

## Comparison Of Hand Grip, Hand Mobility And Upper Extremity Impairments In Type 2 Diabetics, V/S Healthy Matched Individuals

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**Abstract:** Background and Objectives: 'Diabetic hand' includes complications related to joint mobility and muscle strength with functional impairment. The objective was to compare upper extremity impairments, hand grip, pinch strength and joint mobility in patients with Diabetes Mellitus type2(T2DM) with non-diabetic subjects. Methods: Comparative cross-sectional study was conducted using purposive sampling. Thirty participants with T2DM, duration  $\geq 5$  years, age group  $\geq 50$  years were included in group A and thirty age and gender matched healthy non-diabetic controls in group B. UEFS(upper extremity functional scale) was filled by the participants. Hand Grip Strength(HGS) and Key Pinch Strength were measured using Handheld Dynamometer and Pinch Gauge respectively. Joint mobility of hand was assessed using 'Prayer sign' and 'Tabletop test'. Results: Mean $\pm$ SD of HGS group A(diabetics)=18.86 $\pm$ 5.55kg and group B(non-diabetics)=31.73 $\pm$ 6.76kg, Pinch Strength of group A=4.93 $\pm$ 1.74 kg and of group B=7.4 $\pm$ 1.10kg respectively. Mean $\pm$ SD of UEFS group A=55.03 $\pm$ 8.18 and group B=72.66 $\pm$ 4.65 respectively. Prayer sign and Tabletop sign were positive in 7/30(23%) in group A and 1/30(3.3%) in group B. Analysis was done using Mann Whitney test and showed statistically significant difference between diabetics and non-diabetics,  $U=60.50, p<0.001$  for HGS and  $U=111.0, p<0.001$  for Pinch Strength and  $U=25.50, p<0.001$  for UEFS. Conclusion: Upper extremity impairments of grip strength, mobility and function were common in patients with T2DM. [Shah P Natl J Integr Res Med, 2019; 10(1):1--5]

**Key Words:** Handgrip strength, Joint mobility, Type2 diabetes mellitus, Upper extremity function

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**Introduction:** Diabetes mellitus (DM) is a chronic metabolic condition, characterised by persistent hyperglycaemia. In addition to the "classic" complications, diabetics also have a variety of musculoskeletal complications which may cause disability<sup>1</sup>. Diffuse idiopathic skeletal hyperostosis, neuropathic arthropathy, osteoarthritis, osteoporosis, adhesive capsulitis, Dupuytren's disease and carpal tunnel syndrome are frequently seen associated disorders. Musculoskeletal complications have been reported in about 36–75% of diabetic patients<sup>1-3</sup>.

According to World Health Organization, diabetes globally affects approximately 347 million people and diabetes deaths will double between 2005 and 2030. The complications associated with Type 2 Diabetes Mellitus (T2DM) may also lead to functional impairment in older people<sup>4</sup>. There are wide variety of diabetic complications involving bones, joints, and peri-articular soft tissues. However, the development of musculoskeletal disorders is also dependent on age and on the duration of diabetes mellitus<sup>5</sup>.

The diabetic involvement of the hands is known as Diabetic Cheiroarthropathy (DCA) or Stiff Hand Syndrome and causes limitation of mobility fixed contractures, impairment of grip strength and may be accompanied by a thick, waxy and tight skin. Connective tissue disorders, neuropathy, vasculopathy or combinations of these problems,

may be the reasons for increased incidence of musculoskeletal disorders in DM but the exact pathophysiology of most of these disorders remains unknown<sup>6</sup>.

It is usually characterized by painless limited extension of the proximal metacarpophalangeal joints and/or interphalangeal joints with spontaneous flexion of the fingers. There is also decreased ability to fully flex or fully extend the fingers<sup>7</sup>. The affliction can be related with pain and stiffness. A tight waxy skin surface over the dorsum of the hand usually completes the clinical picture<sup>8</sup>. Diabetic cheiroarthropathy can occur in both the types 1 and 2 diabetes mellitus. Some DCA reports suggest an overall prevalence being quoted as 30%<sup>9</sup>. The presence of limited joint mobility and associated impairments at the shoulder and hand may have a significant impact on upper extremity function in patients with diabetes<sup>10</sup>. Raje et al showed that patients with diabetes had higher symptom scores for hand and shoulder symptoms compared to control subjects<sup>11</sup>. Mustafa et al conducted a cross-sectional study on 1000 patients with T2DM. They also found that 695 patients (69.5%) have had some sort of hand disorder<sup>12</sup>.

Handgrip strength (HGS) is the maximal power of forceful voluntary flexion of all fingers under normal bio-kinetic conditions<sup>13</sup>. There is significant reduction in grip strength in diabetic

population, reflecting a link between the metabolic and mechanical functions of the muscle<sup>4</sup>. The effect of the reduced hand strength on hand functional disability has also not been clearly studied before. Hand function is very important in daily activities. This might result in loss of independence and reduced quality of life. With increase in numbers of diabetic patients, this problem may be amplified and is of greater clinical importance than before. Although widely recognized, only few studies have shown the relationship between long duration Diabetes Mellitus Type 2(T2DM) with handgrip strength and hand functions. Less is known about upper limb complications than the lower limbs- thus common but understudied in India.

The aims of present study were to assess upper extremity impairments, handgrip strength, pinch strength, and joint mobility in all subjects, and to compare the values in patients with T2DM and age matched apparently healthy individuals.

**Materials and Methods:** A comparative cross-sectional study was conducted with the permission of head of the physiotherapy department and head of the endocrine department of a General Hospital, Ahmedabad. Using purposive sampling, thirty participants who were diagnosed with T2DM by an endocrinologist for duration  $\geq 5$  years, age group of  $\geq 50$  years were included in group A and thirty age and gender matched healthy non-diabetic controls were included in group B. Participants with history of cervical spondylosis, carpal tunnel syndrome, peripheral nerve injury, during the previous 6 months, or having history of wrist or hand trauma or surgery in past 3 months, rheumatic diseases or other musculoskeletal or neurological conditions were excluded. The control subjects had no diagnosis of diabetes, and hand related pain in the previous 12 months. Subjects unable to understand the procedure were excluded.

Nature and purpose of the study was explained to the subjects, and consent was taken. Demographic information and hand dominance was noted. Hand Grip strength (HGS) of Dominant Hand was recorded using the Handheld Dynamometer (kg) and Key Pinch grip was measured using Pinch Gauge (kg). The subjects were seated in an armless chair with shoulders adducted and neutrally rotated, elbow flexed at

90 degrees, forearm in neutral position with the wrist between 0–30 degrees of dorsiflexion. Participants were instructed to press the handle as hard as attainable. The period didn't exceed five seconds. A period of thirty seconds rest was given between three trials for the dominant hand to be tested and the average of the three trials was taken<sup>14</sup>.

Participants were asked to fill the Upper Extremity Functional Scale (UEFS) which is a patient reported outcome measure (PROM) made up of a 20-item questionnaire measuring the functional status of Upper extremity dysfunction. Each item used a 5-point scale to rate difficulty in performing U/E activities (0=extreme difficulty and 4=no difficulty) and total scoring was done as a simple addition of all the responses of 20 items (0-80)<sup>15</sup>. Diabetic cheiroarthropathy can be diagnosed clinically using "prayer" and "table top" signs. The 'prayer sign' is claimed to occur whenever there's incomplete approximation of 1 or more than 1 digits when the patient makes an attempt to approximate the palmar surfaces of the proximal and distal interphalangeal joints with palms pressed together and the fingers abducted. Inability to completely flatten the palms on a table denotes a positive 'tabletop sign'<sup>7,16</sup>.

**Statistical Analysis:** Data analyses were performed using SPSS 16.0 software for Windows. The numerical scores of Handgrip strength, pinch grip and UEFS were presented as Mean  $\pm$  Standard deviation. Between groups analysis was done using Mann Whitney U test. The level of significance was kept at 5%.

**Results:** The sample composed of thirty participants in each group and the demographic data of diabetics and controls is shown in table 1.

**Table 1 - Demographic data of participants**

	(GROUP A) MEAN $\pm$ SD (n=30)	(GROUP B) MEAN $\pm$ SD (n=30)
AGE(years)	56.43 $\pm$ 0.44	58.56 $\pm$ 9.25
DURATION OF DIABETES(years)	10.66 $\pm$ 5.51	-
MALES/FEMALES	13/17	18/12

Table 2 shows the Mean and Standard deviation of the Hand grip, Pinch grip and the UEFS scores in both the groups along with the between

group comparison using the Mann Whitney test (U).

The Mann Whitney test shows a significant difference in all the outcome measures between group A and B.

**Table 2 – Comparison of outcome measures**

Outcome Measures	Group A Mean±SD	Group B Mean±SD	P value
HGS (kg) <sup>a</sup>	18.86 ± 5.55	31.73 ± 6.76	0.001
PINCH GRIP (kg)	4.93 ± 1.74	7.4 ± 1.10	0.001
UEFS <sup>b</sup>	55.03 ± 8.18	72.66 ± 4.65	0.001

a: handgrip strength, b: upper extremity functional scale

Number of participants showing positive 'Prayer sign' and 'Tabletop test' were 7/30 (23%) in Group A and 1/30 (3.3%) in Group B as shown in table 3.

**Table 3: Joint mobility in both the groups**

	GROUP A	GROUP B
PRAYERS SIGN	7/30 (23%)	1/30 (3.3%)
TABLETOP TEST	7/30 (23%)	1/30 (3.3%)

**Discussion:** The results of the current study showed that there is a significant decrease of the handgrip strength, mobility and scores of upper extremity functional scale in the diabetic patients compared with age and gender matched non-diabetic subjects.

The grip strength test has been commonly done to assess the performances of hand muscles by measuring the maximal grip force that could be executed in one muscular contraction<sup>17</sup>. In the present study, it was carried out according to the 'American Society of Hand Therapists' standardized position, as recommended by several authors<sup>14</sup>.

In the present study it was found that the values of hand grip and pinch grip strength were found lower in diabetics as compared to the non diabetic age matched individuals. Diabetes mellitus is usually associated with mild hand muscle weakness and with peripheral neuropathy. Insulin resistance may have been responsible for this muscle weakness, and so the decreased grip strength<sup>4</sup>. Lower values of hand grip strength and pinch power in T2DM

patients could be explained by distal upper extremity flexor muscle weakness, which may be caused by the severity of neuropathy<sup>18</sup>. Though diabetic neuropathy was not assessed in our study, results of this study are also in close agreement with authors who stated that type 2 Diabetes Mellitus seems to result in a decrease in handgrip strength in both male and female subjects. Similar conclusions were derived by Savas et al, who noted significantly lower handgrip strength in diabetics than the non-diabetic controls<sup>19</sup>. Also, Cetinus et al. found that hand grip and pinch grip strength values were lower in patients with type 2 DM than in age-matched control subjects<sup>18</sup>. However, Pedro Marques et al (2017) examined the association of grip strength with incident T2DM initially aged 50-75 years and also after a follow up of 5.5 years and 10.7 years, and they concluded that the risk of incident T2DM is overall not associated with grip strength over a maximum follow-up of 10.7 years<sup>20</sup>.

Diabetic Cheiroarthropathy (DCA) is a recognized complication of diabetes mellitus. Here it was found that the reduced joint mobility, or DCA was higher in diabetics with positive prayers sign and tabletop test in 7 out of 30 participants. Initially it was found in patients with type 1 diabetics because of the longer duration of their diabetes<sup>21,22</sup> but has now been also found in patients with type 2 diabetes mellitus as well<sup>23</sup>. The genesis of the DCA is likely multifactorial which occurs due to variety of factors. One possible mechanism is that the hyperglycemia facilitates the glycosylation and the crosslinking of collagen. Hence, the collagen proliferates in the skin, subcutaneous tissues, tendons, muscles, and periarticular tissue. These collagen fibers become stiffer. Furthermore, there is decreased collagen degradation<sup>7</sup>. Prayer sign correlates well with goniometer in detection of limited joint mobility<sup>16</sup>.

This study also found lower scores in upper extremity functional scale, which was similar to Casanova et al., who measured hand functions of patients with diabetes. Fifteen diabetes patients with a median age of 48 years, all having used insulin for a minimum of 5 years, were randomly selected from diabetes clinics. The Purdue pegboard, O'Connor tweezer dexterity, and Smith hand function tests were used. Hand functions were significantly decreased in the group with diabetes, and the decrease was out of proportion

to patients' own subjective pretest assessments. These authors noted that diabetes patient's perception of their hand function appear to be much better than their real performance because of insidious onset of the problem and gradual adaptation<sup>24</sup>. Lewko et al found that impaired hand function affects lower acceptance of the disease, occurrence of depression, and reduces patient's quality of life<sup>25</sup>.

Thus, it suggests that long standing type 2 diabetes mellitus is associated with poorer upper limb muscle strength which may lead to physical and functional limitations, and may further contribute to low productivity in people with type 2 Diabetes Mellitus. These results may help to develop appropriate treatment strategies for these individuals for upper extremity impairments. If impairments are identified at an early stage, simple exercises focusing on improving upper extremity ROM and strength can be administered for preventing further complications or any functional disabilities.

Limitation of the study was that measures like BMI and signs for sensory neuropathy were not taken which might also have associations with these diabetic complications. Outcome measure like UEFS is patient-reported (PROM) which may be responsible for bias in results.

Additional research on a large sample of patients with diabetes is needed to determine more clearly the upper limb impairments along with their relations with hand functions in diabetes, their pathological mechanisms, also the methods of prevention and treatment..

**Conclusion:** Patients with Type 2 Diabetes Mellitus have more impairment in upper limb function, grip strength, and mobility compared to age matched healthy individuals, which may lead to physical and functional limitations. Clinical implications are such that timely assessment of handgrip and upper extremity strength along with the assessment of foot can help in detecting early disability, to decide the prognosis (degree of weakness is considered to reflect their general health), for prevention of complications, also planning a proper rehabilitation, thus helping patients improve their quality of life.

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