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The effects of the diabetes related soft tissue hand lesions and the reduced hand strength on functional disability of hand in type 2 diabetic patients

Serpil Savaş[a,*], Banu Kale Köroğlu[b], Hasan Rifat Koyuncuoğlu[c], Ertuğrul Uzar[c], Hakan Çelik[a], Numan Mehmet Tamer[b]

[a] Süleyman Demirel University Medical School, Physical Medicine and Rehabilitation Department, Isparta, Turkey
[b] Süleyman Demirel University Medical School, Endocrinology & Metabolism Department, Isparta, Turkey
[c] Süleyman Demirel University Medical School, Neurology Department, Isparta, Turkey

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Abstract

Objectives: The aim of the present study is to examine the effects of diabetes related soft tissue hand lesions such as Dupuytren's disease, trigger finger and limited joint mobility (LJM) and the reduced hand strength on the functional disability of the hand in type 2 diabetic patients.
Methods: Forty-four type 2 diabetic patients and 60 age and sex matched controls were included in the study. Subjects were examined for the presence of Dupuytren's disease, trigger finger and LJM. Grip strength was tested first with Jamar dynamometer followed by pinch strength measurements using by a manual pinchmeter. Electrophysiological studies were performed in both groups. Duruöz Hand Index (DHI) was used to assess the functional hand disability.
Results: The mean DHI score of the diabetics was significantly higher than controls ($p < 0.0001$). Dupuytren's disease, trigger finger or LJM was not correlated with DHI in diabetic patients ($p > 0.05$). The grip and pinch strengths were significantly lower in diabetic patients than the non-diabetic controls ($p < 0.05$) and the grip and pinch strengths were negatively correlated with DHI in type 2 diabetic patients ($p < 0.001$).
Conclusion: Dupuytren's disease, trigger finger and LJM did not cause to functional disability of hand but low hand strength was found to cause functional disability of hand in our type 2 diabetic patients.

Keywords: Type 2 diabetes; Hand; Grip strength; Pinch strength; Disability

1. Introduction

Type 2 diabetes is a risk factor for functional disability particularly in older people. Multiple factors have been implicated in the development of functional disability in type 2 diabetic patients and coronary and peripheral vascular disease, retinopathy, stroke, nephropathy, neuropathy, diabetic foot problems, depression and cognitive impairment were demonstrated to be the predictors of functional disability in type 2 diabetic patients [1–11]. The incidence of type 2 diabetes and the life expectancy of the diabetic patient have both increased, resulting in the increased clinical importance

* Corresponding author at: Posta kutusu 76, 32000 Isparta, Turkey. Fax: +90 246 2370240.
E-mail address: serpilsavas@yahoo.com (S. Savaş).

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upper extremity problems although patients with type 2 diabetes have reported to be more disabled in self-care tasks and housework than non-diabetic patients [7–9]. The effects of diabetes related soft tissue hand problems such as limited joint mobility, Dupuytren's disease, trigger finger on the functional disability of hand are largely unknown.

Grip and key pinch strength was found to be lower in the hands of type 2 diabetics compared to the non-diabetic controls [12–14] and the effect of the reduced hand strength on hand functional disability has also not been clearly demonstrated before.

We therefore conducted this study to determine the effect of diabetes related soft tissue hand complications, and the reduced hand strength on the functional hand disability in type 2 diabetic patients. We also evaluated the factors effecting hand strength in type 2 diabetic patients.

2. Patients and methods

Sixty consecutive type 2 diabetic patients (34 female, 26 male) attending Suleyman Demirel University Endocrinology outpatient clinic and sex and age matched 60 non-diabetic controls (28 female, 32 male) attending to the Physical Medicine and Rehabilitation outpatient clinic of Suleyman Demirel University other than upper extremity complaints were included in the study. Informed consent was given to all subjects and the study was reviewed and approved by the local ethics committee.

Criteria for the inclusion in the study were that patients had type 2 diabetes, have no documented history of shoulder adhesive capsulitis and carpal tunnel syndrome, the control subjects had no glucose abnormality, no documented history of trauma or cervical radiculopathy or hand related pain in the previous 12 months. Left handed subjects were not also included in the study.

Patients were classified at the time of their first visit as having type 2 diabetes according to traditional clinical characteristics, such as a prior history of using oral agents to control hyperglycemia, the presence of obesity, no history of ketosis, or family history of diabetes. The patients were performed a dilated eye examination for diabetic retinopathy by an ophthalmologist and a screening for microalbuminuria by measurement of the albumin to creatinine ratio in a random spot collection. Diabetic nephropathy was accepted to be present if urinary albumin excretion is ≥ 30 μg/mg creatinine. In all controls, blood glucose was measured. Controls with a blood glucose value in the diabetic range were excluded.

Body mass index (BMI) was calculated by using the formula of weight (kg)/height^2 (m). Smoking status and working status of the subjects and the patients who exercise regularly were noted. We classified the occupation of subjects white collar on the basis of non-manual labour in the course of their occupation, but who practiced regular carpeting, weight lifting or gardening (more than 2 h, three times a week) were classified in the manual labour group.

Diabetic patients were examined for the hand complications of diabetes by the same investigator. LJM was assessed by the 'Prayer sign': patients were asked to bring the palmar surfaces of the fingers together in a praying position with the wrist maximally flexed. Failure of metacarpophalangeal or proximal interphalangeal joints to make a contact was classified as a positive prayer sign, which means LJM [16]. Joint mobility was classified according to test results as follows [17]; Stage 0: ability to make contact at all opposing interphalangial joints in the prayer sign or on the imprint, Stage 1: inability to make contact at one interphalangial joint in the prayer sign or on the imprint, Stage 2: inability to make contact at two or more interphalangial joints in the prayer sign or on the imprint.

The diagnosis of Dupuytren's disease was made by the observation of one or more of the following four features on examination: a palmar or digital nodule, tethering of the palmar or digital skin, a pretendinous band, and a digital flexion contracture [18].

Trigger finger or flexor tenosynovitis was diagnosed by palpating a nodule or thickened flexor tendon with locking phenomenon during extension and flexion of any fingers [19].

3. Disability assessment of the hand

DHI is a self-reported questionnaire developed to assess hand ability in the kitchen, during dressing, while performing personal hygiene, office tasks, and other general items. DHI is derived from 18 validated questions to assess functional disability and handicap of the hand. Each answer is scored on a scale of 0 (no difficulty) to 5 (impossible to do) with a maximum score of 90. A higher score indicated worse disability or handicap. DHI was developed and translated into Turkish by Duruöz et al. and it is a reliable instrument for the assessment of hand functional disability in type 2 diabetic patients [20,21].

4. Electrodiagnostic studies

All studies were performed with the patient supine, at a room temperature of 25 °C, using a Nihon Kohden-Neuropack MEB 5504K (Tokyo, Japan). Motor nerve conduction velocity (MNCV) and amplitude of the compound muscle action potential (CMAP) were measured in the dominant median nerve and the non-dominant peroneal nerve. Sensory nerve conduction velocity (SNCV) and amplitude of the sensory nerve action potential (SNAP) were measured in the non-dominant sural nerve and the dominant median nerve. The follows: sural nerve SNCV $\geq$ 40 m/s, sural nerve SNAP $\geq$ 8 μV, median nerve MNCV $\geq$ 50 m/s, median nerve CMAP $\geq$ 4 mV, peroneal nerve MNCV > 43 m/s and peroneal nerve CMAP $\geq$ 2 mV. Case reports were searched for other explanations of polyneuropathy and all patients were examined by a trained neurologist including sensory, motor and reflex examinations, who decided whether the findings were typical of diabetic neuropathy. The diagnosis of diabetic polyneuropathy was based on both clinical and electrophysiological studies.

Sixteen patients with type 2 diabetes who had carpal tunnel syndrome in ENMG were excluded in order to eliminate the effect of CTS on hand strength.

5. Handgrip and pinch strength measurements

Grip strength was tested first with a single calibrated Jamar dynamometer (Sammons Preston, Inc., Bollingbrook, IL) followed by lateral, palmar and tip pinch measurements by using a manual pinchmeter (Sammons Preston, Inc., Bollingbrook, IL). For each tests of hand strength, the standard test position approved by the American Society of Hand Therapists was used [22]. This testing position is described as sitting in a straight-backed chair with feet flat on the floor, the shoulder adducted and neutrally rotated, elbow flexed at 90°, forearm in a neutral position, and the wrist between 0° and 30° extension and between 0° and 15° ulnar deviation. In all cases the arm should not be supported by the examiner or by an armrest. For grip strength measurement, the dynamometer is presented vertically and in line with the forearm to maintain the standard forearm and wrist positions. For standardization, the handle of Jamar dynomometer is set at the second handle position (3.8 cm) for all subjects. For pinch strength the pinch gauge was positioned between the pad of the thumb and the radial side of the middle phalanx of the index finger. For tip strength the pinch gauge was positioned between the tip of the thumb and the tip of the index finger. For palmar strength the pinch gauge was positioned between the pad of the thumb and the pad of the index and middle fingers. For each strength test the scores of three successive trials were recorded and the mean of three trials was used. Both the dynamometer and pinch gauge were reset to zero prior to each reading and were read to the nearest increment of the two scale divisions.

6. Statistics

Results were given as mean $\pm$ standard deviation (S.D.) and range. The difference between groups was metric variables and Mann–Whitney U test in non-parametric variables. Pearson's correlation analysis in parametric variables and Spearman correlation analysis in non-parametric variables was used to express the strength of the association between two variables. The significance level was set at $p < 0.05$ for all tests. Analyses were performed using the software program SPSS Statistics 11.0 (SPSS International BV, Chicago, IL, USA).

7. Results

Forty-four type 2 diabetic patients (18 female, 26 male) with a mean age of 60.22 $\pm$ 8.88 years (46–75) and 60 controls (28 female and 32 male) with a mean age of 58.98 $\pm$ 9.07 years (45–75) took part in the study. There was no difference for the mean age ($p = 0.48$) and sex ($p = 0.56$) between the groups. The mean BMI did not differ between the groups (28.05 $\pm$ 3.76 versus 28.31 $\pm$ 4.41, $p = 0.76$). Eight (18.2%) patients with diabetes and 8 (13.3%) controls were regular smokers ($p = 0.71$). None of the patients and the subjects was exercising regularly. Clinical characteristics of the diabetic patients are shown in Table 1.

In the diabetic group, 22 patients were house-wives, 14 patients were retired, 5 patients were officials, 3 patients were tradesmen. In the control group, 30 subjects were house-wives, 19 subjects were retired, 4 subjects were officials, 6 subjects were tradesmen, 1 subject was a manager. Self-reported working status of all subjects was classified as all white collar workers.

The mean DHI score was 4.75 $\pm$ 8.99 (0–40) in diabetics and 0.06 $\pm$ 0.31 (0–2) in controls ($p < 0.0001$).

Twenty (45.5%) diabetic patients had LJM consisting of 18 (40.9%) stage 1 and 2 (4.5%) stage 2 LJM. Thirteen (29.5%) diabetic patients had Dupuytren's disease and 4 (9.1%) patients had trigger finger. None of the patients with Dupuytren's disease had digital flexion contracture. None of the controls had LJM, Dupuytren's disease or trigger finger. LJM, Dupuytren's disease or

Table 1
Characteristics of the type 2 diabetic patients

	Diabetic patients (n = 44)
Diabetes duration (years)	12.15 $\pm$ 5.28 (5–28)
HbA1c (%) (mean $\pm$ S.D.)	9.37 $\pm$ 1.60 (5.20–12.90)
Retinopathy (n, %)	24 (54.5)
Nephropathy (n, %)	28 (63.6)
Polyneuropathy (n, %)	29 (65.9)

Comparison of the hand strength measurements of the diabetic patients and controls (mean ± S.D.)

Measurement	All diabetic subjects ($n = 44$)	Control subjects ($n = 60$)	p
Grip (kg)	27.48 ± 9.26	31.72 ± 9.86	0.02
Pinch lateral (kg)	7.50 ± 2.17	8.65 ± 2.43	0.01
Pinch tip (kg)	4.00 ± 1.56	4.90 ± 1.23	0.001
Pinch palmar (kg)	6.01 ± 1.79	7.20 ± 1.71	0.001

Table 3
Comparison of electrophysiological parameters (mean ± S.D.)

	Type 2 diabetes ($n = 44$)	Controls ($n = 60$)
L sural nerve SNCV	31.50 ± 19.86	47.59 ± 4.62[a]
L sural nerve SNAP	9.63 ± 8.40	19.87 ± 9.24[a]
R median nerve MNCV	48.66 ± 4.45	55.94 ± 4.08[a]
R median nerve CMAP	12.60 ± 3.36	15.35 ± 4.70[a]
L peroneal nerve MNCV	41.11 ± 8.63	49.99 ± 4.31[a]
L peroneal nerve CMAP	3.02 ± 2.50	6.88 ± 4.35[a]

[a] $p < 0.05$.

trigger finger was not correlated with DHI score in diabetic patients ($p > 0.05$).

The grip and pinch strengths were significantly lower in diabetic patients than the non-diabetic controls in both hands ($p < 0.05$) (Table 2). The mean grip and pinch strengths was significantly correlated between the right and left hands in both groups ($p < 0.0001$) so, the right hands were taken into consideration for the statistical analyses. The mean grip strength, palmar pinch strength, and key pinch strength was negatively correlated with the mean DHI in type 2 diabetic patients ($r = -0.47$, $p = 0.002$; $r = -0.44$, $p = 0.004$ and $r = 0.54$, $p = 0.0001$, respectively). The mean tip pinch strength was not correlated with the mean DHI score ($r = -0.26$, $p = 0.12$). The grip and pinch strength measurements were not correlated with the duration of diabetes, HbA1c levels and presence of retinopathy or nephropathy ($p > 0.05$).

Twenty-nine (65.9%) diabetic patients had symetric distal sensorymotor polyneuropathy. None of the controls had polyneuropathy or carpal tunnel syndrome. Electrophysiological measurements are summarized in Table 3. Polyneuropathy was not correlated with the mean DHI score ($p > 0.05$) and with the grip and pinch measurements ($p > 0.05$). The grip and the pinch strength values were not different between the diabetic patients with or without polyneuropathy ($p > 0.05$) (Table 4).

The presence of Dupuytren's disease, trigger finger and LJM was not correlated with the grip and pinch strength measurements in type 2 diabetic patients ($p > 0.05$).

8. Discussion

Hand is an important target for diabetic musculoskeletal complications in type 2 diabetes. The upper extremity complications, known as 'diabetic hand', include not only more specific diabetic-related conditions such as LJM, but conditions related to the non-diabetic hand, such as trigger finger, Dupuytren's disease and CTS [23,24]. Whether diabetic hand complications effect hand functional disability, defined as difficulty in performing activities of daily living, in type 2 diabetes has not been investigated before.

LJM is a common manifestation of type 2 diabetes which results in painless, non-inflammatory limitation of the hand, feet and larger joints [25]. It is thought to be a manifestation of the diffuse collagen abnormalities found in diabetic patients [26]. LJM is not usually disabling enough to make a patient seek treatment [27]. In line with this data, LJM did not cause functional hand disability in our diabetic patients.

Trigger finger is reported to be a common cause of pain and disability in the hand [28]. However in our study trigger finger did not cause any functional hand disability

Table 4
Comparison of the hand strength measurements of the diabetic patients with and without polyneuropathy (mean ± S.D.)

Measurement	Diabetics with polyneuropathy ($n = 29$)	Diabetics without polyneuropathy ($n = 15$)	p
Grip (kg)	26.26 ± 9.22	29.84 ± 9.20	0.23
Pinch lateral (kg)	7.52 ± 2.09	7.47 ± 2.40	0.94
Pinch tip (kg)	3.75 ± 1.55	4.49 ± 1.50	0.13
Pinch palmar (kg)	5.95 ± 1.80	6.13 ± 1.81	0.75

with trigger finger, studying with a larger group of patients with trigger finger may give more precise results.

Dupuytren's disease did not cause to hand disability in our diabetic patients. The reason for this result may be that the disease form was mild since none of our diabetic patients had contracture of the fingers. It is known that Dupuytren's disease is milder in diabetic patients than the normal population, it rarely causes to severe contracture of the fingers and it has a benign prognosis in those patients [29]. Our result supports this data.

Our patients with type 2 diabetes had low grip and pinch strength values than the non-diabetic controls and the reduced hand strength caused to hand functional disability. There are few studies in the literature assessing the hand strength in type 2 diabetic patients. Sayer et al. [12] assessed 1391 men and women with type 2 diabetes aged between 60 and 70 years and they reported that known diabetes status was associated with significantly lower grip strength, particularly in men. Özdirenç et al. [13] compared the hand grip strength in 30 type 2 diabetic patients with non-diabetic controls and found that the handgrip strength is impaired in diabetic patients. Herriott et al [30] used 1-RM values for type 2 diabetic subjects and did not found a difference from controls however the number of the patients was only nine and the test they used was not sensitive. Hand disability was not assessed in these three studies although hand grip strength is known to be an independent factor of ADL disability among older adults [31]. The only study assessing the effect of the reduced hand strength on the daily life was Çetinus et al.'s study [14]. In that study, they found low hand grip strength and pinch power in 76 type 2 diabetic patients compared to 47 non-diabetic controls and implications on life and activities, as a consequence of the patients' lower hand grip and pinch strength values, were investigated by asking the patient if their hand power and the daily activities was affected. 34.9% of their patients stated that decreased hand strength affected their daily activities but the methodology used in that study was rather subjective. In the present study, we demonstrated hand functional disability in type 2 diabetics due to the reduced hand strength with a more objective method.

The reason for the low hand strength in patients with type 2 diabetes was explained by the severity of neuropathy in Cetinus' study [14] although they did not analyze diabetic neuropathy in their study. Diabetic polyneuropathy usually presents with sensory disturbances. Later on, motor disturbances can occur in more the muscles of the muscles of the lower leg and foot [32]. It is well known that impaired muscle strength at the ankle and knee in type 2 diabetic patients is related to the presence and the severity of peripheral motor neuropathy which causes axonal loss and muscle atrophy and the weakness is progressive [32,33]. In the present study, we could not find a relationship between the presence of diabetic distal symmetric polyneuropathy and hand strength values. Somewhat although not reaching statistical significance, lower grip and pinch tip strength was detected in the neuropathic patients as compared with the non-neuropathic patients. The low statistical power may be due to the exclusion of 16 patients with carpal tunnel syndrome. With our result, we may also assume that motor neuropathy in our patients was not severe enough to cause hand muscle weakness.

Lundbaek [34] stressed that stiffness of the subcutaneous tissue in the hand of diabetic patients might have an influence on the hand strength measurements. In the present study the presence of LJM was not correlated with the hand strength measurements however the lack of a negative correlation may be due to the presence of mild form of LJM in our diabetic patients.

Although we did not analyzed, reduced physical fitness may be responsible for the reduced hand muscle strength in our diabetic patients by causing reduced general muscle strength. Physical functional capacity is found to be lower in type 2 diabetic patients than in age-matched control subjects [13,35]. Özdirenç et al. [13] found that low functional capacity caused to decreased muscle strength of lower extremities and they concluded that physical fitness evaluation should be taken into consideration when exercise programs as designed for type 2 diabetic patients. Sayer et al. [12] found a graded association between the weaker grip strength and impaired physical capacity in their diabetic patients.

It was previously reported that, hyperglycemia can effect contractile function and force generation in animal models [36]. Sayer et al. [12] demonstrated an association between the increased glucose levels and weaker hand strength in type 2 diabetic patients but they conclude that low levels of physical activity could explain the relationship between the increased glucose level and reduced grip strength. After adjustment for level of physical activity they concluded that the observed association may be causal [12]. Andersen et al. [33] also found no correlation between the blood glucose, HbA1c and the reduced strength at the knee

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