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CORRELATION OF DISEASE DURATION AND GLYCATED HEMOGLOBIN LEVELS WITH MOTOR DEXTERITY IN PATIENTS WITH TYPE 2 DIABETES OF BENGALURU POPULATION: A CROSS SECTIONAL STUDY

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Abstract

Background: Diabetes is associated with a loss of somatosensory and motor function, leading to impairments in gait, balance, and manual dexterity. The effect of diabetic neuropathy in relation to sensory system has been extensively researched. But literature regarding the effect of diabetic neuropathy on motor system is less. Hence the present study is undertaken to assess motor function and to correlate it with the duration of the disease and glycated haemoglobin levels in patients with type 2 diabetes of Bengaluru population.

Methods: 28 uncomplicated type 2 diabetic patients in the age group of 40 to 55 years of Bengaluru city were studied. Fasting glycated haemoglobin was estimated and O'Connor Tweezer Dexterity Test was conducted on the subjects. Relationship between duration of disease and motor skills, and between HbA1c levels and motor skills and the strength was measured by using Spearman's correlation.

Results: There was positive correlation ($\rho = 0.482$) between disease duration and motor skills, which was statistically significant ($p < 0.05$). There was also positive correlation ($\rho = 0.455$) between HbA1c levels and motor skills, which was statistically significant ($p < 0.05$). **Conclusions:** systematic review with meta-analysis suggested reduced hand function, specifically grip and pinch strength, for people with type 2 diabetes mellitus versus healthy controls. Our study results have shown a statistically significant positive correlation between disease duration and motor skills as well as between HbA1c levels and motor skills.

Keywords: glycated haemoglobin**,** O'Connor Tweezer Dexterity Test, type 2 diabetics.

Introduction

Diabetic neuropathy (DN) affects both somatic and autonomic nerves in a distal, symmetrical form that progresses following a fiber-length-dependent pattern. It is one of the major complications in humans with diabetes [1]. Humans with diabetes, especially those with DN, show several motor dysfunctions, such as an increased risk of falling, altered gait and balance, and increased body sway [2–4].

Lots of research has been conducted and much attention has been paid to the causes of motor dysfunction in relation to sensory neuropathy in diabetics. In contrast, motor system involvement has little attention paid in research studies. This may be due to the following factors

First, symptoms of diabetic neuropathy occur in the distal part of the extremities, where sensory deficits predominate and the primary clinical problems are almost exclusively centered on neuropathic pain and loss of sensation [5]. Conversely, population-based studies have reported clinically evident motor dysfunction, including the inability to stand on heels, which reflects muscle weakness of the

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ankle dorsal flexors in only 1–6% of humans with diabetes [6]. Therefore, motor symptoms are believed to be a rare manifestation associated with severe DN.

Second, experimental studies have also shown data supporting the hypothesis that the motor nervous system is more resistant to DN than the sensory nervous system [7,8]. These differences may be due to the anatomical difference between motor and sensory neurons. The cell body of dorsal root ganglion (DRG) neurons are located outside of the blood–brain barrier (BBB), whereas motor neurons (MNs) are located within the ventral horn of the spinal cord and inside the BBB, which keeps it away from systemic metabolic and oxidative stressors [9].

In other words, the systems that control voluntary movement within the CNS are thought to be largely unaffected by diabetes. Therefore, if the relationship between the CNS and motor deficits in humans with diabetes has ever been mentioned, it has only been discussed in the context of the association of diabetes with stroke. Diabetes increases the risk and severity of stroke and causes delayed functional recovery from stroke [10–12].

The effect of diabetic neuropathy in relation to sensory system has been extensively researched. But literature regarding the effect of diabetic neuropathy on motor system is less. Sensory and muscle impairment are considered to be the main culprits for Motor deficits in diabetics. However, recent clinical and experimental studies have revealed that the brain and spinal cord, which are involved in the motor control of voluntary movement, are also affected by diabetes. Hence the present study is undertaken to assess motor function and also to correlate it with the duration of the disease and glycated haemoglobin levels in patients with type 2 diabetes of Bengaluru population.

Objectives

1. To evaluate motor skills in patients with type 2 diabetes of Bengaluru population.
2. To correlate motor skills with the duration of the disease in patients with type 2 diabetes of Bengaluru population.
3. To correlate motor skills with glycated hemoglobin levels in patients with type 2 diabetes of Bengaluru population.

Materials and Methods:

Source of data:

The study was conducted on 28 uncomplicated patients with type 2 diabetes of Bengaluru population in the age group of 40 to 55 years.

Method of collection of data (including sampling procedure):

Subjects were matched for age & sex and selected based on inclusion and exclusion criteria after taking a written informed consent.

a) Study period: August 2022- March 2023

b) Study group: 28 uncomplicated patients with type 2 diabetes of Bengaluru population

c) Sample size: 28

Inclusion Criteria:

- Subjects in the age group of 40-55 years.
- Subjects who are willing to give written informed consent
- Type 2 diabetes mellitus diagnosed as per American Diabetes Association 2018
- Uncomplicated type 2 diabetic patients (as per the medical records)
- Patients on oral hypoglycaemic agents

Exclusion Criteria:

- Patient not willing to give consent
- History of smoking and alcohol consumption
- Diabetic patients on insulin
- Hypertensive
- Obesity (BMI >25kg/m^2)
  - pregnancy
  - History of cardio-respiratory illness
- Neuromuscular disorders

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- Skeletal deformities
- Cases of endocrinal disorders
- Cases of psychiatric disorders

Methodology:

The subjects were recruited from medicine outpatient department, Bharat earth movers limited (BEML), Bengaluru as per the inclusion / exclusion criteria. Written informed consent was taken; each participant was explained about the whole procedure and objective of the study. Detailed history was taken including personal history, history of medical illnesses, treatment and medication history. Thorough clinical examination also done to rule out any abnormalities.

Study group includes 28 type 2 diabetes mellitus patients willing to participate in the study. During the study period, participants were advised to continue the same hypoglycaemic drug without alteration of the dosage. Diet and physical activity daily diaries were reviewed.

Blood samples (five millilitres) were collected using standard venipuncture technique between 9:00 and 11:00 AM. Serum samples were separated immediately after centrifugation at +4°C, 4000 rpm for 10 minutes and stored at −20°C until analysis.

Percent concentration of HbA1c in whole blood was measured with Roche diagnostics HbA1c kits with auto analyzer (Cobas Integra 800 Auto analyzer, Roche Diagnostics, Germany). This assay is based on the immune turbidometric determination of the stable glucose adduct to N-terminal group of the haemoglobin beta chain.

Tweezer dexterity test was conducted on the subjects. On arrival at the OPD, subjects were asked to empty their bladders if necessary and to sit in a comfortable armchair. All the subjects were asked to relax for a period of 30 minutes.

Tweezer Dexterity test

Fine motor skill (or dexterity) is the coordination of small muscles, in movements—usually involving the synchronization of hands and fingers—with the eyes. The complex levels of manual dexterity that humans exhibit can be attributed to and demonstrated in tasks controlled by the nervous system.

Description

The O'Connor Tweezer Dexterity Test consists of 5 7/8" W x 11 5/8" L board. Located in the Upper half of the board is a pin well measuring 4 ¾" in diameter arranged in 10 rows of 10 holes each spaced ½" apart. Into these holes, the subject can insert one pin 1" long and 1/16" in diameter.This test measures the speed with which the subject using tweezers is able to pick up pins one at a time and place them in small holes on a metal plate.

Test Administration

1. The subject should be seated comfortably at a table about 30 inches in height. The Tweezer Dexterity Test is placed before him about one foot from the edge of the table with the tray at the right, if the right hand is to be used, and at the left if the left hand is preferred. It should be at an angle of about 90 degrees with the subjects working hand, but may be changed if so desired.
2. The examiner should read the following instructions:

"The board in front of you consists of 100 holes each large enough to hold one pin. Pick up one pin at a time with the tweezers and fill the holes, placing one pin in each as fast as you can. 'Pick up the pins by the end opposite or farthest away from you. Use only the hand in which you hold the tweezers.'"

3. Show by gesturing, that the holes are to be filled from left to right, for a right-handed subject, and each row completed before the next is started. Explain that the elbow may rest on the table, but do not give this or any of the other suggestions in a mandatory form; say, for example, "Some people like to…" Have the subject place ten (10) pins, thus filling the top line of ten holes, for practice.
4. Allow neither more nor less than the prescribed practice of filling the top ten holes, since this affects performance on the test. Tip the pins out, allow a moment's rest, and then time accurately with a stop-watch the number of seconds required to fill the board from placing the first pin to placing the last.
5. Instruct the subject to begin.

Scoring

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The score equals the number of seconds elapsing between the placement of the first and last pins

Early Norms

Men Women

Upper Quartile 300 324

Median 340 372

Lower Quartile 372 438

RESULTS

Statistical analysis: Data was analyzed by descriptive statistics such as mean, median, standard deviation, interquartile range (IQR), percentages, tables, and graphs wherever necessary. Scatter plot was used to look for relationship between duration of disease and motor skills, and between HbA1c levels and motor skills and the strength was measured by using Spearman's correlation.

The present study was conducted on 28 subjects in the age group of 40-50 years with the mean age (in years) of 47.5 ± 3.46. The study consisted of 15 (54%) males and 13 (46%) females. Table 1 shows the observed findings of the present study. Figure 1 and 2 are scatter plots. Figure 1 shows linear relationship between disease duration and motor skills. Figure 2 shows linear relationship between HbA1c levels and motor skills. Table 2 shows Spearman's correlation done to see relationship between disease duration and motor skills and between HbA1c levels and motor skills. There was positive correlation ($\rho = 0.482$) between disease duration and motor skills, which was statistically significant ($p < 0.05$). There was also positive correlation ($\rho = 0.455$) between HbA1c levels and motor skills, which was statistically significant ($p < 0.05$).

Table 1: Different parameters that were observed in the present study

Parameters	Mean ± SD
Age	47.5 ± 3.46
Disease duration	7.7 ± 6.3
HbA1c	7.75 ± 1.21
Motor skills	494.7 ± 129.03

Figure 1: Scatter plot showing relationship between duration of disease and motor skills

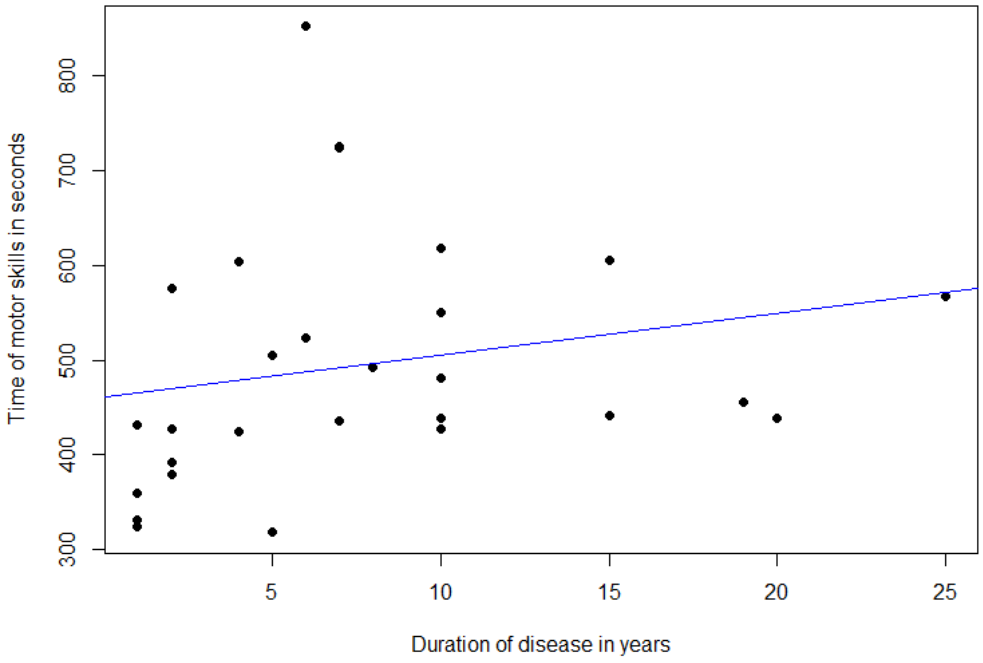

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Figure 2: Scatterplot showing relationship between HbA1c levels and motor skills

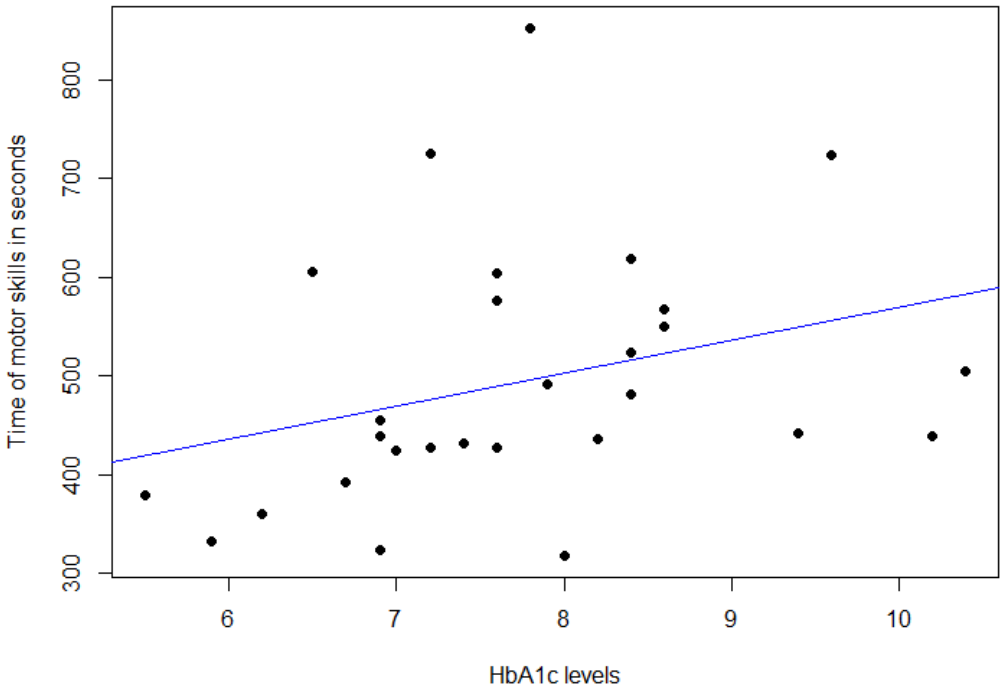

Table 2: Spearman's correlation of disease duration in years and HbA1c levels with motor skills in seconds

	Spearman's correlation co-efficient (ρ)	p-value
Disease duration	0.482	0.009*
HbA1c	0.455	0.014*

Statistical Significance at p-value < 0.05

Discussion

Our study conducted on 28 type 2 diabetics showed statisticallysignificant positive correlation between disease duration and motor skills as well as between HbA1c levels and motor skills.

Peripheral neuropathy with a diabetes origin affects both upper and lowerextremities. Throughout the literature, peripheral neuropathy of foot complications with T2DM are given much attention and less is known about peripheral neuropathy of the hand [13].In T2DM, abnormal cross-linking of collagen fibers occurs due to accumulation of advanced glycosylation end-products, which leads to skin thickening and formation of nodules and contractures [14].

Dexterity assessed by the Purdue Pegboard test evaluates the gross movement of the fingers, hands, and fine fingertip dexterity necessary in assembling the task. Meta-analysis of 2 studies of dexterity assessed by the Purdue Pegboard test conducted on type 2 diabetics showed no significant difference in the combined mean for the dominant hand [15, 16]. But our study results suggested a statistically significant positive correlation between disease duration and motor skills as well as between HbA1c levels and motor skills.

With the increase in prevalence of T2DM worldwide and in India, the accompanying complications may disturb activities of daily living and quality of life. Unlike the diabetic foot, complications of hands with T2DM are easily neglected. Only a few studies have assessed hand strength, dexterity and dysfunction in people with T2DM. The reporting of hand dysfunction in these patients lacks agreement among studies. Thus, considering the increasing rate in number of people living with T2DM and the increased life expectancy, a study of hand function may help improve care, independence in activities of daily living and quality of life.

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