ASIAN JOURNAL OF PHARMACEUTICAL AND CLINICAL RESEARCH

INNOVARE ACADEMIC SCIENCES
Knowledge to Innovation

Vol 9, Issue 2, 2016

Online - 2455-3891
Print - 0974-2441

Research Article

SKELETAL MUSCLE: ONE OF THE SILENT TARGETS OF DIABETIC COMPLICATIONS

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Received: 18 December 2015, Revised and Accepted: January 6, 2016

ABSTRACT

Objective: Muscle weakness in diabetes has been considered a rare manifestation associated with severe diabetic neuropathy. However, similar findings are lacking in individuals with early diabetes. Handgrip strength is a reliable measurement of the disability index. The present study was designed to determine the effect of early Type 2 diabetes on handgrip strength in adults by handgrip dynamometer.

Methods: 30 subjects with diabetes (1-5 years duration) were taken as case, and thirty age and sex-matched subjects without diabetes were taken as controls. Subjects with hypertension, heart diseases, and neuromuscular disorders were excluded. Skeletal muscle function was determined using hand grip dynamometer. Maximum voluntary contraction (MVC) was measured thrice and best of that it was taken. For endurance time (ET) 50% of MVC was taken. Anthropometric measurements were taken, and random blood sugar testing was done.

Results: Compared to controls, cases had decreased mid forearm circumference (23.97±1.7 cm vs. 23.8±2.7 cm, p<0.005). MVC and ET were also significantly reduced in cases when compared with control subjects (MVC, 32.46±6.865 kg vs. 22.48±4.420 kg, p<0.025) and ET (44.57±17.294 seconds vs. 16.63±9.810 seconds, p<0.022).

Conclusion: Our study suggests that there is a decline in skeletal muscle strength in type 2 diabetes even before the disease manifests severely. This provides evidence that impaired grip strength is associated with adverse metabolic profile, in addition, to the loss of physical function, and the potential for grip strength to be used in the clinical setting needs to be explored.

Keywords: Skeletal muscle function, Handgrip, Diabetes, Endurance time, Maximum voluntary contraction.

INTRODUCTION

The incidence of diabetes mellitus (DM) has reached epidemic proportions and is one of the greatest biomedical challenges of the 21st century [1]. Diabetic complications include retinopathy, neuropathy, nephropathy, and micro and macro vascular complications. The skeletal musculature is also significantly involved in diabetic complications, that is, contractile weakness, fiber-type changes, decreased oxidative activity, and peripheral insulin resistance [2]. 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. Muscle strength appears to be an important parameter in maintaining physical function and mobility of the individuals [3]. Though muscle weakness in diabetes has been considered a rare manifestation associated with severe diabetic neuropathy, a significant reduction in skeletal muscle strength can affect the daily activities of diabetic individuals. Individuals with long-standing T2DM have been found to have an increased risk of developing functional disabilities. Handgrip strength, a simple bedside tool, has been shown to be a valid surrogate measurement of overall muscular strength [4,5]. If handgrip assessments are done for a diabetic at the time of diagnosis and routine monitoring is incorporated during clinical visits, the development of disability can be detected at the earliest. As the data from previous studies in muscle strength on early diabetics is scarce, we intended to do this study. Thus, this study was designed to determine the effect of early Type 2 diabetes on handgrip strength in adults with early DM.

METHODS

Study population and design

After obtaining the institutional ethical clearance an observational, case-control study was conducted in a private IT company. The study was conducted in accordance with the ethical guidelines for biomedical research on human subjects by the Central Ethics Committee on Human Research. We included thirty subjects with T2DM on treatment (1-5 years duration) as cases and thirty age and sex-matched subjects without diabetes as controls. Both cases and controls were explained in detail regarding the study, and written consent was obtained from each subject prior to inducting them in the study. Subjects with hypertension, heart diseases, and neuromuscular disorders were excluded from the study. Skeletal muscle function was determined using hand grip dynamometer, INCO Company. It is calibrated from 0 to 60 kg. Maximum voluntary contraction (MVC) was measured in three trials with a brief pause, and best of that was taken. Subjects were encouraged to exert their maximal grip. 50% of MVC is taken for endurance time (ET). Anthropometric measurements such as height and weight were measured with indoor clothes and without shoes. Blood pressure (BP) was measured twice in right arm using mercury sphygmomanometer while the participant was in supine position. Random blood sugar was measured using glucometer and blood sample was drawn for HbA1C, and it is measured using auto-analyzer.

Statistical analysis

Data were compiled in MS excel Office 2010 and analysis was performed in SPSS version 22. Values were expressed as mean ± standard deviation. Comparisons between participants with diabetes and controls were made using unpaired Student's *t*-test. p<0.05 was considered to be significant.

RESULTS

In our study, as shown in Table 1, we have found that there were no significant difference noted among cases and controls in body mass index (BMI) and BP. Diabetic cases had increased blood sugar and increased HbA1C values compared to controls, and it was statistically significant. In Table 2, we have shown that subjects with T2DM had decreased mid forearm circumference (p=0.005). MVC and ET were

Table 1: Comparison of anthropometric measures between control and diabetics

Parameters	Control (n=30)	Diabetics (n=30)	p value
BMI (kg/m^2)	24.679±3.46	25.216±4.04	0.583
Random blood glucose (mg/dl)	105.57±13.16	165.97±32.67	0.000*
HbA1C (%)	4.98±0.49	6.54±0.63	0.000*
Systolic blood pressure (mmHg)	125.33±10.41	129.33±10.14	0.137
Diastolic blood pressure (mmHg)	84.67±9.37	84.60±8.25	0.977

*p<0.05 is considered to be significant, BMI: Body mass index

Table 2: Comparison of skeletal muscle parameters between control and diabetics

Parameters	Control (n=30)	Diabetics (n=30)	p value
Mid forearm circumference (cm)	23.97±1.7	23.8±2.7	0.005*
MVC (kg)	32.46±6.865	22.48±4.420	0.025
ET (sec)	44.57±17.294	16.63±9.810	0.022

*p<0.05 is considered to be significant, ET: Endurance time, MVC: Maximum voluntary contraction

also significantly reduced in diabetics when compared with control subjects (MVC p=0.025 and ET [p=0.022]).

DISCUSSION

Diabetes is characterized by high blood sugar levels which can cause serious complications such as organ failures and/or destruction of the kidneys, eyes, and various cardiovascular diseases [6]. It can also lead to skeletal muscle impairment which causes disability in diabetic individuals. In the present study, we found a significantly lower hand grip parameters in individuals with diabetes when compared with controls and the mid forearm circumference is significantly lesser in diabetics than controls. Handgrip strength is a non-invasive, low-cost measure; that may serve as a useful marker to help identify people at risk of T2DM in clinical or public health practice [7]. Skeletal muscle comprises a large percentage of body mass and is the most abundant insulin-sensitive tissue. It also plays an important role in the maintenance of systemic glucose metabolism [8]. Insulin resistance in skeletal muscle represents one of the main features of diabetes-related dysregulation and probably develops during a relatively early phase of the pre-diabetic state [9]. Skeletal muscle insulin resistance is considered to be the primary defect that is evident decades before ß-cell failure, and overt diabetes develops [10,11]. In humans, 75-80% of insulin-stimulated muscle glucose disposal during a euglycemic insulin clamp is converted to glycogen, whereas the remaining 20-25% is oxidized to CO_2 and H_2O. Impaired glycogen synthesis secondary to reduced glycogen synthase activity is the earliest detectable metabolic defect in Type 2 diabetes [12]. A study done by Helmersson *et al.* (2004) [13] shows that insulin resistance and hyperglycemia causes a reduction in the number of mitochondria in the muscle cells, a decrease in glycogen synthesis and an increase in the amount of circulating systemic inflammatory cytokines, all of which have a detrimental effect on the skeletal muscles. Other than these effects few more studies have postulated that hyperglycemia produces an increase in flux through the polyol pathway which causes increased production of sugar alcohols, results in slowing of muscle fiber contraction and relaxation [14]. Furthermore, prolonged hyperglycemia can result in non-enzymatic glycosylation of intracellular and extracellular proteins. Glycation of myosin causes structural and functional changes in the skeletal muscle which further deteriorate the performance. The probable cause for the reduction in the muscle strength in diabetics could be attributed to the above-mentioned pathways.

Skeletal muscle impairment is found to be a rare entity in severe diabetes but in our study, we have proved that skeletal muscle deterioration can be seen in early diabetes itself [15]. Skeletal muscle impairment affects the quality of life in diabetes, and it will be one of the leading causes for fall and fracture in diabetic individuals. In our present study, we have also found that the hand grip strength is independent of BMI, as there is no significant difference in BMI among cases and controls. So, the skeletal muscle change in diabetics is independent of their BMI. Determining muscle strength using hand grip dynamometer is a non-invasive, easy, and rapid technique. So, the diabetic individuals can be benefitted, and they can adopt primary prevention strategies such as lifestyle modification and dietary invention.

CONCLUSION

Our study suggests that there is the decline in skeletal muscle strength in Type 2 diabetes even before the disease manifests severely. Increasing muscle strength by physical activity and strengthening exercises in diabetics may thus have a favorable impact on old age morbidity and mortality.

LIMITATIONS

Our study has few limitations. Our study is cross-sectional, therefore, it is not possible to ascertain the direction of the association between muscle strength and hyperglycemia, but it is possible that influences in both directions can occur and are important. Longitudinal and interventional studies are required to investigate this further.

ACKNOWLEDGMENT

I sincerely thank all the subjects who participated in this study. I thank Dr. R. Sitalakshmi for helping me in this study.

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