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Comparison of Sonographic Evaluation of the Median Nerve and Fourth Flexor Tendon Between Asymptomatic Subjects With and Without Diabetes

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Diabetes mellitus (DM) is a common metabolic disease associated with carpal tunnel syndrome (CTS) and tendinopathy. This study aimed to assess the ultrasonographic (US) parameters of the flexor tendon and median nerve in asymptomatic subjects with diabetes in comparison with controls without diabetes. In this study, 22 DM and 22 non-DM subjects with no symptoms or manipulations in non-dominant hands and wrists were assessed. Ultrasound evaluations of the length, width, cross-sectional area, and circumference of the fourth flexor tendon and the median nerve were performed in the two groups. There was no statistically significant difference in age (*P* value= 0.473), gender (*P* value= 0.364), or wrist circumference (*P* value= 0.1921) between the groups. This study showed no significant difference between the two groups in median nerve length (*P* value= 0.35), width (*P* value= 0.17), cross-sectional circumference (*P* value= 0.23), or cross-sectional area (*P* value= 0.16). Also, a comparison of the sonographic data of the fourth flexor tendon between the two groups presented no significant difference in length (*P* value = 0.68), width (*P* value= 0.80), cross-sectional circumference (*P* value= 0.70), or cross-sectional area (*P* value= 0.80). In conclusion, data from the present study showed that sonographic values of the median nerve and fourth flexor tendon in asymptomatic subjects with DM did not differ significantly with those of non-diabetics. These findings demonstrate that still more case studies and more evaluations are required to validate the applicability of ultrasonography in the prediction of carpal tunnel syndrome and tendinopathy in diabetic patients.
Keywords: diabetes mellitus; carpal tunnel syndrome; tendinopathy; ultrasonography

Introduction

Diabetes mellitus (DM) is a chronic metabolic disease [1] with two common types. It is a common, serious, and costly public health problem worldwide [2] and causes chronic damage to many organs and systems [3]; one of these complications occurs in the musculoskeletal system and can cause pain, dysfunction, and disability in both types of diabetes [2, 4, 5]. The conditions include adhesive capsulitis of the shoulder, limited joint mobility (diabetic hand syndrome or cheiropathy), tendinopathy, Dupuytren's contracture, Charcot's foot, carpal tunnel syndrome (CTS), osteoarthritis, and other rare complications [2].

CTS is usually related to compression of the median nerve within the carpal canal [6]. This compression mononeuropathy is characterized clinically by numbness, tingling, and/or pain in the part of the hand innervated by the median nerve, and thenar atrophy and weakness in severe cases, which typically worsens at night [1, 6, 7].

The diagnosis of CTS is usually clinical and is documented by electromyography (EMG) [8–10]. Electrophysiologic studies have been considered the "gold standard" in diagnosing CTS [10]. Several recently published studies, however, have suggested that ultrasonography (US) is a useful, reliable, and cost-effective method in the diagnosis of CTS. It can reveal median nerve enlargement at the proximal wrist, median nerve compression during stress testing, and muscle intrusion during hand motion (digit flexion or extension) that compresses the median nerve [7, 10].

Stenosing flexor tenosynovitis, or trigger finger of the thumb and fingers, is a common cause of hand pain [11–14]. It seems to be caused by the thickening and narrowing of annular pulleys or tendon abnormalities which result in pain, clicking, snapping, or locking of the affected finger. A diagnosis of trigger finger is based on symptoms and physical examination [12, 13]. Ultrasound imaging is commonly used for the clinical diagnosis of trigger finger severity [11]. Changes in the cross-sectional area of flexor tendons of the hand may precede clinical tendinopathy in diabetic patients.

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Early detection of CTS, before the occurrence of neural deficit and motor weakness, is very important, because inattention to CTS, which is prevalent in diabetic patients, causes occupational disability with the loss of hand function, resulting in high economic costs [1]. Even though a CTS diagnosis is feasible using clinical features and electromyography-nerve conduction velocity (EMG-NCV) [10], it is a time-consuming, costly, and painful diagnosing method and is not available everywhere.

This study aimed to compare the sonographic indexes of the flexor tendon and the median nerve between asymptomatic subjects with and without DM to indicate whether it is possible to use sonographic indexes for the prediction of CTS or hand flexor tendinopathy in diabetic patients before the appearance of clinical findings.

Materials and Methods

This prospective, case-control study involved 22 diabetic patients as subjects and 22 non-diabetic individuals as controls with no articular or peri-articular clinical symptoms.

There were 5 patients with DM type 1 and 17 patients with DM type 2 in the diabetic group. The study exclusion criteria were as follows: (1) any prior manipulations (surgery, trauma, injection) on either the tendon flexor of the fourth finger or median nerve sheet; (2) anatomical abnormality; (3) neurologic symptoms (paraesthesia, neuropathy) in hands; (4) pregnancy; or (5) any other condition known to be related to CTS. For this purpose, all participants underwent a full clinical examination, including Tinel's sign and Phalen's test, and were questioned about symptoms of CTS.

Ultrasonography was performed for all participants by two experienced rheumatologists trained in musculoskeletal ultrasonography, and the results of ultrasonographic examination were taken from the rheumatologists' total comments. Examinations were performed with an 18-MHz linear array transducer (Supersonic Imagine Company, Aixplorer model), and transverse images of the median nerve were obtained.

The participants were divided into two groups, and the larger diameter (length), shorter diameter (width), cross-section circumference (centimeters), and cross-section area (square centimeters) of the median nerve at the carpal tunnel and fourth flexor tendon at the metacarpophalangeal joint in the non-predominant hand were evaluated. The general characteristics such as age, gender, and BMI of all patients were recorded to determine the study results. A p-value of less than 0.05 was considered statistically significant. SPSS version 21 was used in the performance of all statistical analyses.

For the analysis of data, based on the results of the normality test of variables (Kolmogorov-Smirnov test), the T-test or Mann-Whitney U test was applied to compare differences between the two independent groups.

In this study, all participants signed an informed consent form before the beginning of the study. The research was approved by the Iran University of Medical Sciences Ethics Committee. Ultrasonography was performed as a non-invasive modality, and it did not result in any physical or mental complications. Furthermore, no payment was forced, and personal information was kept confidential.

Results

Twenty-two diabetic patients were recruited from the endocrinology clinic of Rasool-Akram Hospital together with 22 healthy controls. The mean ages of the diabetic patients and controls were 46.77 ±16.4 and 43.27 ±15.6, respectively (*P* value= 0.473). The female-to-male ratios in diabetic patients and controls were 12/10 and 10/12, respectively (*P* value= 0.364). Therefore, no statistically significant differences in demographic features (age, gender) between the two groups were found. Furthermore, wrist circumferences at the level of proximal crease were found to be 17.23 ± 1.3 versus 16.73 ±1.2 in diabetic patients and healthy controls, respectively (*P* value= 0.192); this value was also not significant in differences between two groups. Nonetheless, there was a statistically significant difference between the BMI of diabetic patients (31.6 ± 5.8) and that of the controls (26.86 ± 6.6) (*P* value= 0.002). Ultrasonography was done in the non-dominant hands; 22 wrists and 22 tendons were evaluated in each group. Comparison results for the sonographic measurements of the median nerve and flexor tendon of the fourth finger along with the probability values are summarized in Table 1.

There was no significant difference between the two groups in cross-sectional length (*P* value= 0.35), width (*P* value= 0.17), circumference (*P* value= 0.23), or area (*P* value= 0.16) of the median nerve (Fig. 1a-d). Similarly, the comparison of sonographic data for the fourth flexor tendon between diabetics and non-diabetics showed no significant differences in length (*P* value= 0.68), width (*P* value= 0.80), cross-sectional circumference (*P* value= 0.7), or cross-sectional area (*P* value= 0.80) (Fig. 2a-d).

Table 1. Analysis of demographic features and the ultrasonographic characteristics of the median nerve and the flexor tendon of the 4th finger between diabetic patients and healthy controls

Characteristic	Healthy Controls	Diabetic Patients	*P* value
Age	43.3 ± 15.62	46.8 ± 16.46	0.473
Gender (M/F)	12/10	10/12	0.364
BMI [a]	26.86 ± 3.63	31.66 ± 5.86	0.002
Median Length [b]	0.496 ± 0.09	0.52 ± 0.1	0.350
Median Area [c]	0.074 ±0.02	0.086 ± 0.03	0.160
Median Width [b]	0.186 ± 0.05	0.2 ± 0.05	0.170
Median Circumference [b]	1.13 ± 0.2	1.2 ± 0.19	0.230
Flexor Width [b]	0.37 ± 0.05	0.37 ± 0.06	0.812
Flexor Length [b]	0.61 ± 0.08	0.63 ± 0.11	0.680
Flexor Area [c]	0.18 ± 0.04	0.19 ± 0.05	0.810
Flexor Circumference [b]	1.58 ± 0.18	1.56 ± 0.26	0.705

M: Male; F: Female; BMI: Body Mass Index , [a] In Kg/m^2 , [b] In cm ,[c] In cm^2

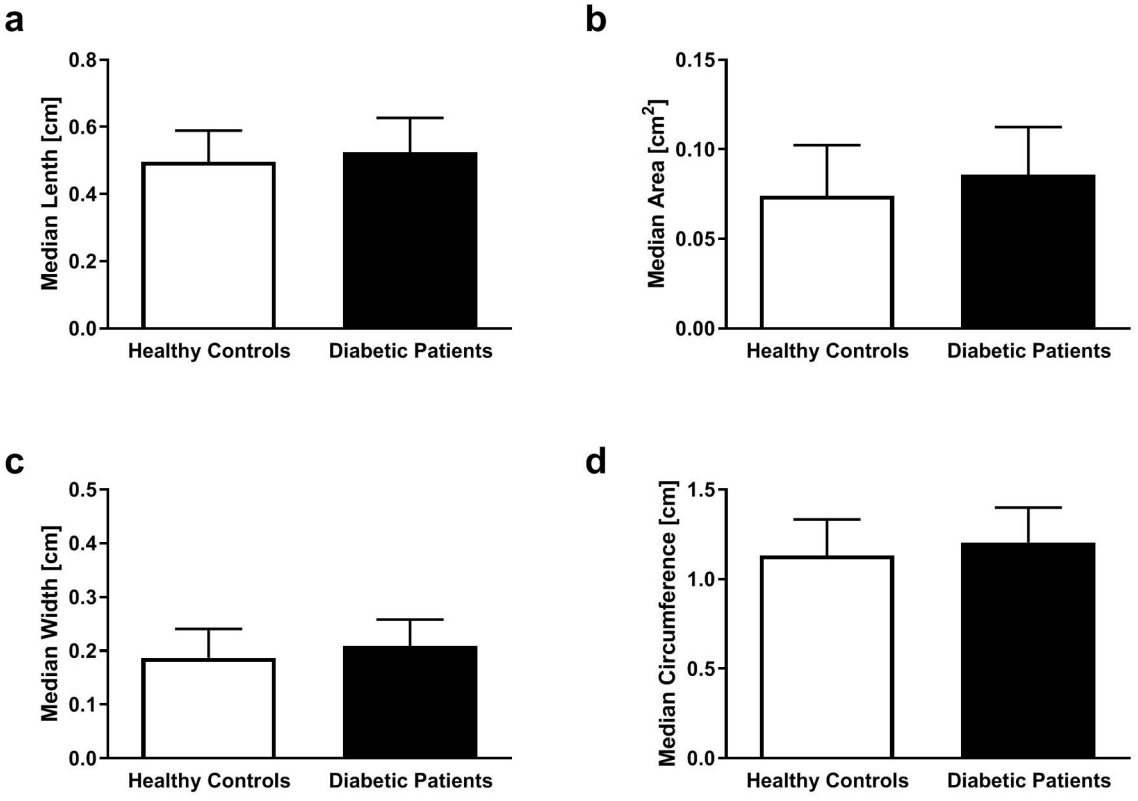

Figure 1. Comparison of the median nerve parameters between diabetic patients and healthy controls, including length (a), area (b), width (c), and circumference (d) (n=22 for each group).

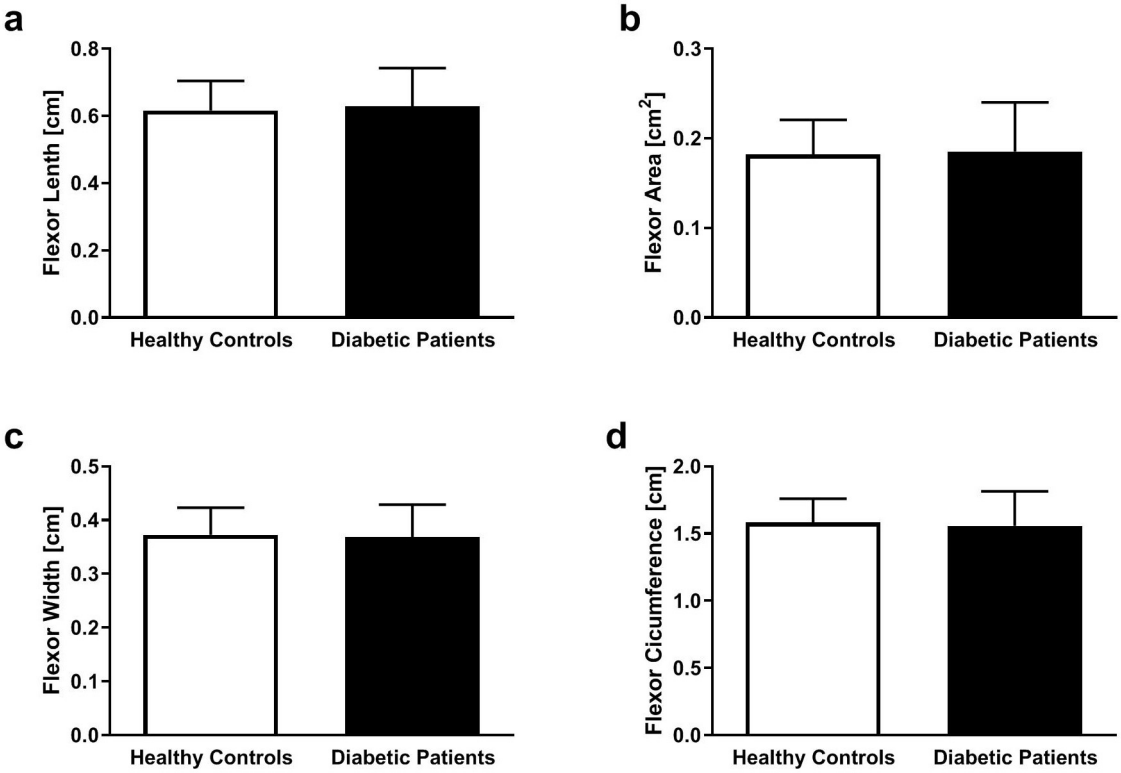

Figure 2. Comparison of the fourth flexor tendon parameters between diabetic patients and healthy controls, including length (a), area (b), width (c), and circumference (d) (n=22 for each group).

Discussion

The present study aimed to find whether it is possible to predict CTS or flexor tendinopathy in the hands of diabetic patients before the appearance of clinical findings. As the results showed, the demographic factors of age and gender and the wrist circumference were not statistically different between the two study groups. The present study showed that there were no significant differences in the length, width, circumference, or area of the median nerve between diabetic patients and healthy controls. Similarly, no significant difference was found between the two groups in indices of the fourth flexor tendon. No similar study was found that analyzed sonographic parameters of the median nerve in asymptomatic participants and then compared the results between diabetics and non-diabetics; however, some previous studies have reported that the median nerve cross-sectional area (CSA) was significantly larger in diabetic patients with CTS than in patients with idiopathic CTS [15].

Also, some articles reported no significant difference between patients with idiopathic CTS and patients with CTS and DM. For example, Tasi et al. showed that the median nerve CSA at the outlet was significantly larger in CTS patients compared to normal hands, yet they found no difference between the diabetic and non-diabetic groups [16]. In another study, Kim et al. supported Tasi's article and reported no difference between diabetic and non-diabetic CTS patients [17].

Some articles, however, reported the usefulness of US in diagnosing CTS [18–22]. Visser et al. [23] and Wong et al. [24] showed that the accuracy of sonography in patients with a clinical diagnosis of CTS is similar to that of EMG. Salman Roghani et al. [25] highlighted the complementary role of ultrasonography in diagnosing CTS in conjunction with NCV in patients with clinical CTS and negative NCV. Some authors indicated that sonography is a preferable alternative to EMG/NCV for diagnosing neuropathy of the median nerve and CTS in patients [10, 23, 24, 26–28]. Some studies even introduced US as the first-line confirmatory test for measuring the median nerve area [18, 29]. Some articles have shown the relationship between US measurements of the median nerve and EMG/NCV or clinical severity in CTS. Karadağ et al. reported that US can give additional information about the severity of median nerve involvement and introduced US as a cost-effective

modality in patients with suspected CTS, which reduced the number of NCV [30]. Nkrumah et al. showed CSA findings in US were able to predict the severity of CTS in certain patients and influenced the decision to proceed with surgery [31].

Ultrasound measurements of the median nerve, especially in the cross-sectional area of the median nerve in the wrist, could be used as complementary data to diagnose CTS and determine its severity in the clinical context [32]. The usefulness of sonography in monitoring CTS has been investigated by many authors [33, 34]. Takahashi et al. suggested that sonographic evaluation of wrist tissue thickness is a useful method to assess subclinical CTS in patients receiving long-term haemodialysis [35]. Witt et al. showed that NCV did not predict the outcome of conservative management in CTS patients, and US may be a useful and cost-effective method for monitoring CTS patients undergoing non-surgical treatments, especially those with suspected CTS and fewer clinical criteria for diagnosis [36].

In the same field, Abate et al. used US to evaluate the shoulder in asymptomatic elderly diabetics and showed that tendon thickness (supraspinatus tendon and biceps tendon) was significantly greater in diabetics than in non-diabetics. They indicated that ultrasound is a useful modality for the detection of degenerative changes in the rotator cuff tendon in subjects in the early stages [37]. In another study, Abate et al. compared the morphologic characteristics of the Achilles tendon in diabetics with those in subjects without diabetes. They reported that asymptomatic sonographic abnormalities (ASA) were significantly increased in the diabetic group [38]. They also studied the thickness of the plantar fascia and Achilles tendon with US and reported that the thickness of both was increased in the early stages of type II diabetes; they found BMI to be more related to plantar fascia than Achilles tendon thickness [39]. De jonge et al. also used US to study the Achilles tendon of people with type 2 diabetes. They reported poorer US Achilles tendon structure in diabetic patients, and that may be a risk factor for tendinopathy [40]. Akturk et al. reported the same results, as they observed increased Achilles tendon thickness (ATT) in type 2 female diabetic patients [41].

The current study can help other investigators re-evaluate sonographic parameters in the median nerve and flexor tendons for the early detection of CTS and trigger finger to improve management and avoid progression to severe stages. It is suggested that more studies be conducted that compare diabetic and non-diabetic asymptomatic subjects by sonographic evaluation of the median nerve at proximal and distal of carpal tunnel. This comparison can also be performed on other flexor tendons for the early detection of tendinopathy.

Conclusion

Ultrasound measurements of the median nerve and the fourth flexor tendon of the hand were not significantly different in asymptomatic diabetic patients compared with the healthy controls. It is suggested that another study be conducted in a larger group of asymptomatic diabetic patients and with a long follow-up period to find a point which could lead to the prediction of future CTS or tendinopathy in diabetics.

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Conflict of Interest

The authors declare no conflicts of interest.

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