

ORIGINAL ARTICLE

# Musculoskeletal disorders of the hand in type 2 diabetes mellitus: prevalence and its associated factors

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## Abstract

**Aim:** To assess the prevalence of musculoskeletal disorders of the hand among adult patients with type 2 diabetes mellitus (T2DM) and their relation to disease duration, glycemic control and microvascular complications.

**Methods:** A cross-sectional study was conducted at the National Center for Diabetes, Endocrinology and Genetics in Amman, Jordan.

**Results:** One thousand patients with T2DM were included in this study (mean age  $57.8 \pm 9.5$  years, 52.2% females and 47.8% males). Hand disorders were seen in 69.5% of patients, limited joint mobility (LJM) was the most prevalent (63.1%) condition followed by Dupuytren's contracture (DC) (18.6%). Trigger finger, thick skin and carpal tunnel syndrome (CTS) were found in 7.2%, 6.2% and 5.5% of patients, respectively. One disorder was seen in 45.4% of patients, two in 18.2%, three in 4.9%, four in 0.9%, while only 0.1% of patients had all disorders. Female gender, age over 60 years and long duration of diabetes were associated with hand abnormalities. Hypertension was significantly associated with DC while retinopathy was associated with increased odds of thick skin, DC and CTS with *P*-values 0.037, < 0.005 and 0.002, respectively.

**Conclusion:** Hand disorders are very common in T2DM. Female gender, old age, duration of diabetes, retinopathy and hypertension were significantly associated with hand disorders in T2DM.

**Key words:** carpal tunnel syndrome, diabetes mellitus, Dupuytren's contracture, flexor tenosynovitis, limited joint mobility.

## INTRODUCTION

Diabetes mellitus (DM) is a common metabolic disorder associated with multiple complications; some are associated with serious damage. Musculoskeletal complications have been reported in about 36–75% of diabetic patients,<sup>1–7</sup> leading sometimes to severe disability. These complications are heterogeneous, involving not

only joints, but bones, soft tissues and periarticular structures. Only few are considered intrinsic complications of DM, like diabetic muscle infarctions and limited joint mobility (LJM). Limited joint mobility was described as stiff hand by Lundbaek in 1957,<sup>8</sup> also known as cheiroarthropathy, and as diabetic hand syndrome (DHS).<sup>9,10</sup> The term DHS was introduced first by Jung in 1771 to describe flexion contractures of the fingers and nerve conduction delays in the median nerve.<sup>10</sup> Other hand complications include: LJM, trigger finger, Dupuytren's contracture (DC), carpal tunnel syndrome (CTS) and thick skin. Although these are seen more frequently with diabetes, they do occur in other non-endocrine conditions.<sup>8,10–13</sup>

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The association of hand complications with both types 1 and 2 DM, and their relationship with microvascular complications are well recognized.<sup>6,7,11,13</sup> Most of the studies that looked into the prevalence of rheumatic manifestations in DM were conducted in Western countries, and to a lesser extent, in other parts of the world. However, there is very little data available from Arab countries. Because of the paucity of such studies in this field, this study was conducted to determine the prevalence of hand musculoskeletal disorders in patients with type 2 DM (T2DM), their associated factors and their relationship to other diabetic complications, including microvascular complications, in Jordan.

## MATERIALS AND METHODS

A cross-sectional study was conducted on 1000 patients with T2DM. Patients were selected systematically by including every third patient attending diabetic clinics at the National Center for Diabetes, Endocrinology and Genetics (NCDEG) Amman, Jordan, over a period of 3 months. Patients with a history of hand trauma, epilepsy, hypothyroidism, inflammatory arthritis, family history of DC, central or peripheral nervous system disease and alcohol intake, were excluded from the study. Ethical approval was obtained from the NCDEG ethics committee.

Demographic and clinical characteristics of patients were recorded, including: age, sex, height, weight, body mass index (BMI), blood pressure, duration of DM, glycemic control (judged by the average of three HbA1c readings, one at the examination day, and two previous readings), total cholesterol (TC), triglyceride (TG), high-density lipoprotein (HDL), and low-density lipoprotein (LDL).

Microalbuminuria was evaluated on a 24-h urine collection. It was considered present if urinary albumin was  $\geq 30$ –299 mg/24 h. Dyslipidemia was defined according to American Diabetes Association (ADA) criteria, 2008.<sup>14</sup> Hypertension was considered present if the average of three readings was  $> 130/80$  mmHg according to the Seventh Report of the Joint National Committee of Prevention, Detection, Evaluation and Treatment of High Blood Pressure (JNC 7), or if the patient reported taking antihypertensive drugs. Diabetes was considered controlled if HbA1C level was  $< 7\%$  according to ADA criteria, 2008.<sup>14</sup>

The presence of retinopathy was confirmed by a detailed ophthalmology assessment which was part of

the comprehensive care delivered to each patient with DM followed at our centre.

Hand complications (LJM, DC, trigger finger, CTS and thick skin) were evaluated by a specialist diabetes nurse who received adequate training from a rheumatologist (the primary investigator). Limited joint mobility was considered present if one or more interphalangeal or metacarpophalangeal joints failed to make a contact when the patient was asked to oppose the palmar surfaces of the fingers in a praying position with the wrist maximally flexed 'Prayer sign'.<sup>13</sup> Dupuytren's contracture was diagnosed if there was a palpable nodule along flexor tendons, tethering of the palmar or digital skin, a pretendinous band or a digital flexion contracture. Trigger finger or flexor tenosynovitis was diagnosed if there was locking upon flexion in extension of any finger, or there was thickened flexor tendon over the metacarpophalangeal joint.<sup>15</sup> Carpal tunnel syndrome was considered if there was a dull, aching discomfort in the hand, forearm or upper arm, paresthesia in the hand, dryness of the hand, increase in symptoms during sleep and improvement by shaking the wrist. Tinel's and Phalen's signs with pin prick test were also performed on each patient who had symptoms suggestive of CTS.<sup>16</sup> History of CTS surgery was considered as evidence for the presence of CTS. Electromyographic nerve conduction studies were not part of the required criteria for the diagnosis of CTS in our study. Patients with symptoms suggestive of diabetic neuropathy in the lower limbs were not included in the CTS group. Thick skin was defined as described by Seibold;<sup>17</sup> palpation of patient skin was done over the dorsum and palmer aspect of fingers. Sclerodactyly was considered to be present if the examiner was unable to tent the skin between index finger and thumb over the dorsal or palmer aspect of the fingers on both hands.

Statistical analysis was carried out using the Statistical Package for Social Sciences (SPSS, version 15; SPSS Inc., Chicago, IL, USA). Descriptive statistics were obtained, such as mean values for continuous variables and proportions for categorical variables. The relation between prevalence of hand disorders and various variables was assessed for statistical significance using the Chi-square test. Multiple logistic regression analysis was conducted to assess the multivariate associations between hand complications and related factors and microvascular complications of diabetes. Separate logistic regression models were produced for each of the diabetic hand changes. A  $P$ -value  $< 0.05$  was considered statistically significant.

## RESULTS

### Participants characteristics

Of the 1000 patients studied, 47.8% were male and 52.2% were female. The mean ( $\pm$ SD) age was  $57.8 \pm 9.5$  (range 23–88) years. About 18.1% of patients were current smokers and 17.6% were ex-smokers. The duration of diabetes ranged between 1 and 24 years with a mean  $9.3 \pm 7.2$  years. The mean of HBA1c was  $7.5 \pm 1.3\%$ ; 61.8% of the patients had HBA1c levels of 7% or more. About 32.7% of patients were overweight, 58.3% were obese, 25.1% had reti-

nopathy, 17% had nephropathy, 81.1% had dyslipidemia and 78.3% had hypertension (Table 1).

### Prevalence of hand abnormalities

Six hundred and ninety-five patients (69.5%) had some sort of hand disorder. The highest prevalence was for LJM (63.1%) followed by DC (18.6%). The prevalence rates of trigger finger, thick skin, and CTS were 7.2%, 6.2% and 5.5%, respectively. Less than half the patients (45.4%) had a single hand disorder, 18.2% had two disorders, 4.9% had three disorders, 0.9% had four disorders and 0.1% had all disorders. The prevalence rates

**Table 1** Prevalence of hand disorders according to socio-demographic and other relevant variables in type 2 diabetic patients attending National Center for Diabetes, Endocrinology and Genetics (NCDEG) Amman, Jordan

| Variable                             | Diabetic hand disorders<br><i>n</i> (%) | Limited joint mobility<br><i>n</i> (%) | Thick skin<br><i>n</i> (%) | Dupuytren's contracture<br><i>n</i> (%) | Trigger finger<br><i>n</i> (%) | Carpal tunnel syndrome<br><i>n</i> (%) |
|--------------------------------------|---|--|----------------------------|---|--------------------------------|--|
| Gender                               |   |  |                            |   |                                |  |
| Male                                 | 311 (65.1)*                             | 281 (58.8)*                            | 45 (9.4)*                  | 97 (20.3)                               | 29 (6.1)                       | 12 (2.5)*                              |
| Female                               | 384 (73.3)                              | 350 (67.0)                             | 17 (3.3)                   | 89 (17)                                 | 43 (8.2)                       | 43 (8.2)                               |
| Age (years)                          |   |  |                            |   |                                |  |
| < 50                                 | 135 (59.2)*                             | 121 (53.1)*                            | 8 (3.5)*                   | 17 (7.5)*                               | 9 (3.9)                        | 10 (4.4)                               |
| 50–60                                | 253 (67.3)                              | 231 (61.4)                             | 18 (4.8)                   | 45 (12.0)                               | 30 (8.0)                       | 22 (5.9)                               |
| > 60                                 | 307 (77.5)                              | 279 (70.5)                             | 36 (9.1)                   | 124 (31.3)                              | 33 (8.3)                       | 23 (5.8)                               |
| Smoking                              |   |  |                            |   |                                |  |
| Non                                  | 453 (70.5)*                             | 408 (63.5)                             | 27 (4.2)*                  | 113 (17.6)*                             | 53 (8.2)*                      | 113 (17.6)*                            |
| Current                              | 112 (61.9)                              | 103 (56.9)                             | 12 (6.6)                   | 27 (14.9)                               | 5 (2.8)                        | 27 (14.9)                              |
| Past                                 | 130 (73.9)                              | 120 (68.2)                             | 23 (13.1)                  | 46 (26.1)                               | 14 (8)                         | 46 (26.1)                              |
| Duration (years)                     |   |  |                            |   |                                |  |
| < 7                                  | 297 (59.3)*                             | 268 (53.5)*                            | 14 (2.8)*                  | 45 (9.0)*                               | 23 (4.6)*                      | 21 (4.2)                               |
| $\geq$ 7                             | 398 (79.8)                              | 363 (72.7)                             | 48 (9.6)                   | 141 (28.3)                              | 49 (9.8)                       | 34 (6.8)                               |
| Hemoglobin A1C (%)                   |   |  |                            |   |                                |  |
| $\geq$ 7                             | 437 (70.7)                              | 399 (64.6)                             | 46 (7.4)*                  | 128 (20.7)*                             | 50 (8.1)                       | 30 (4.9)                               |
| < 7                                  | 258 (67.5)                              | 232 (60.7)                             | 16 (4.2)                   | 58 (15.2)                               | 22 (5.8)                       | 25 (6.5)                               |
| Body mass index (kg/m <sup>2</sup> ) |   |  |                            |   |                                |  |
| Normal (< 25)                        | 59 (65.6)                               | 57 (63.3)                              | 6 (6.7)                    | 11 (12.2)                               | 7 (7.8)*                       | 1 (1.1)*                               |
| Overweight (25–29.99)                | 220 (67.3)                              | 196 (59.9)                             | 24 (7.3)                   | 60 (18.3)                               | 14 (4.3)                       | 8 (2.4)                                |
| Obese ( $\geq$ 30)                   | 416 (71.4)                              | 378 (64.8)                             | 32 (5.5)                   | 115 (19.7)                              | 51 (8.7)                       | 46 (7.9)                               |
| Dyslipidemia                         |   |  |                            |   |                                |  |
| Yes                                  | 569 (70.2)                              | 518 (63.9)                             | 57 (7.0)*                  | 159 (19.6)                              | 64 (7.9)                       | 46 (5.7)                               |
| No                                   | 126 (66.7)                              | 113 (59.8)                             | 5 (2.6)                    | 27 (14.3)                               | 8 (4.2)                        | 9 (4.8)                                |
| Hypertension                         |   |  |                            |   |                                |  |
| Yes                                  | 566 (72.3)*                             | 514 (65.6)*                            | 50 (6.4)                   | 170 (21.7)*                             | 64 (8.2)*                      | 46 (5.9)                               |
| No                                   | 129 (59.4)                              | 117 (53.9)                             | 12 (5.5)                   | 16 (7.4)                                | 8 (3.7)                        | 9 (4.1)                                |
| Microalbuminuria                     |   |  |                            |   |                                |  |
| Yes                                  | 127 (74.7)                              | 118 (69.4)                             | 12 (7.1)                   | 49 (28.8)*                              | 13 (7.6)                       | 5 (2.9)                                |
| No                                   | 568 (68.4)                              | 513 (61.8)                             | 50 (6.0)                   | 137 (16.5)                              | 59 (7.1)                       | 50 (6.0)                               |
| Retinopathy                          |   |  |                            |   |                                |  |
| No                                   | 493 (65.8)*                             | 446 (59.5)*                            | 33 (4.4)*                  | 95 (12.7)*                              | 46 (6.1)*                      | 31 (4.1)*                              |
| Yes                                  | 202 (80.5)                              | 185 (73.7)                             | 29 (11.6)                  | 91 (36.3)                               | 26 (10.4)                      | 24 (9.6)                               |

\**P*-value < 0.05.

according to demographic and clinical characteristics are shown in (Table 1).

### Multivariate analysis

In the multivariate analysis, the only factors that were significantly associated with one or more hand disorders were gender, age, duration of diabetes, retinopathy and hypertension. Females were more likely to have hand disorders overall (oddr ratio [OR] = 1.8 [95% CI: 1.3, 2.5]). This was highest for CTS (OR = 2.9 [95% CI: 1.4, 6.3]) followed by LJM (OR = 1.7 [95% CI: 1.3, 2.4]).

However, they were less likely to have thick skin (OR = 0.4 [95% CI: 0.2, 0.8]). Age also seemed to confer higher risk, thus patients older than 60 years were more likely to have hand disorders than those below 60 (overall OR = 2.3 [95% CI: 1.7, 3.1]), LMJ (OR = 1.5 [95% CI: 1.1, 2.2]) and DC (OR = 3.1 [95% CI: 1.7, 5.5]). Having diabetes for > 10 years was associated with increased risk of all hand disorders except CTS. Retinopathy was significantly associated with increased odds of thick skin (OR = 1.9 [95% CI: 1.1, 3.4]), DC (OR = 2.4 [95% CI: 1.6, 3.5]) and CTS (OR = 2.8 [95% CI: 1.4, 5.4]). Hypertension seemed to only be significantly associated with DC (OR = 2.0 [95% CI: 1.1, 3.6]) (Table 2).

### DISCUSSION

Diabetes mellitus has been linked to a variety of musculoskeletal disorders. Such disorders might not be a source of severe disability receiving great attention, yet they could be a marker of more severe microvascular complications. This link has been a field of several studies, the results of which have been at best inconsistent. Most epidemiologic studies about diabetic hand complications have shown inconsistent results with regard to both prevalence and their relation to microvascular complications.

The current study is the first to include a large number of Arab patients (*n* = 1000) with T2DM.

Hand disorders (one or more) were seen in over two-thirds of our patients. In previous reports, the prevalence ranged between 26% and 64%.<sup>3,4,7,18,19</sup> In our study female gender, duration of diabetes and age above 60 years were observed to be associated with such disorders. These findings are similar to the results of previous studies.<sup>18,20-24</sup> Nevertheless, such association was not supported by some previous reports.<sup>25</sup> One and two disorders were seen in 50% and 20% of our patients, respectively, while three or four disorders

**Table 2** Multivariate analysis of factors associated with hand disorders and their components\*

| Variable                     | Diabetic hand disorders |         | Limited joint mobility |         | Thick skin     |         | Dupuytren's contracture |         | Carpal tunnel syndrome |         |
|------------------------------|-------------------------|---------|------------------------|---------|----------------|---------|-------------------------|---------|------------------------|---------|
|                              | OR (95% CI)             | P-value | OR (95% CI)            | P-value | OR (95% CI)    | P-value | OR (95% CI)             | P-value | OR (95% CI)            | P-value |
| Gender                       |                         |         |                        |         |                |         |                         |         |                        |         |
| Male                         | 1                       |         | 1                      |         | 1              |         | 1                       |         | 1                      |         |
| Female                       | 1.8 (1.3, 2.5)          | 0.001   | 1.7 (1.3, 2.4)         | 0.001   | 0.4 (0.2, 0.8) | 0.009   | 2.9 (1.4, 6.3)          | 0.005   | 2.9 (1.4, 6.3)         | 0.005   |
| Age (years)                  |                         |         |                        |         |                |         |                         |         |                        |         |
| < 50                         | 1                       |         | 1                      |         | 1              |         | 1                       |         | 1                      |         |
| 50-60                        | 1.2 (0.8, 1.7)          | 0.378   | 1.2 (0.8, 1.7)         | 0.292   |                |         | 1.2 (0.6, 2.1)          | 0.650   |                        |         |
| > 60                         | 2.3 (1.7, 3.1)          | 0.017   | 1.5 (1.1, 2.2)         | 0.033   |                |         | 3.1 (1.7, 5.5)          | < 0.005 |                        |         |
| Duration of diabetes (years) |                         |         |                        |         |                |         |                         |         |                        |         |
| < 7                          | 1                       |         | 1                      |         | 1              |         | 1                       |         | 1                      |         |
| ≥ 7                          | 2.3 (1.7, 3.1)          | < 0.005 | 1.9 (1.5, 2.7)         | < 0.005 | 2.5 (1.2, 4.8) | 0.010   | 2.3 (1.5, 3.4)          | < 0.005 | 2.8 (1.4, 5.4)         | 0.002   |
| Retinopathy                  |                         |         |                        |         |                |         |                         |         |                        |         |
| No                           | 1                       |         | 1                      |         | 1              |         | 1                       |         | 1                      |         |
| Yes                          |                         |         |                        |         | 1.9 (1.1, 3.4) | 0.037   | 2.4 (1.6, 3.5)          | < 0.005 |                        |         |
| Hypertension                 |                         |         |                        |         |                |         |                         |         |                        |         |
| No                           | 1                       |         | 1                      |         | 1              |         | 1                       |         | 1                      |         |
| Yes                          |                         |         |                        |         | 2.0 (1.1, 3.6) | 0.017   | 2.0 (1.1, 3.6)          | 0.017   |                        |         |

\*The only variable that was associated with trigger finger is duration of diabetes (OR [95% CI] is 1.9 [1.1, 3.3] and P-value = 0.036 [≥ 7 vs. < 7 years]).

in the same patient were seen infrequently and having all components together was an extremely rare finding. Such findings were not different from what has been observed in previous reports. In Gamsted *et al.*,<sup>4</sup> they reported more than one abnormality in 26% of diabetic patients. Similar findings were reported by Yosipovitch *et al.*<sup>19</sup> who found 27% of diabetic patients to have one or more hand abnormalities. Ravindran *et al.*<sup>18</sup> reported that one hand change was found in 38.8% and two hand changes in 22.3% of their patients with T2DM.

In our study, LJM was found in 63.1% followed by DC seen in 18.6% of patients. Trigger finger, thick skin and CTS were found in 7.2%, 6.2% and 5.5% of patients, respectively. Prior studies reported variable prevalence rates of LJM ranging between 8% and 76%.<sup>1,11,21,23,25,26</sup> The prevalence rate of DC ranged between 2.26% and 42%.<sup>1,2,18,27-29</sup> and the prevalence rate of CTS ranged between 0.32% and 20%.<sup>1,2,4,22</sup> Flexor tenosynovitis (trigger finger) prevalence rate was reported between 2.58% and 40%.<sup>1,2,4,22,28,30,31</sup> and diabetic sclerodactyly in type I diabetes mellitus prevalence rate was reported between 17% and 51%.<sup>32,33</sup>

The relationship between microvascular complications and hand disorders in DM is not fully understood. Although they may share the same etiological mechanisms, they might serve as independent markers of each other. Exploring such assumptions is hampered by multiple factors, including: gender, age, disease duration, long-term glycemic control and other comorbidities. Tight glycemic control is linked to reduced microvascular complications in DM.<sup>34</sup> Some reports demonstrated a link between long-term hyperglycemia and various diabetic hand changes,<sup>13,19</sup> while other reports failed to demonstrate such associations.<sup>4,24,35,36</sup> In our report, HgA1c was not found to be linked to any of the hand disorders, similar to other reports.<sup>2,6,18,23</sup> This is conceivable since a single or a mean HgA1c over a short period of time does not reflect long-term glycemic control.

Microvascular complications such as retinopathy were significantly associated with increased odds of thick skin, DC and CTS. This most likely reflects the effects of long-term hyperglycemia. We also observed an association between DC and hypertension. The reason for this is not obvious. Previous studies have shown significant correlation between various hand abnormalities and microvascular complications,<sup>6,13,18,21,27,35,37</sup> while others failed to confirm such associations.<sup>4,36</sup>

There are some important limitations to our study. First, we relied on clinical rather than electrodiagnostic

criteria to diagnose CTS. However, patients with symptoms suggestive of diabetic neuropathy in the lower limbs were excluded from the diagnosis of CTS. Thus the presence of clinical manifestations suggestive of CTS is unlikely to be secondary to diabetic peripheral neuropathy. Second, having a specialized diabetes nurse, not rheumatologist, evaluating the hand complications is another limitation of this study.

## CONCLUSION

In the present study, musculoskeletal hand disorders were prevalent in T2DM patients in Jordan. Limited joint mobility was the most frequently seen complication. One or more disorders were significantly associated with female gender, age, duration of diabetes, retinopathy and hypertension and could serve as a marker for microangiopathic complications.

## CONFLICTS OF INTEREST

None.

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