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CORRELATION OF AUDITORY AND VISUAL REACTION TIME WITH DURATION OF DIABETES

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ABSTRACT

Diabetes Mellitus affects peripheral nerves in the somatosensory and auditory system, slows psychomotor responses and has cognitive effects on patients without proper metabolic control, all of which may affect reaction time. This study was done to correlate auditory and visual reaction time among type II diabetic patients to the duration of diabetes. This study was conducted in Dr D Y Patil Medical College and Hospital, Nerul, for a period of 3 months on a total of 90 male participants aged between 40-50 years. A total of 60 type II diabetic male patients were grouped as the study group with a total of 30 male patients with the duration of diabetes from 1-5 years as group-1 and 30 patients with the duration of diabetes from 5-10 years as group-2. A total of 30 non diabetic male participants were grouped as the control group. We found that both the auditory and visual reaction time were significantly prolonged in diabetics ($P<0.001$). The group-1 diabetics performed significantly better than group-2 diabetics ($P<0.001$). Delayed reaction time in diabetics without signs and symptoms of clinical neuropathy can be taken as a non-invasive, low cost, sensitive indicator of psychomotor slowing and early nerve damage. Hence, reaction time can be used as a routine clinical screening test for diabetic patients to prevent or delay the onset of diabetic neuropathy.

KEYWORDS: Diabetic neuropathy, duration of diabetes, auditory and visual reaction time.

INTRODUCTION

Diabetic Peripheral Neuropathy (DPN) is one of the the most common complications associated with Diabetes Mellitus. Reported estimates of the prevalence of DPN vary due to

differences in study populations and diagnostic criteria [1]. Chronic sensorimotor distal symmetric polyneuropthy is the most common form of DPN [2] and can lead to substantial sensory loss, muscle weakness, and pain. The typical presentation of DPN is a gradual onset of sensory impairments that include burning and numbness in the feet. In fact, the onset is so gradual that the disease may go undiagnosed for years. Neuropathic pain may be severe when it is present but this type of pain is reported to occur in only 11% to 32% of individuals with DPN [3]. DPN leads to a number of impairments and functional limitations including foot ulceration and subsequent lower-extremity amputation. The severity of Diabetic Peripheral Neuropathy is related to the duration of diabetes and degree of glycaemic control [4]. Diabetes Mellitus has been shown to affect peripheral nerves in the somatosensory [5] and auditory system [6], slows psychomotor responses [7], and has cognitive effects on those individuals without proper metabolic control [8-11], all of which may affect reaction times. Different neurophysiologic tests are required to identify dysfunction of different nerves in diabetes mellitus [12-13]. Auditory and visual reaction time is considered as an ideal tool for measuring sensory motor association [14-15]. Reaction time (RT) is the elapsed time between the presentation of a stimulus which can be of any modalities of sensory input like visual, auditory, pain, touch or temperature and the subsequent behavioural response to occur. It is considered to be an index of speed of processing. The behavioural response is typically a button press but can also be an eye movement, a vocal response, or some other observable behaviour [16]. We undertook this study as there is paucity of data correlating auditory & visual reaction time among type II diabetic patients to the duration of diabetes and also to emphasize the importance of assessing auditory and visual reaction time in routine clinical examination of type II diabetic patients to reduce the neuropathy related morbidity.

MATERIALS AND METHODS

This study was conducted in Dr D Y Patil Medical College and Hospital, Nerul, for a period of 3 months on a total of 90 male participants aged between 40-50 years after obtaining the permission of the ethical committee of our institution. In order to avoid the gender bias only male participants were included in the study. A total of 60 type II diabetic patients were grouped as the study group with further sub-division of the study group as Group 1 and 2. A total of 30 male type II diabetic patients with the duration of the disease from 1-5 years were grouped as group-1 and 30 male type II diabetic patients with the duration of the disease from 5-10 years were grouped as group-2. A total of 30 non diabetic male participants were grouped as the control group.

Criteria for Inclusion

Study group: A total of 60 type II diabetic male patients with good metabolic control, without any complications.

Group 1

30 type II male diabetics, aged 40-50 years, with the duration of the disease ranging from 1 – 5 years.

Group 2

30 type II male diabetics, aged 40-50 years, with the duration of the disease ranging from 5 – 10 years.

Control group: A total of 30 age matched healthy male participants from the non-teaching staff of our institute.

Criteria for Exclusion (Study Group)

1. Duration of diabetes more than 10 years
2. Diabetics with auditory or visual disturbances
3. Alcoholics, smokers, history of hypertension
4. Clinical evidence of peripheral neuropathy or myopathy
5. Any pathology or injury to the upper limb.

The auditory and visual reaction time was measured by reaction time instrument, 'Response Analyzer' by "Yantra Shilpa" Systems, Pune, which had a display accuracy of 0.001 second. The instrument is specially designed to measure response time in milliseconds. The reaction time was recorded for auditory tone and click sound stimuli and visual reaction time for red and green light stimuli. As soon as the stimuli was perceived by the participant, they responded by pressing the response switch. The display indicated the response time in milliseconds. After familiarising the participant with the instrument and after repeated practice, three readings for each parameter were noted. The average of the three readings was taken as the value for reaction time task.

Data was collected and was statistically analysed using Graphpad online statistics software. Reaction time was taken as mean ± standard deviation (SD). The level of significance was tested by student's t-test (paired). The observation was taken as significant with P value less than 0.001.

RESULTS

Table 1: Comparison of Auditory and Visual Reaction Time in Control and Study Group (Group 1 and 2)

Reaction Time (msec)	Control (30) (Mean ± SD)	Study Group (1+2) (60) (Mean ± SD)	t-test	P value
Auditory (Tone)	0.192±0.017	0.215±0.025	4.5357	P<0.001*
Auditory(Click)	0.153±0.013	0.179±0.018	7.0383	P<0.001*
Visual (Red)	0.240±0.0215	0.268±0.028	4.8091	P<0.001*
Visual (Green)	0.190±0.018	0.219±0.021	6.4649	P<0.001*

*P<0.001 highly significant

Controls performed better than the diabetics for auditory click and tone sound stimuli and visual green and red light stimuli at P< 0.001 for both.

From the above table it can also be seen that auditory reaction time is faster than visual reaction time in both diabetics as well as controls.

Table 2: Comparison of Auditory and Visual Reaction Time in Study Group 1 and 2 Diabetics.

Reaction Time (msec)	Group 1 (30) (Mean ± SD)	Group 2 (30) (Mean ± SD)	t-test	P value
Auditory (Tone)	0.203±0.018	0.228±0.021	4.9507	P<0.001*
Auditory (Click)	0.163±0.013	0.196±0.011	10.6139	P<0.001*
Visual (Red)	0.256±0.015	0.279±0.019	5.2040	P<0.001*
Visual (Green)	0.205±0.011	0.232±0.029	4.7680	P<0.001*

*P<0.001 highly significant

Group 1 diabetics performed better than group 2 diabetics for auditory tone and click sound stimuli and visual red and green light stimuli at P< 0.001 for both.

DISCUSSION

Type II Diabetes mellitus, the most common endocrine disorder is responsible for significant morbidity and mortality because of the various complications associated with it [17]. Diabetic neuropathy (DN) is one of the complications accounting for 28% of all the complications in diabetics [18]. It is a disorder of the nerve caused by diabetes mellitus which may be diffused, affecting several parts of the body, or focal, affecting a specific nerve and part of the body. Symptoms usually develop gradually over years and are non-specific [19]. Therefore, there is a need for tests to identify DN before the development of serious complications like cognitive disabilities and diabetic foot. Chronic hyperglycemia in diabetic patients affects peripheral

nerves in the somatosensory and auditory system. It also slows psychomotor responses and has cognitive effects on those individuals without proper metabolic control, all of which may affect reaction time [20-22]. In view of this, present study has been undertaken to assess and compare the auditory and visual reaction time in diabetics and normal healthy controls and also to correlate the reaction time in diabetics with respect to the duration of diabetes.

The first finding of our study was that the visual reaction time (VRT) was found to be longer than the auditory reaction time (ART) in the healthy participants as well as the diabetic patients. This may be due to the fact that the visual reaction time (VRT) involves chemical changes in its occurrence and the visual pathway has many collateral pathways to various association areas and hence a greater delay in comprehension of visual stimulus [23]. Reaction time is dependent on several factors like arrival of stimulus at the sensory organ, conversion of the stimulus by the sensory organ to a neural signal, neural transmissions and processing, muscular activation, soft tissue compliance, and the external measurement parameter. The auditory stimulus takes only 8-10 milliseconds to reach the brain, but on the other hand a visual stimulus takes 20-40 milliseconds [24]. This implies that the faster the stimulus reaches the motor cortex, faster will be the reaction time to the stimulus. Therefore since auditory stimulus reaches the cortex faster than the visual stimulus the auditory reaction time is faster than the visual reaction time.

This finding of our study was in accordance with similar studies done in the past. Mohan et al, studied visual and auditory reaction times in patients of diabetes mellitus and aged matched normal controls and found that auditory reaction time was shorter than visual reaction time in controls as well as diabetics. In diabetic patients, there was significant prolongation of both ART and VRT [25]. R Niruba and K N Maruthy found VRT to be longer than ART [26].

The second finding was that there is a significant prolongation of both ART and VRT in diabetics as compared to normal healthy controls. The possible mechanism being that, the raised blood glucose associated with diabetes causes chemical changes in nerves and damages blood vessels that carry oxygen and nutrients to the nerves. Excessive glucose metabolism causes decrease in the Nitric Oxide in nerves that dilates blood vessels, and low levels of Nitric Oxide may lead to constriction of blood vessels supplying the nerves in diabetic patients [27]. The perfusion deficit is sufficient to cause endoneural hypoxia. These early events occur well before the development of clear pathological alterations to nerve

capillaries such as basement membrane thickening, and are accompanied by functional deficits such as reduced Nerve Conduction Velocity, hence increased reaction time [28]. Our study is in accordance with the study of Dobrzanski et al, Prabhjot Kaur and others. Dobrazanski et al, found a doubling of visual reaction time in diabetics (473ms) versus that measured in healthy individuals (216ms) [29]. Prabhojot Kaur, Maman Paul, Jaspal Singh Sandhu found that both the VRT and ART was more in type 1 diabetics [30].

The third finding was that the ART and VRT in group-1 diabetics (duration of diabetes 1-5 years) is faster than in group-2 diabetics (duration of diabetes 5-10 years). As a consequence of longstanding hyperglycaemia, a downstream metabolic cascade leads to peripheral nerve injury through an increased flux of the polyol pathway, enhanced advanced glycation end-products formation, excessive release of cytokines, activation of protein kinase C and exaggerated oxidative stress. Sparse vascular supply with impaired autoregulation is likely to cause hypoxic damage in the nerve. Such dual influences exerted by long-term hyperglycaemia are critical for peripheral nerve damage, resulting in distal-predominant nerve fibre degeneration. The axonal degeneration of both the myelinated and unmyelinated fibres, axonal shrinkage, thickening of the basement membrane and microthrombi are responsible for delayed motor nerve conduction and hence, the increased reaction time [31].

This finding was also in accordance to other similar studies. In a study by Partanen J et al, patients with type II DM and controls were followed up for a period of 10 years. At the start 8.3% of patients had neuropathy as compared to 2.3% in controls. After 10 years the prevalence of neuropathy was 41.9% in diabetics and 5.8% in controls and those with neuropathy had poor glycaemic control than those without, thus concluding that the incidence of neuropathy in DM increases with time [32]. Pitrat J , in an extensive study of nearly 4400 clinical patients, reported a prevalence rate of diabetic neuropathy ranging from7% of individuals within one year of diagnosis to 50% for those with diabetes for more than 25 years. The risk for complications of neuropathy increases with increasing duration and severity of hyperglycaemia [33].

CONCLUSION

The results of our study indicate that there is a significant difference in the auditory and visual reaction time of diabetics and normal healthy controls. We observed a prolonged auditory and visual reaction time in diabetics, which increased with the duration of the disease. This increase in reaction time can be an early manifestation of diabetic peripheral

neuropathy. Delayed reaction time in diabetics without clinical neuropathy can be taken as a non-invasive, low cost, sensitive indicator of early nerve damage without clinical signs or symptoms.

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