hearing impairment are some of late complications of DM which are depend upon the type of diabetes, duration and instability in blood sugar level [3].

Different views exist in regard to the adverse effects of diabetes mellitus on thehearing ability.The literature have described, the type of hearing loss typically found in Diabetes mellitus (DM) is bilateral gradually sensori-neural hearing loss especially high frequencies [4, 5]. However, some authors found low frequency hearing loss and some middle frequency hearing loss [6, 7].

Many studies have tried to identify the relationship between hearing loss and diabetes mellitus. Such studies are justified as controversy still view indistinctly in this topic, and given that while many diabetic patients showed hearing loss and many do not. Generally most of the time diabetes mellitus involves older patients, thus making harder to connect hearing loss to diabetes mellitus due to presbycusis. However, an evaluation of the existing studies showed that the relationship between diabetes and hearing loss is controversial. Some studies showed increased risk of hearing loss in diabetes patients, other studies did not find any hearing loss between controls and diabetes patients [8-10].The influence of age on ABR has been a matter of controversy. Some studies have reported that the ABR latencies progressively shift with age and other studies reported that there is no delay in the central conduction time with age [11, 12]. Although the relationship between diabetes and hearing loss has previously been studied, still there have not been sufficient prospective studies of hearing loss and type 2 diabetes mellitus (DM) that included elderly patients with presbycusis [13].

Due to the high prevalence of diabetes mellitus in the community and its probable adverse effects, it is worthwhile to examine the relation between hearing loss and type 2 diabetes mellitus in elderly patients with presbycusis.

The aim of this study was to evaluate hearing function and possible correlations between alternations of the auditory brain stem function in elderly diabetics with presbycusis and to compare the data with elderly healthy controls with presbycusis. All the subjects had presbycusis and sensorineural hearing loss not greater than 60 dB to avoid possible complications in BAEP data evaluation.

Material and Methods:

This study was conducted at the ENT department of Pt. JNM Medical College associated with Dr.BRAM hospital, Ayush health Science University. Thirty-five healthy elderly presbycusis subject with age range of 60–80 years [19 male (54.28 %) and 16 female (45.71%)] where mean age was 71.54 years (SD: ±4.17) were kept in the control group and whereas 35 elderly presbycusis with type 2 diabetes mellitus since > 10 years with age range of 60-82 years [20 male (57.14%) and 15 female (42.85%)], where mean age was72.05 years (SD: ±3.79) were taken as in the experimental group.Out of data from 140 ears [70 subjects (35 diabetic & 35 non-diabetic)], in diabetic group, data of 10 ears were not under normality, and in non-diabetic group, data of 16 ears were not under normality. So a total data of 124 were selected for statistical analysis i.e., 65 from diabetic group and 59 from non-diabetic group. Patients were excluded, if they had ear discharge, tinnitus, head injury, neurological deficit, and history of noise exposure in past, history of drug intake known to cause central neuropathy such as alpha methyl dopa, phenytoin or nitrofurantoin, reserpine. Consents were obtained from all patients after explaining the test procedure.

Ethical consideration:

Prior to testing all participants were explained regarding the aim of the study and the procedures which will be done on them during ENT evaluation audiological testing. Inform consent was duly signed by all the participants prior to initiation of any evaluation procedure.

First of all, otoscopic examination was performed for all case. Tuning fork tests were performed at all fundamental series from 256 Hz to 1024 Hz and conventional pure tone audiometry was performed by using the modified Hughson-Westlake procedure [14] by (Interacoustic, AC 40, Denmark) with TDH 39 earphone at each octave frequencies from 250Hz to 8000Hz for air conduction and from 250Hz to 4000Hz for bone conduction were executed for each ear in sound treated double room with ambient noise level within permissible limits [15]. Pure tone average was calculated based on the air-conduction average threshold levels in each ear at 500Hz, 1000Hz and 2000Hz.Speech recognition threshold (SRT), speech discrimination score (SDS) was evaluated for all patients. SRT testing was done using spondee word lists and SDS was estimated using phonemically balanced monosyllable word lists.

Tympanometry and reflexometry were obtained using a calibrated GSI-Tympstar diagnostic Middle Ear Analyzer. Tympanometry was carried out bilaterally using 226Hz probe tones, and measurements of ipsilateral and contra lateral acoustic reflex thresholds at 500, 1000, 2000, 4000Hz was attempted. Auditory brainstem response audiometry (ABR) was done using Smart-EPs of Intelligent Hearing System (IHS). This was done through two-channel recording using four electrodes applied according to the Smart-EP manual specification. Which are as following

Table 1: Acquisition parameters Used in ABR.

Type of stimuli	**Clicks**
Stimulus intensity	80dBnHL
Filter setting	100-3000Hz
Analysis window	12ms
Repetition rate	21.1
No of sweeps	2000
Polarity	Rarefaction
Amplifier gain	100k
Electrode montage	No inverting electrode (+): Vertex (Cz). Inverting electrode (−): Test ear mastoid (A1/A2) ground electrode: Fore head (Fz)
Transducer	EAR 3A (Insert Receiver)

At least two trials were performed for acquisition of wave to see the repeatability. The absolute latencies of wave I, III and V, as well as inter-peak latencies (IPLs) I–III, III–V and I–V were calculated for each ear separately. Shapiro-Wilk test was done to test normality.ANOVA was carried out to compare latencies, interpeak latencies, SRT and SDS between two groups. The post hoc Bonferroni multiple Comparison test was done to compare between absolute latency of wave I, wave III and wave V and interpeak latency of I-III, III-V and I-V separately for both the groups, by applying SPSS (statistical package for social sciences) software version 20.0. The level of significance was set at 0.05.

Results:

Significant difference were found between the elder type 2 diabetes mellitus with presbycusis and elder with presbycusis in terms of several auditory measurements of both right and left ears. The elder type 2 diabetes mellitus with presbycusis showed elevated thresholds with compared to non-diabetic with presbycusis subjects. In left ear (Table-2), the mean PTA was 40.76±1.77dB HL in elder type 2 DM with presbycusis and 35.14±2.22 dB HL in control groups ($P<0.05$).

Table 2: Results of Audiological measurement findings for left ear obtained from Experimental and Control group.

Audiological measurements (Pure tone frequencies)	Experimental Group (Mean and SD)	Control group (Mean and SD)	P Value
250Hz	32.00±4.05	28.57±5.08	.839
500Hz	33.42±4.66	30.28±4.68	.649
1000Hz	43.85±4.03	36.71±4.84	.000*
2000Hz	45.00±3.63	38.42±5.11	.009*
4000Hz	53.85±4.86	45.28±5.13	.000*
8000Hz	65.28±4.01	57.00±4.40	.001*
PTA	40.76±1.77	35.14±2.22	.023*
SRT	44.71±4.36	41.57±4.33	.718
SDS (%)	60.85±4.10	66.14±3.85	.333

*indicates Significant difference between two groups for p value <0.05. SD:Standard Deviation

In right ear (Table-3), the mean PTA was 41.09±1.97dB HL and 35.09±2.24.Difference in SRT between two groups in right ear was found significant (P< 0.05), but no significant value was found in left ear (P >0.05). Although the control group had better SDS than the diabetic with presbycusis group, the differences were not found statistical significant for either in the right or in left ear.

In ABR, we calculated the absolute latency values of waves I, II, III and inter-peak latency values of waves I-III, III-V, I-V. The latency of wave I values were considered for peripheral transmission time (PTT) and the inter-peak latency values were considered for central transmission time (CTT).

Table 3: Results of audiological measurement of right ear obtained from both the groups.

Audiological measurements (Pure tone frequencies)	Experimental Group (Mean and SD)	Control group (Mean and SD)	P Value
250Hz	33.57±2.86	28.57±5.22	.000*
500Hz	38.85±4.03	30.28±4.68	.000*
1000Hz	39.14±4.61	36.71±4.84	.082
2000Hz	45.28±3.62	38.28±5.13	.000*
4000Hz	51.85±5.01	45.42±4.90	.123
8000Hz	64.57±3.50	57.42±4.90	.003*
PTA	41.09±1.97	35.09±2.24	.044*
SRT	41.28±4.26	36.57±4.33	.056*
SDS (%)	62.71±3.90	68.00±4.72	.292

*indicates Significant difference between two groups for p value <0.05. SD:Standard Deviation

Auditory brain-stem response results of left ear for all patients with type 2 DM with presbycusis and control group are shown in **Table 4**. It can be concluded that diabetic patient (type 2 DM) with presbycusis have significantly delayed absolute latencies of I and III compared to control group (P < 0.05), but there was no significant statistical difference of wave V (P > 0.05) and the interpeak latencies of wave I-III and I-V between control and type 2 DM with presbycusis was found significant (P < 0.05).

Table 4: ABR results for Experimental and control group (In left ear).

ABR Latencies in ms	Experimental group (Type 2 DM with Presbycusis)		Control group (Presbycusis without diabetes)		P-Value
	Mean	SD	Mean	SD	
Wave I	1.54	±0.03	1.50	±0.04	.000*
Wave III	3.55	±0.05	3.49	±0.03	.040*
Wave V	5.61	±0.05	5.51	±0.03	.173
Wave I-III	2.00	±0.07	1.98	±0.07	.000*
Wave III-V	2.06	±0.07	2.02	±0.05	.211
Wave I-V	4.06	±0.06	4.00	±0.05	.000*

*indicates Significant difference between two groups for p value <0.05. SD: Standard Deviation.

Auditory brain-stem response results of right ear for all patients with type 2 DM with presbycusis and control group are shown in **Table 5**, only absolute latency of wave I was found significant as compared to control and type 2 DM with presbycusis and the inter-peak latencies of wave I-III and I-V between control and type 2 DM with presbycusis was found significant ($P < 0.05$)

Table 5: ABR results for Experimental and control group (In right ear).

ABR Latencies in ms	Experimental group (Type 2 DM with Presbycusis)		Control group (Presbycusis without diabetes)		P-Value
	Mean	SD	Mean	SD	
Wave I	1.52	±0.02	1.47	±0.03	.001*
Wave III	3.54	±0.03	3.49	±0.02	.334
Wave V	5.57	±0.03	5.48	±0.02	.203
Wave I-III	2.02	±0.04	2.01	±0.04	.008*
Wave III-V	2.02	±0.05	1.99	±0.03	.084
Wave I-V	4.05	±0.04	4.00	±0.03	.002*

*Indicates significant. SD: standard deviation. ABR: auditory brain stem response. DM; Diabetes mellitus.

Discussion:

The present study conducted on elderly type 2 DM with presbycusis participants, produced the following findings: (1) the diabetic with presbycusis had higher thresholds when compared to control groups; (2) speech recognition threshold were significantly higher in diabetic than control group; (3) The elderly type 2 DM had lower speech discrimination scores than control group. Previous studies have reported high-frequency loss, others have reported low-frequency loss, and others reported hearing loss across the frequencies. A cross-sectional study included 94 participants with type 2 DM and 94 controls, found that high-frequency hearing loss associated with duration of the disease and age of the participant. The mean age was 50 years, the mean duration of the disease was 7.2 years, and patients those who have history of noise exposure were excluded [16].

ABR recording is an objective, non-invasive, clinically useful procedure to rule out the early impairment both of the auditory nerve and of brainstem function [17]. Delay of ABR waves in diabetic patients have been reported previously.

Taylor et al were the first to compare and correlate the ABR findings with central diabetic neuropathy [18].

There are many previous studies on the prevalence of influence of aging on ABR [19, 20] .It has been showed there is a latency shift of the principle components, but did not find any significant delay in central transmission time (CTT) in the elderly [19]. And also there are studies which conflicted with this study and found significant latency shift limited to waves I and III and there was no significant delay in inter-peak latency I-V in elderly subjects even at high click rates. [20]

In diabetic patients the prolongation of wave I could be due to the reduction of peripheral transmission time in the auditory nerve that occurred secondary to diabetic neuropathy. [21] The delay in inter peak latencies I–III and I–V are evidence of central conduction delay in the auditory pathway of diabetics at the level lower and midbrain stem and this delay of wave III and V in the diabetics indicates neuropathy at brain-stem and mid-brain level in the auditory pathway.[22]

In our study, the absolute latency of wave I and the inter-peak latencies of wave I-III and I-V in both ears in type 2 DM in elderly patients with presbycusis was significantly delayed as compare to healthy elderly subjects with presbycusis. This study is supported other stories. [23, 24]

Bilateral, symmetrical, gradually slopping high frequency sensor neural hearing loss with slow onset in nature is usually seen in patients suffering from diabetes. This is may be due to both cochlear and retro cochlear or individual. The result of this present study showed that latency of wave I and interpeak latencies of wave I-III and I-V in both ears were delayed in comparison with healthy control groups. However, the prolongation of absolute latency of wave I and interpeak latency of wave I-III and I-V were most pronounced among other parameters. So it can be speculated that the impairment of neural is both central and peripheral in elderly type 2 DM patients. Since the ABR peaks are postsynaptic potential and the synaptic efficacy plays a significant impact on recognition and resolution and ABR duration.

Conclusion:

ABR recording can represent a useful, simple non-invasive procedure to detect both acoustic nerve and central nervous system damage even in the group of elderly patients with presbycusis and type-2 diabetes. It seems that ABR test should be a complementary diagnostic tool for diagnosis of any auditory alterations and periodic evaluation on diabetic patients and may have some implication for patients with speech perception ability, rehabilitation expected and intervention regarding metabolic regulations.

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