ISSN: 2279 - 0594

Journal of Biomedical and Pharmaceutical Research

Available Online at www.jbpr.in

CODEN: - JBPRAU (Source: - American Chemical Society)

Volume 5, Issue 4: July-August; 2016, 11-15

Research Article

Central auditory processing and visual reaction time study in type 2 diabetes patients and age matched non-diabetic control subjects

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Received 24 June 2016; Accepted 06July 2016

ABSTRACT

Background: Type 2 diabetes patients all suffering sensorineural hearing loss and their non-diabetic matched controls having 29.4% prevalence of hearing loss was reported earlier. Further investigations toward deeper insight to the malady are undertaken in same patients. **Method:** All 51 type 2 diabetic patients and their even numbered age-sex matched controls were subjected to Brainstem auditory evoked potential testing and simple visual reaction time study. **Result:** Significant delay in central auditory processing was evident in diabetic patients. Visual reaction times were also delayed significantly in the diabetes group. **Conclusion**: BAEP study early in management of type 2 diabetes can detect risk of hearing loss before manifestation and guide to prevent degradation of quality of life and safety. Simple visual reaction time test is also worth routine application toward patient guidance and supportive care to check accidents and drug overdose.

Keywords: BERA; Visual reaction time; Diabetic hearing loss; Diabetic cognitive decline; Diabetes and aging

INTRODUCTION:

Diabetic hearing loss is understood to affect several structural/functional elements of auditory reception, perception and reaction. There are current efforts to understand the disease as enhanced aging process posing varied threats of neural degeneration and dysfunction. Heterogeneity of involvement of the neural structures is of direct clinical relevance and worth examination. Study of treated type 2 diabetes cases and age matched non-diabetic subjects in select age range of 40-60 years, revealed all the diabetics suffering some degree of sensorineural hearing loss compared to 29.4% of non-diabetic controls (1). Any bearing of glycaemic control or disease duration on hearing loss was not subject to be discerned. Among the controls many of the l15 (of 51) subjects bearing some degree of hearing loss were pre-hypertensive.

Diabetes is recognized also as chronic state of subclinical systemic inflammation causing atherosclerosis and micro and macrovascular sequel (2). That includes damage to strial vasculature of cochlea leading to sensorineural hearing loss. Examination of central auditory processing using the brainstem auditory evoked potential (BAEP) have generally indicated dysfunction of varied magnitudes (3-5) or no consequences (6). The study subjects were thus further investigated testing possibilities of central mechanisms implicated and relevant to clinical address BAEP study was done to evaluate afferent arm of auditory processing. Sensory integration in to central perception occurs through dynamic association across relevant cortical areas. The same may be indirectly examined by studying visual (not auditory, as many were suffering hearing loss), reaction time in the subjects. BAEP test auditory brainstem impulse transmission and processing. Reaction time measurement includes the latency in sensory neural code traversing peripheral and central pathways; perceptive and cognitive processing and a motor signal traversing both central and peripheral neuronal structures and finally, the latency in end effector (i.e. muscles) activation. The present report summarizes observations from BAEP study and visual reaction time tests on the diabetic and non-diabetic compared groups.

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Subjects and method

The study was carried out at Departments of otorhinolaryngology and Physiology, MGM Medical College, Navi Mumbai during October 2007 to December 2008 period. Relevant details of protocol approval and study subjects recruitment (patients and controls) were reported earlier (1). Briefly, diagnosed type 2 diabetes patients of either sex or age matched controls each comprised of groups of 51. Sex distribution among diabetics was 19 males and 32 females. Among the non-diabetic control there were 29 males and 22 females. Either group was in 40 to 60 year age range, but median age among diabetics was 51 year while in non-diabetics, 58 years. The controls were carefully screened for absence of significant clinical morbidity, any chronic drug prescriptions, of habits of alcohol or tobacco consumption. Any history of major medico-surgical intervention in ears was carefully excluded. For either group the exclusion criteria were blood pressure above 135mmHg systolic and/or 90mmHg diastolic; any history of prolonged (more than a week) hospitalization in past 3 years and clean uneventful preceding month. Antidiabetic drugs were the only acceptable medications being taken by patients. Written informed consent was obtained from every participant with assurance of keeping personal identity undisclosed. Study protocol was approved by college research board.

BAEP study

Brainstem evoked potentials were tested in the ENT Department, employing RMS EMG EP Mark II-PC based machine of Indian make. The stimulus delivered was at 60dB higher to known hearing threshold of the subjects. It was delivered as a brief click of square wave pulse of 0.1 msec. The click was delivered through earphone. A click rate of 11Hz was used. 200 clicks were delivered to both the ears and the average of them was accepted as BAEP (Brain auditory evoked potential) response. The stimulation was picked by surface electrodes and recorded as wave I-V was obtained on the screens, on being averaged. Minimum three readings were obtained in each patient to ensure validity.

Following BAEP parameters were analysed: (i). Absolute latency of waves I, III, V.
(ii). Interpeak latency of I-III, I-V, III-V.

Reaction time study

All testing was carried out between 9am to 10am. A PC1000 device was used for reaction time study. It is a 1000 Hz square wave oscillator with soft keys for starts and stop function. PC1000 reaction time equipment has two components connected to each other. First component has a START button which is exclusively handled by the examiner. Second component has a STOP button which has to be operated by test subject and it also has a small red LED, which receives the visual stimulus. Red and green lights were selected for study, with red being the most enduring on retina. Both the examiners and test subject's components are connected to a computer which has audacity software installed. Audacity software records the reaction time in msec in wave format.

Examiner presses the START button in first component, held away from subjects view. The subject is trained to press the STOP button of his/her second component with index finger of dominant hand, as soon as light signal is seen in the instrument. The reaction time so gets displayed. The study subjects were familiarized with the system and actions by running 10 practice test cycles. After this 5 visual reaction time test cycles were conducted, recording the smallest of the readings as final data for the subject. Visual reaction time for green and red light stimuli were recorded.

Observations and Result

Table 1: The table below depicts auditory evoked potential parameters in control and type 2 diabetes groups

Parameters Group (Mean +SD)	Control Group (Mean +SD)	Type 2 Diabetes Group (Mean +SD)
Wave I latency	1.7367 ±0.2331	1.7412 ±0.2282
Wave III latency	3.6573 ±0.2624	3.8202 ±0.3126
Wave V latency	5.7091±0.2807	6.0508 ±0.3560*
Interpeak latency I-III	1.9387±0.3011	1.9406± 0.2988
Interpeak latency I-V	3.0630±0.3339	3.5271±0.3503*
Interpeak latency III-V	2.0480± 0.3541	2.2800± 0.4752*

*Statistically significant pair of comparison

Significant changes in BAEP parameters in diabetic subjects as opposed to non-diabetic control are observed, viz increased peak V latency and increased interpeak latencies in I-V and III-V peaks.

Table 2: The reaction time profiles of diabetic and non diabetic male and female subjects

Group	Visual Reaction Time (VRT) in ms (Mean ±SD)	
	Males	Females
VRT for Green light		
Control	196 ±52 (n=29)	204 ±56 (n=22)
Diabetics	284 ±86 (n=32)*	268 ±78 (n=19)*
VRT for Red light		
Control	184 ±55 (n=29)	198 ±58 (n=22)
Diabetics	276 ±81 (n=32)*	262 ±72 (n=19)*

*statistically significant with compared controls.

Males generally display shorter visual reaction times compared to females. The diabetic patients have clear delay in visual reaction time by 44.9% and 50% in males and by 31.4% and 32.3% in females to green and red light stimuli respectively. Females suffer less compared to males due to diabetes as per these observations. There is relatively quicker reaction to red light compared to green light stimulus.

Discussion

Early diagnosis and intervention in hearing loss of mature people is crucial to protect erosion of quality of life and personal safety. Pure tone audiometry assesses peripheral hearing function. Quality of peripheral hearing comes from central auditory processing (7, 8). Diabetes largely resembles an enhanced aging process. Studies point to functional plasticity changes in diabetic nervous system (9). BAEP tests behold merit in care of hearing loss. BERA measures neural synchrony of the auditory nerve as it passes through structures in auditory brainstem (10). Evoked potentials are electric signals from the central nervous system, triggered in response to the stimulation of a receptor. Damage to nerve tract will increase the latency and reduce amplitude of response wave. Changes in the wave latencies can be ascribed to specific anatomic structures in the brain. The hearing devices amplify sound volume, facilitating its reach and decoding in ear. Nonetheless, it is through central processing that auditory stimuli get linguistic meaning. BAEP parameters did show significant delays in auditory processing components in diabetic subjects. The findings are in agreement to earlier referred reports (3-5) while contradicting other (6). Delay in central processing of sound is thus a shared characteristic between age associated and diabetic hearing deficits.

The reaction time test reveals delay in studied sample of diabetics as compared to the control group. Red light persists little longer in retina and that may have led to more brisk responses than to green light. The slow reactivity of females relative to males is known phenomenon. But females

appear to suffer less damage compared to men in diabetes. Their differences in regard to duration of disease and relative glycaemic control etc are not examined. More consumption and more exertion may promote increased free radical stress in males and contribute to greater damage to sensory integration and response structures. Diabetes affects both peripheral and central neuronal integrity and function (11). Visual reaction time is longer than auditory reaction time (12). The visual reaction time incorporates more chemical changes in mediation, the nature of receptors and their mode of activation are different from those in auditory system. Visual pathway has many collateral pathways to various association areas. A greater delay in more complex perception of visual stimulus may be expected. Reaction time is measure of sensorimotor association (13) as well as performance of individual (14). It is test of integrity of both central and peripheral neural structures (15). Reaction time in diabetes may be affected by neuropathic changes (16, 17), and slowed down psychomotor performances, including impaired cognition (18, 19). Reaction time involves processing of sensory stimulus by CNS and consequent motor response decision and execution (20). Study has reported doubling of visual reaction time in diabetics (21).

Conclusion

BAEP are considered to display electrophysiological abnormalities even before complaints of hearing loss (5). BAEP investigation early in management of type 2 diabetes would be logical to timely take steps toward checking worsening of hearing and quality of life and safety of vast diabetes sufferers. Reaction time monitoring provides diabetes related neurocognitive and sensorimotor dysfunction that may forewarn for greater care in regard to patient safety against falls and accidents. Dementation poses risk of forgetful overdosing with antidiabetic and serious hypoglycaemias. Visual reaction time being simplest to perform must be essential element of quality diabetes care.

Conflict of interest statement

There are no conflicts among the authors.

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