ARE WE IGNORING DIABETIC DISABILITY: A CROSS SECTIONAL STUDY OF DIABETIC MYOPATHY

SWATI SHAH, PRANALI SONAWANE, PRADEEP NAHAR, KIRAN BUGE, SAVITA VAIDYA

ABSTRACT

BACKGROUND: The complications associated with type 2 Diabetes Mellitus (DM) may cause functional impairment in older people. Recently it has been proved that motor dysfunction in the form of skeletal muscle dysfunction does occur in type II DM. However very few studies have assessed the upper limb skeletal muscle dysfunction. OBJECTIVES: The study was aimed to assess the hand grip strength, endurance in type 2 DM patients and compare the same with age matched healthy controls. We also correlated glycosylated Hb and duration of illness with the hand grip strength and endurance in the patients. MATERIALS AND METHODS: Hand grip dynamometer was used to measure the hand grip strength and endurance in sixty diagnosed patients of type II DM. Similar tests were performed in age matched healthy controls. Blood samples were collected for blood glucose fasting, postprandial levels and HbA1c in both the groups. Comparisons between patients and controls, and correlations were done by applying suitable tests. RESULTS: The hand grip muscle strength and endurance in type II DM patients were significantly lower as compared to the normal controls ($P < 0.05$, $P < 0.001$). There was no correlation between the hand grip muscle strength and endurance with HbA1c and the duration of the disease in the patients of type II DM ($P > 0.05$). CONCLUSIONS: The present study shows that type II DM patients suffer from skeletal muscle dysfunction in the form of reduced hand grip strength and endurance. Hence the treating Physician should not be ignorant about these disabilities. In addition to the strict measures to control the blood glucose levels, interventions to improve the muscle mass and strength in these patients should be undertaken.

Key words: Diabetes myopathy, endurance, handgrip strength

BACKGROUND

The incidence of diabetes mellitus (DM) is rising at a very high pace. There is an alarming increase in the incidence and prevalence of DM particularly in Indians. The prevalence of diabetes for all age groups worldwide was 2.8% in 2000 and is estimated...
to reach 4.4% by 2030.\textsuperscript{[1]} DM is considered as a systemic disease involving multiple organs. A number of researches have shown the adverse effects of diabetes on different organs, i.e., eyes, kidneys, nerves, blood vessels, etc. Recently, it has been proved that motor dysfunction in the form of skeletal muscle dysfunction does occur in type II DM. There are many studies showing physical disability in type II DM.\textsuperscript{[2,3]} Although studies carried out by Cetinus and Lazarus have shown that handgrip strength is reduced in type II Diabetes, there is lack of uniformity in the results.\textsuperscript{[4,5]} Also the number of studies are comparatively very few. So, it becomes necessary to find out exact correlation between diabetes and upper limb skeletal muscle dysfunction. Handgrip strength is very important for daily routine activities. So in the current study, we tried to find out whether type II diabetes affects handgrip strength and endurance. Moreover, the severity of DM as measured by glycosylated hemoglobin (HbA1c) and the duration of the disease may affect the skeletal muscle strength. Hence, we began this study with the hypothesis that the upper limb handgrip muscle strength and endurance were reduced in type II DM and the decrease in strength and endurance might correlate with HbA1c levels and the duration of the disease.

In view of these observations, this study was aimed to compare the handgrip strength and endurance between the patients with type II DM and age, body mass index, and gender-matched controls as well as to correlate muscle strength, endurance with HbA1c, and the duration of diabetes in these patients.

**MATERIALS AND METHODS**

This study was carried out in the outpatient Department of DM at Sassoon General Hospitals, Pune. Sixty male subjects, who were diagnosed as patients of type II DM by the treating physician, taking oral hypoglycemic drugs were randomly selected for the study. Detailed history was taken and complete physical examination was done. They belonged to the age group of 40-60 years. Exclusion criteria were smokers, patients on insulin, patients with major cardiorespiratory and endocrine disorders, and patients with any musculoskeletal diseases. For control population, 60 normal healthy age and BMI-matched males of the same socio-economic status were selected from the relatives of the patients.

After selection written informed consent was obtained from patients as well as the controls. Fasting blood glucose as well as post-prandial blood glucose levels were measured by the glucose-oxidase method. Glycosylated Hb level of all the patients was estimated by cation-exchange resin method using diagnostic glycohemoglobin kits of AsrithaDiatech as per the guidelines provided.\textsuperscript{[6]}

A handgrip dynamometer (INCO India Ltd., Ambala) was used to measure the muscle strength and endurance of the upper limbs according to the technique described and validated by Madanmohan et al.\textsuperscript{[7]} After explaining the procedure to the study subject and giving a demonstration, they were asked to hold the handgrip dynamometer in the dominant hand in the sitting position. The forearm was extended over a table and elbow
flexed at 90°. Subjects were asked to hold the dynamometer in such a way that the second phalanx was against the inner stirrup. Subjects were then asked to grip the dynamometer handle with as much force as they possibly could apply. Whenever necessary, the researcher stabilized the dynamometer and encouraged the subjects to give their best performance. The handgrip muscle strength was recorded in kilograms as indicated by the pointer on the dynamometer. Three recordings were taken with a gap of 2 min between each effort and the maximum value was recorded for the analysis.

The handgrip endurance was measured by asking the subjects to maintain their grip on the handgrip dynamometer at 1/3 of their maximum handgrip strength for as long as they could. The duration for which they could maintain the grip strength was noted in seconds. Two recordings were obtained with a gap of 5 min between each effort and the maximum value was recorded for the analysis.

Statistical methods
All data were collected in a data collection form and then transferred to an excel sheet by two independent data entry operators. Discrepant values were corrected by checking the data collection form. Clean data were then statistically analyzed.

Muscle strength and endurance of controls and diabetic patients were compared by applying Student’s unpaired \( t \)-test. \( P \) value < 0.05 was considered statistically significant. Correlation between handgrip strength and endurance and glycosylated Hb was calculated by Pearson’s coefficient.

RESULTS
Table 1 shows that there is no statistical difference between the age, height, weight of the control as well as diabetes patients \( (P > 0.05) \). There was statistically significant difference in the blood glucose fasting levels (BSL-F), blood glucose post-prandial levels (BSL-PP), and HbA1c levels between the two groups. All these values were significantly higher in DM patients when compared with the controls \( (P < 0.05) \). The mean duration of the disease in the patients was \( 6.56 \pm 5.86 \) years.

Table 2 and Figure 1 shows that the mean handgrip strength in diabetes patients \( (29.13 \pm 6.64) \) was lower than the mean handgrip strength \( (31.16 \pm 4.28) \) in the normal controls. This difference was statistically significant \( (P < 0.05) \). The mean muscle endurance in diabetic patients \( (77.55 \pm 35.38) \)

Table 1: Physical characteristics of controls and diabetes mellitus patients

<table>
<thead>
<tr>
<th>Parameter</th>
<th>DM patients, ( n=60 ) Mean±SD</th>
<th>Controls, ( n=60 ) Mean±SD</th>
<th>( P ) value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>53.90±8.45</td>
<td>54.88±8.28s</td>
<td>( P&gt;0.05 )</td>
</tr>
<tr>
<td>Height (cms)</td>
<td>159.23±7.86</td>
<td>161.28±7.33</td>
<td>( P&gt;0.05 )</td>
</tr>
<tr>
<td>Weight (kgs)</td>
<td>61.57±7.38</td>
<td>64.42±8.70</td>
<td>( P&gt;0.05 )</td>
</tr>
<tr>
<td>BSL-F (mg/dl)</td>
<td>153.8±54.9</td>
<td>90.23±16.93</td>
<td>( P&gt;0.05 )</td>
</tr>
<tr>
<td>BSL PP (mg/dl)</td>
<td>196.34±49.13</td>
<td>127.89±7.95</td>
<td>( P&gt;0.05 )</td>
</tr>
<tr>
<td>HbA1c (%)</td>
<td>7.12±1.36</td>
<td>4.3±1.5</td>
<td>( P&gt;0.05 )</td>
</tr>
<tr>
<td>Duration of DM (years)</td>
<td>6.56±5.86</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

DM = Diabetes mellitus, BSL-F = Blood glucose fasting levels, BSL-PP = Blood glucose post-prandial levels

Table 2: Comparison of handgrip strength and endurance in controls and diabetes mellitus patients

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Controls, ( n=60 ) Mean±SD</th>
<th>DM patients, ( n=60 ) Mean±SD</th>
<th>( P ) value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Handgrip strength (kg)</td>
<td>31.16±4.28</td>
<td>29.13±6.64</td>
<td>( P&lt;0.05 )*</td>
</tr>
<tr>
<td>Endurance (s)</td>
<td>108.32±33.73</td>
<td>77.55±35.38</td>
<td>( P&lt;0.001 )*</td>
</tr>
</tbody>
</table>

\*\( P<0.05 \) = Statistically significant; \*\( P<0.001 \) = Statistically highly significant, DM = Diabetes mellitus
was also lower when compared with normal control population (108.32 ± 33.73). [Table 2 and Figure 2] This difference was statistically highly significant ($P < 0.001$).

On correlating various parameters, there was no statistically significant correlation found between handgrip strength and endurance with HbA1c and the duration of disease in diabetic patients [Table 3 and Figures 3, 4].

**DISCUSSION**

Our study demonstrated that the mean handgrip strength in patients of type II DM was lower than that in the normal controls; the difference was statistically significant ($P < 0.05$). The mean handgrip endurance in these patients was remarkably lower when compared with the normal control population ($P < 0.001$) [Table 2 and Figures 1, 2].

<table>
<thead>
<tr>
<th>Parameters</th>
<th>$r^2$</th>
<th>$P$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MS with HbA1c</td>
<td>0.0003</td>
<td>0.8859</td>
</tr>
<tr>
<td>ME with HbA1c</td>
<td>0.0132</td>
<td>0.3811</td>
</tr>
<tr>
<td>MS with duration</td>
<td>0.0183</td>
<td>0.3017</td>
</tr>
<tr>
<td>ME with duration</td>
<td>0.0166</td>
<td>0.3252</td>
</tr>
</tbody>
</table>

$P > 0.05 = \text{Statistically not significant, } MS = \text{Muscle strength, } ME = \text{Muscle endurance}$

**Figure 1:** Comparison of handgrip muscle strength in patients of type II diabetes mellitus and normal control population. $P < 0.05$: Statistically significant

**Figure 2:** Comparison of handgrip muscle endurance in patients of type II diabetes mellitus and normal control population. $P < 0.001$: Statistically highly significant

**Figure 3:** Correlation of handgrip muscle strength and endurance with HbA1c. $P > 0.05$: Statistically not significant
Cetinus and colleagues found that handgrip strength was reduced in type II DM.[4] Sayer and Park also found similar results.[8,9] Study by Casanova has shown that in diabetic patients hand function was significantly reduced.[10] As Andersen and Colleagues showed that the extensors and flexors’ strength at the knee was reduced, but at the wristand elbow, the muscle strength was preserved.[11] Their sample size was only thirty. This may be the reason behind their findings. None of these studies have recorded the handgrip endurance which we have recorded.

The probable reason for the skeletal muscle dysfunction could be DM which like other chronic disorders is also associated with increased systemic inflammatory cytokines such as Tumor Necrosis Factor (TNF) -α and interlukin-6. These cytokines can have deleterious effects on the skeletal muscle function. Glycosylation of skeletal muscle proteins, i.e., actin and myosin results in reduced strength in skeletal muscle. Uncontrolled hyperglycemia can result into catabolism which is accompanied by muscle protein breakdown and inadequate energy utilization.[9] These changes may result into sub-clinical function weakness in diabetes patients. Neuropathic processes which involve motor neurons could be another possible mechanism for the poor muscle function in diabetes.[11]

Studies have shown that there is significant and selective atrophy of type IIb fibers in diabetic rats.[12] In fact, some of the studies have shown altered contractile function and force generation in muscles due to hyperglycemia,[13] reduced muscle endurance could be due to reduced oxidative enzyme activity and lower maximal aerobic capacity.[9] Studies have shown that hyperinsulinemia induces an increase in the number of white muscle fibers which are least fatigue-resistant.[14] These might be the reason for the lower endurance in DM patients when compared with the normal controls in our study.

On correlating the hand grip strength and hand grip endurance with HbA1c and duration of the disease, we found that there was no correlation between these parameters.

However, in a study by Jekal et al., it was found that subjects with high HbA1c levels had significantly lower muscular endurance...
than the subjects with normal HbA1c.\(^{[15]}\) Park and colleagues found that the muscle quality (strength/mass) was associated with the duration of DM and also with the glycemic control.\(^{[9]}\)

Individual susceptibility of the target organs to hyperglycemia may vary in patients of DM. Also HbA1c is a marker of glycemic control over the past 2-3 months only. Irregularity in the treatment will also have a role in the complications produced. Probably, all these factors are responsible for our findings.

Over the recent years, many studies have clearly indicated that type II diabetes is associated with an impairment of ability to maintain daily activities.\(^{[3]}\) Rekeneire \textit{et al}. had shown in their studies that diabetes was associated with a 40% increased risk of sub-clinical functional limitation.\(^{[2]}\) Hand function is neglected by many treating physicians, but it is very crucial for productivity and good quality of life. Moreover, handgrip strength is directly proportional to the walking distance of the subject.\(^{[16]}\) Researchers have shown that lower grip strength is associated with reduced health-related quality of life.\(^{[17]}\) Hence, measurement of the simple test of the handgrip strength can give an idea to the treating physician about the hidden disability of the diabetic patient.

Moderate strength training in type II DM can improve the muscle strength.\(^{[18]}\) Studies are emerging that show diabetes as an independent contributor to the risk of functional limitation. Further studies are required to investigate whether better glycemic control will have a beneficial effect on physical quality of life of these patients.

**SUMMARY AND CONCLUSIONS**

This study shows that type II DM patients suffer from skeletal muscle dysfunction in the form of reduced handgrip strength and endurance. Hence the treating physician should not be ignorant about these disabilities. In addition to the strict measures to control the blood glucose levels, interventions to improve the muscle mass and strength in these patients should be undertaken.

**REFERENCES**

7. Madanmohan, Mahadevan SK, Balakrishnan S, Gopalakrishnan M, Prakash ES. Effect of six weeks yoga training on weight loss following step


