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RESEARCH ARTICLE

Study of handgrip strength and handgrip endurance in Type 2 diabetics

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ABSTRACT

Background: Unlike the many systems which are targets for diabetic complications such as the cardiovascular system, eyes, kidney, and nervous system even the musculoskeletal system is a silent target organ for diabetic complications although less valued than the others. **Aims and Objectives:** To study of handgrip strength (HGS) and handgrip endurance (HGE) in Type 2 diabetics. **Materials and Methods:** A total of 64 Type 2 right-handed male diabetic subjects in the age group of 41–55 years, having a duration of diabetes between 5 and 10 years were compared with 64 healthy controls. The subjects were divided into three groups as Group I: 41–45 years, II: 45–50 years, and III: 51–55 years. **Results:** The mean values for fasting blood sugar, post-meal blood sugar, and glycosylated hemoglobin (HbA1c) % were significantly higher in all the three groups of diabetics than the controls. HGS was significantly decreased in all groups of diabetics while HGE was also significantly decreased in Group I and III of diabetics as compared to controls. Group I (−0.19) and Group III (−0.27) showed very weak negative correlation between HbA1c % and HGS while Group II (0.04) showed almost none. Furthermore, very weak negative correlation between HbA1c % and HGE was found for Group II (−0.16) and III (−0.16) while it was very weakly positive for Group I (0.084). **Conclusion:** This study clearly suggests that all patients with diabetes should be screened for musculoskeletal manifestations regularly as early rehabilitative methods may reduce the disease burden in this population.

KEY WORDS: Type 2 Diabetes; Handgrip Strength; Handgrip Endurance

INTRODUCTION

The work done by skeletal muscle depends on bulk, nutrition, and oxygen supply to the muscle and health status of body. The total force generated and duration for which the work is done by a muscle depends on the setting of fatigue in the muscle. It is observed that in the muscle that has undergone fatigue electrical excitatory process is not much affected and action potential is produced and still spreads over the muscle fiber. Hence, it is assumed that the major problem might be occurring with metabolic hypoactivity which associates with fatigue. The metabolic program of muscle mainly goes with availability of glucose in circulation. Thus, the availability of glucose for the muscle cell organelle will decide the force generation, endurance, and fatigability of muscle. The normal non-contracting skeletal muscle is very less permeable to glucose, but same muscle becomes more permeable to glucose if it is in physiological state of contraction. Further, if the same muscle cell is supplemented with insulin the glucose uptake increases 15 times. This means insulin availability and exercise are the major and promoting factors for glucose uptake by muscle cell. Diabetes mellitus (DM) is a condition in which there occurs disturbance in insulin secretion or its action or both. It is also associated with many secondary complications and a great variety

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of musculoskeletal manifestations, many of which are subclinical and correlated with disease duration and its inadequate control.[1] These musculoskeletal complications are often found and although less valued than the vascular ones, they significantly compromise the patients' quality of life.[2] A study by Wander *et al*. reported that the important biomarker of survival in a diabetic population included hand grip strength, described as a measure of total body strength which is significantly associated with physical performance.[3,4] One of the ways of improving exercise prescription and fitness in patients with Type 2 diabetes (T2D) is to establish evidence on physical fitness measures such as functional exercise capacity, muscular strength, and cardiovascular endurance tests.

As kinetic abilities being dependent on glucose supply, glucose supply being dependent on insulin level, as also diabetes affects central nervous system and peripheral nerves, it was hypothesized that the maximal isometric tension and endurance time, thus the kinetic ability of muscle decreases and fatigability increases. To test this hypothesis, the present work was executed.

MATERIALS AND METHODS

The study was carried out in the Department of Physiology at NKP Salve Institute of Medical Sciences, Nagpur, after obtaining Institutional Ethical Clearance from the Institute. After explaining the purpose of the study, written informed consent from all the subjects was taken. The study group consisted of 64 cases and 64 controls. A detailed history and thorough clinical examination of the study group was carried out. Cases included diagnosed Type II right-handed diabetic subjects (only males) in the age group of 41–55 years, having a duration of diabetes between 5 and 10 years. The exclusion criteria included females, left-handed males, those involved in regular handgrip exercise and those suffering from asthma, chronic obstructive pulmonary disease, congestive cardiac failure, myasthenia gravis, and hypothyroidism. Furthermore, factors that interfere with glycosylated hemoglobin (HbA1c) test results were also excluded, for example, uremia, hyperbilirubinemia, chronic alcoholism, etc. The control group included 60 normal male subjects within the same age group, having nearly same height and built and belonging to the same socioeconomic status and ethnicity as that of the cases. The control group subjects were selected from staff members in campus. The anthropometric parameters such as height and weight of all the subjects were recorded. They were also investigated for fasting blood sugar and post-meal blood sugar (PMBS) by glucose oxidase biosensor method and HbA1c % by cation-exchange resin method. To measure the muscle strength, the measurements for handgrip strength (HGS) and handgrip endurance (HGE) were taken between 10 am and 12 pm for all subjects to avoid diurnal variation by handgrip dynamometer. A proper demonstration was given to the subject and it was ensured whether the subjects understood the procedure correctly. HGS was recorded in standing position with arms by the side of the subject and the instrument held comfortably in his right hand. He was then asked to squeeze the dynamometer with as much force as possible, being careful to squeeze only once for each measurement. Three trials were made with a pause of about 10–20 s between each trial to avoid the effect of fatigue. The result of each trial was recorded to the nearest kilogram. If the difference in score was within 3 kg, the test was complete while if the difference between any two measures was more than 3 kg, then repeat test was done after rest period. Best of three measurements (that is highest of three) was used as data.[5] To record the HGE, the subject was asked to squeeze the dynamometer to 80% of HGS and to maintain it for as long as he could and time in seconds was recorded using stopwatch.[6] For statistical analysis, the study group was divided into three groups according to their age as Group I (41–45), Group II (46–50), and Group III (51–55). Mean and standard deviation was calculated and significance of difference was tested statistically significant by the unpaired Student's *t*-test at $P \leq 0.05$. Correlation coefficient (r) was calculated and tested for statistical significance.

RESULTS

No statistically significant difference was found between the three groups of controls and T2D for age, height, and weight suggesting that the two groups were comparable. The normal reference range for fasting and PMBS and HbA1c % was considered to be <120 mg %, <140 mg %, and <6%, respectively.[7] The mean values for fasting and PMBS and HbA1c % were significantly higher in all the three groups of diabetics than the controls as shown in Table 1. HGS was significantly decreased in all groups of T2D while HGE was also significantly decreased in Group I and Group III in T2D as compared to controls. Group I (−0.19) and Group III (−0.27) showed very weak negative correlation between HbA1c % and HGS while Group II (0.04) showed almost none. Furthermore, very weak negative correlation between HbA1c % and HGE was found for Group II (−0.16) and III (−0.16) while it was very weakly positive for Group I (0.084) as shown in Table 2.

DISCUSSION

The mean values for fasting, PMBS, and HbA1c % were significantly higher in all the three groups of diabetics than the controls suggesting that the diabetics had uncontrolled blood sugar. HGS was significantly decreased in all groups of T2D while HGE was also significantly decreased in Group I and Group III in T2D as compared to controls. Group I (−0.19) and Group III (−0.27) showed very weak negative correlation between HbA1c % and HGS while Group II (0.04) showed almost none. Furthermore, very weak negative correlation

Table 1: Mean±SD values and *P* value of different parameters for diabetics (D) and controls (C)

Parameters	Groups	I (41–45 years) mean±SD	*P* value	II (46–50 years) mean±SD	*P* value	III (51–55 years) mean±SD	*P* value
FBS (mg %)	D	149.9±0.69	0.02*	147.9±0.641	0.05*	170.1±0.552	0.004*
	C	90±0.295		89.95±0.51		89.9±0.552	
PMBS (mg %)	D	239.04±4.101	0.001*	244.9±0.447	0.009*	259.7±0.923	0.002*
	C	113.9±0.464		104±0.394		113.9±0.394	
HbA1c %	D	7.98±0.056	0.005*	9.19±0.055	0.005*	8.6±0.032	0.004*
	C	4±0.051		3.99±0.022		3.99±0.039	
HGS (kg)	D	59.91±0.653	0.001*	56.95±0.394	0.001*	52.05±0.51	0.002*
	C	46.79±0.508		44.1±0.307		41.9±0.447	
HGE (s)	D	9.23±0.005	0.005*	10.83±0.007	0.08	10.29±0.006	0.007*
	C	11.89±0.04		9.23±0.003		9.33±0.005	

*$P<0.05$-significant. SD: Standard deviation, FBS: Fasting blood sugar, PMBS: Post-meal blood sugar, HbA1c: Glycosylated hemoglobin, HGS: Handgrip strength, HE: Handgrip endurance

Table 2: Values for statistical correlation coefficient for HbA1c % and HGS and HGE

Parameters	Group I	Group II	Group III
HbA1c and HGS	−0.19	0.04	−0.27
HbA1c and HGE	0.084	−0.16	−0.16

HbA1c: Glycosylated hemoglobin, HGS: Handgrip strength, HGE: Handgrip endurance

between HbA1c % and HGE was found for Group II (−0.16) and III (−0.16) while it was very weakly positive for Group I (0.084). Our findings suggest that the HGS and Handgrip Endurance are definitely reduced in diabetics than controls although magnitude of reduction in muscle strength is not in linear correlation with the glycemic status of the individual.

Previous studies have also shown similar findings.[8-11] Crispin and Alcocer proposed that prolonged hyperglycemia results in glycosylation of collagen which is less soluble offers increased resistance to collagenases and accumulates in connective tissue.[12] This alters the extracellular matrix structure and function and also affects cell viability[13] Park *et al*. suggested that poor glycemic control for a longer duration is associated with poorer muscle quality[14] T2D is usually diagnosed later in life, so the concurrent effect of advanced age in patients with T2D mellitus must be considered. As age advances, there is reduced protein synthesis in the organelles, particularly in the rough endoplasmic reticulum. In addition to being insulin insensitive, the T2D also have excess visceral adipose tissue which upregulates the inflammatory response[15,16] that leads to increased catabolism and may consequently contribute to further decline in muscle mass and quality. Many studies have also found lower exercise capacity in patients with T2D[17,18] and suggested that this decrease is due to the less number of glucose transporter Type 4 (GLUT4) at the plasma membrane of skeletal muscle fiber. The expression of this GLUT4 transporter protein is related to fiber volume in human skeletal muscle fibers which is reduced in T2D.[19] In our study, also the HbA1c % was higher suggesting a state of prolonged hyperglycemia which might have led to decrease in HGS. As change in muscle fiber distribution relates closely to insulin concentration, it is suggested that hyperinsulinemia induces increase in number of Type II b fibers which are least fatigue resistance.[20]

The limitation of our study is that the connective tissue disorders, neuropathy, or vasculopathy associated with diabetes may have a synergistic effect on the increased incidence of musculoskeletal disorders in DM, which our study has not considered. Future work considering all these factors needs to be undertaken to delineate the contribution of these factors toward musculoskeletal complications in diabetes.

CONCLUSION

Skeletal muscle weakness is definitely produced in diabetics although magnitude of affection will depend on individual susceptibility and susceptibility of muscles as well as the drug intake culture which individual is practicing. Furthermore, connective tissue disorders, neuropathy, or vasculopathy associated with diabetes may have a synergistic effect on the increased incidence of musculoskeletal disorders in DM. Many studies have reported that patients with T2D had greater impairments in mobility and more difficulties performing basic activities of daily living than similarly aged non-diabetic persons which leads to loss of independence, and it may predict future hospitalization, institutionalization, and death.[21] Our study clearly suggests that all patients with diabetes should be screened for musculoskeletal manifestations regularly as early rehabilitative methods may reduce the disease burden in this population.

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