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Original article:

Study of handgrip strength & handgrip endurance in Type 1 & Type 2 Diabetics

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Abstract:

Background: The metabolic programme of muscle mainly goes with availability of glucose in circulation which also decides the force generation, endurance and fatigability of a muscle. As kinetic abilities being dependent on glucose supply, glucose supply being dependent on insulin level the present project was carried out in diabetics to measure handgrip strength and endurance in type1 and type2 diabetics.

Methodology: The study included 120 normal subjects, 64 subjects with Type 1 diabetes and 64 subjects with Type 2 diabetes. The study and control group were age matched. the study and control groups were compared for fasting blood sugar (FBS), postmeal blood sugar (PMBS), HbA_1c%, Handgrip strength (HGS) and endurance (HGE). For statistical analysis the study group was divided into 3 groups according to age as: 1) Type I Diabetics (n=64) - Group I (31-35), Group II (36-40), Group III (41-45)2) Type II Diabetics (n=64) - Group I (41-45), Group II (46-50), Group III (51-55).

Results: It was observed that for all groups of Type 1 and Type 2, FBS, PMBS and HbA_1c% were significantly higher in the study group than the control group. HGS was also significantly decreased in all groups of Type 1 and Type 2 Diabetics as compared to control. HE was significantly increased in Group I and Group II in Type 1 diabetics but significantly decreased in Group I and Group III in Type 2 diabetics as compared to controls. There was no linear correlation between HbA_1c % and handgrip strength. Statistical correlation coefficient was -0.19, 0.04, and 0.23 for Group I, II, III of Type 1 diabetics respectively and -0.19, 0.04, -0.27 for Group I, II, and III of Type 2 diabetics respectively.

Conclusion: This study clearly suggests that all patients with diabetes should be screened for musculoskeletal manisfestations regularly as a part of regular health check ups as early rehabilitative methods may reduce the disease burden in this population.

Key words: Type 1 diabetes, Type 2 Diabetes, handgrip strength, handgrip endurance.

Introduction

Muscle strength appears to be an important parameter in maintaining physical function and mobility of the individuals. [1] In the hospital setting Handgrip strength (HGS) is often used as a bedside tool to measure the muscle function.[2] It is a valid measurement of mobility and Quality of life. It has been shown to be a valid surrogate measurement of overall muscular strength.

Diabetes is well known for its macro and microvascular complications which have been studied extensively but musculoskeletal complications in Diabetics are mostly less discussed and if at all addressed, it is rarely associated with diabetes as its complication. The possibility that the skeletal muscle is also a target organ for Diabetic complication was first suggested by Sayer A.A et al who found reduced muscle strength and impaired physical function in Type 2 Diabetes.[3] Muscle is the most important insulin-dependent glucose sink in the body; therefore, impaired hormonal signaling as seen in Type 2 DM

(T2DM) has a deleterious effect on glucose uptake. Hyperglycemia associated with diabetes can alter the fiber-type, affect the contractility of the muscles, decrease oxidative activity and can lead to peripheral insulin resistance.[4] Thus to study the magnitude of effect of diabetes on muscle strength, the present study was undertaken in both type 1 and type 2.

Methodology

The present study was carried out in the Department of physiology at NKP Salve Institute of Medical Sciences, Nagpur after obtaining Institutional ethical clearance. After explaining the purpose of the study, written informed consent from all the subjects was taken. Detailed history & thorough clinical examination of all the subjects was done. The subjects were divided into two groups: A) Study Group B) Control Group

Study Group:

Based on the treatment history, study group was divided into two groups:

Type I group: Included diabetic male subjects on insulin therapy – insulin dependent diabetes mellitus within the age group of 31-45 years, having duration of diabetes between 5-10 years.

Type II group: Included diabetic male subjects on oral anti diabetic drugs- non-insulin dependent diabetes mellitus within the age group of 41-55 years, having duration of diabetes between 5-10 years.

B) Control Group

The selection of control group was based on detail history, physical examination and investigations same as that of study group. For comparison, separate group of subjects for Type I and Type II diabetic who belonged to the same age groups (31-45 and 41-55) years having nearly same height and built were selected. They were belonging to the same socio-economic status, ethnic group as that of the study group, but with normal blood sugar levels (no history of diabetes or disorder of defective sugar metabolism). They were selected from staff members in campus. Subjects who were Left handed, Involved in regular handgrip exercise, those suffering from (asthma, COPD, CCF, Myasthenia gravis and hypothyroidism) were excluded from study. Factors that interfere with HbA_1c test results were excluded. eg. Uremia, hyperbilirubinemia, chronic alcoholism etc.

After selection, the subjects from both controls as well as study group were given appointments and were asked to report in the Department of Physiology in the morning hours (time: 10-12 a.m) for measurement of anthropometric parameters and blood investigations. Standing height of the adult was measured by simply making the subject stand against a wall on which measuring scale was inscribed. The subject would stand with bare feet on a flat floor against the wall with both feet parallel and with heels, buttocks and occiput touching the wall. The head was held erect with eyes aligned horizontally and ears vertically without any tilt. Then with the help of the plastic ruler, the top-most point of the vertex was identified on the wall. Weight was measured with KRUPS weighing machine in light weight garments without foot wears. They were also investigated for Fasting (FBS) and Post Meal (PMBS) blood sugar by Glucose Oxidase Biosensor method and Glycosylated Hemoglobin (HbA1c%) by Cation - Exchange Resin Method. To measure the muscle strength the measurements for Handgrip Strength (HGS) and Handgrip Endurance (HGE) were taken between 10am to 12pm 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 10-20seconds 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 kgs, the test was complete while if the difference between any two measures was more than 3 kgs, 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 handgrip strength and to maintain it for as long as he could and time in seconds was recorded using stop watch [(6).] For statistical analysis the study group was divided into 3 groups according to age as:

1) Type I Diabetics (n=64) - Group I (31-35), Group II (36-40), Group III (41-45).
2) Type II Diabetics (n=64) - Group I (41-45), Group II (46-50), Group III (51-55).

Mean and Standard Deviation was calculated and significance of difference was tested statistically by the unpaired student's "t test" at p</= 0.05. Correlation coefficient (r) was calculated and tested for statistical significance.

Observations & results:

The present study was undertaken in 120 normal subjects, 64 subjects with Type 1 diabetes and 64 subjects with Type 2 diabetes. The study and control group were age matched. It was observed that for all groups of Type I and Type II, fasting blood sugar (FBS), postmeal blood sugar (PMBS) and HbA_1c% were significantly higher in the study group than the control group as shown in the table no.1& 2. Handgrip Strength is significantly decreased in all groups of Type 1 and Type 2 Diabetics as compared to control. Handgrip Endurance is significantly increased in Group I and Group II in Type 1 diabetics as compared to controls but significantly decreased in Group I and Group III in Type 2 diabetics as compared to controls.

There is no linear correlation between HbA_1c % and handgrip strength as shown in table no.3. Statistical correlation coefficient is -0.19, 0.04, and 0.23 in Group I, II, III of Type 1 diabetics respectively. Statistical correlation coefficient is -0.19, 0.04, -0.27 for Group I, II, and III of Type 2 diabetics respectively as shown in table no. 4.

Table 1: Mean ± Standard deviation (Mean ± SD) values & P value of different parameters for Type I Diabetics (D) & controls (C).

Parameters	Groups	I(31-35yrs) Mean ± SD	P value	II(36-40yrs) Mean ± SD	P value	III (41-45yrs) Mean ± SD	P value
FBS (mg%)	D	170±0.57	0.002*	200±0.55	0.005*	150±0.58	0.004*
	C	85±0.42		90±0.6		90±0.62	
PMBS (mg%)	D	294±0.51	*0.003	320±0.54	*0.001	245±0.42	*0.007
	C	120±0.62		130±0.09		134±0.53	
HbA1c%	D	9.5±0.04	*0.005	9.4±0.06	*0.004	9.4±0.24	*0.006
	C	4±0.03		4.6±0.04		4.5±0.09	
HGS (kgs)	D	40±0.54	*0.02	39±0.41	*0.001	37±0.01	*0.001
	C	46±0.24		56±0.32		53±0.02	
HE (sec)	D	11.3±0.52	*0.004	11.3±0.07	*0.002	10.42±0.05	0.11
	C	10±0.47		9.9±0.14		10.41±0.07	

*P<0.05- significant

Table 2: Mean ± Standard deviation (Mean ± SD) values & P value of different parameters for Type II Diabetics (D) & controls (C).

Parameters		I(41-45yrs) Mean ± SD	P value	II (46-50yrs) Mean ± SD	P value	III (51-55yrs) 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± 0.55	
PMBS (mg%)	D	239.04±4.1	0.001*	244.9±0.45	0.009*	259.7± 0.92	0.002*
	C	113.9± 0.46		104± 0.394		113.9± 0.39	
HbA1c%	D	7.98± 0.056	0.005*	9.19± 0.06	0.005*	8.6± 0.032	0.004*
	C	4± 0.051		3.99± 0.02		3.99± 0.039	
HGS (kgs)	D	59.91± 0.65	0.001*	56.95±0.39	0.001*	52.05± 0.51	0.002*
	C	46.79± 0.51		44.1± 0.31		41.9± 0.44	
HE (sec)	D	9.23± 0.005	0.005*	10.83±0.01	0.08	10.29± 0.01	0.007*
	C	11.89+0.04		9.23+0.003		9.33+0.005	

*P<0.05- significant

Table 3: Values for Statistical correlation Coefficient for Glycated Hemoglobin (HbA1c%) and Handgrip strength(HGS) & endurance (HGE) in Type 1 diabetics.

	Group I	Group II	GroupIII
HbA1c*HGS	-0.19	0.04	0.23
HbA1c*HGE	0.53	0.45	-0.27

Table 4: Values for Statistical correlation Coefficient for Glycated Hemoglobin (HbA1c%) and Handgrip strength(HGS) & endurance (HGE) in Type 2 diabetics.

	Group I	Group II	GroupIII
HbA1c*HGS	-0.19	0.04	-0.27
HbA1c*HE	0.084	-0.16	-0.16

Discussion:

The present study was undertaken in 120 normal subjects, 64 subjects with Type 1 diabetes and 64 subjects with Type 2 diabetes. On the day of examination, the values for fasting, post meal blood sugar and glycosylated hemoglobin were significantly higher in all the groups of the study group than the controls. Thus it is clear that blood sugar was not monitored for last 90 days. Handgrip Strength is significantly decreased in all groups of Type 1 and Type 2 Diabetics as compared to control suggesting that the muscle strength is definitely decreased in diabetics. Many studies have also shown similar results.[5,6,7,8,9] Metabolic consequence of uncontrolled hyperglycemia is catabolism, which depending on the severity is accompanied by muscle protein breakdown and inadequate energy use, potentially resulting in poor muscle function. Diabetes is also associated with increased systemic inflammatory cytokines, such as tumor necrosis factor alpha (TNF-alpha) and interleukin -6, which have decremental effect on muscle function.[10,11,12] At molecular level, glycation of skeletal muscle myosin was associated with significant reduction in the in vitro motility speed, suggesting a structure related decline in myosin mechanics in response to glucose exposure. A significant reduction in actin filament speed has been observed for both slow and fast myosin after incubation with glucose, demonstrating decline in the mechanical performance of the motor protein.[13] Changes in molecular organization of structural and regulatory proteins of sarcomere unit will lead to decrease in Exication-contraction coupling i.e. Excitation--Activation----Attachment---power stroke---Detachment---Displacement.

Handgrip endurance is significantly decreased in Group I and III of Type II diabetics while it is significantly increased in Group I and II of Type I diabetics as compared to controls. This increase might be due to change in muscle fiber composition. In experimentally diabetic rat, it has been demonstrated that, with hypoinsulinemia muscle fiber composition is shifted towards type I predominance.[14,15]

Also, there is positive relationship between muscular endurance and the proportion of type I (fatigue resistance) fibers has been observed.[16] Increase in proportion of fatigue resistance type I muscle fiber, because of hypoinsulinemia seen in

Type I diabetics might be responsible for increased Handgrip Endurance as compared to controls. After few seconds of contraction, lactic acid and H+ accumulate intracelluraly and pH decreases. These changes impair contractile properties of muscle fibers. In diabetic patients, increase in muscular endurance may be caused by higher resistance against ischemia, which is a well known finding in diabetic nerves.[17]

There is no linear correlation between HbA_1c % and handgrip strength. Statistical correlation coefficient is -0.19, 0.04, and 0.23 for Group I, II, III of Type I diabetics respectively while that for Group I, II, and III of Type II diabetics is -0.19, 0.04, -0.27 respectively. Handgrip strength is decreased in diabetics than in controls. This observation gives the meaning that in uncontrolled diabetes, skeletal muscle weakness is produced but magnitude of affection will depend upon individual susceptibility and susceptibility of muscles as well as the drug intake culture which individual is practicing.

Correlation between HbA1c % and Handgrip Endurance is also studied. Statistical correlation coefficient is 0.53, 0.45, -0.27 in Group I, II and III of Type 1 diabetics respectively while that for Group I, II and III of Type 2 diabetics is 0.084, -0.16, -0.16 respectively. Above findings might be due to variation in individual susceptibility as it is generally seen in clinical practice of diabetology. In some patients there is affliction of retina, in some kidneys and in some there is affliction of coronaries etc. The magnitude of suffering goes on varying from patient to patient. Another reason can be drug intake culture of patient. Majority of the patients were unmonitored suggesting that there might be irregularities in drug intake culture. Considering these irregularities, the linear correlation might not have been observed.

Conclusion:

From review and discussion it reveals that diabetes mellitus if uncontrolled, produces weakness of skeletal muscle. We would suggest the diabetics regularly be screened for musculoskeletal disabilities as early detection may predict future hospitalization, institutionalization, and death.

Limitations: In our study we did not measure nerve function at baseline which might be contributing to decrease in handgrip strength, thus we are unable to examine the potential pathway.

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