Prevalence of Carpal Tunnel Syndrome in Diabetic Patients with and without Metabolic Syndrome

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Abstract: *Background and Objectives*: Carpal tunnel syndrome (CTS) is defined as the impaction of the median nerve in the carpal tunnel of the wrist. Metabolic disorders are closely associated with CTS; and metabolic syndrome (MS) is found to be more in patients with CTS. Metabolic syndrome is highly prevalent in patients with type 2 diabetes. This study was conducted to determine the prevalence of CTS in diabetic patients with and without metabolic syndrome.

Material and Methods: In this cross-sectional study, 439 diabetic patients that participated in the study of risk factors for coronary artery disease in Kerman (KERCADRS) were enrolled. People with positive clinical symptoms for CTS and a positive Boston questionnaire, were referred to a neurologist for further diagnosis. For the diagnosis of metabolic syndrome, three criteria (ATPIII, IDF and new criteria in Kerman) were used. Also, electro-diagnostic tests were used for the diagnosis of CTS. Data were analyzed by independent t-test and chi square test in SPSS20.

Results: The prevalence of CTS in diabetic patients was 24.23%. The prevalence of the disorder in male and female patients was 16.21% and 30.65%, respectively. The results showed that there is no significant difference in the prevalence of CTS in diabetic people with and without metabolic syndrome, in overall as well as sex subgroups.

Discussion and Conclusion: The higher prevalence of CTS in diabetic patients in this study compared to other studies shows the lack of prevention and case finding in diabetic patients. Therefore, screening, educating and informing at risk people about the disease is necessary.

Keywords: Prevalence, Carpal Tunnel Syndrome, Metabolic Syndrome, Diabetes.

INTRODUCTION

Carpal Tunnel Syndrome (CTS) is defined as the impaction of the median nerve in the carpal tunnel of the wrist and is the most common entrapment that affects upper limbs. The onset of the disease usually starts by tingling and numbness or pain in the median nerve area and eventually leads to weakness and impaired hand function [1]. The signs usually appear gradually [2].

The prevalence of CTS varies in different countries [3]. The disease usually occurs in 30-60 years old and is more prevalent in females. The female to male ratio for prevalence of the disease varies from 3.1 to 10.1. Studies show that 14.4% of people have clinical symptoms of CTS and 2.7% of the general population is affected by this syndrome in terms of clinical and electro-diagnostic tests. The prevalence of this syndrome in diabetic patients varies from 14% in patients without neuropathy to 30% in patients with neuropathy. Currently, there is no precise information regarding the prevalence of this syndrome in Iran [1, 4].

In order to diagnosis the disease, clinical history and physical examination, two-point discrimination test, Weinstein test and other preclinical tests are used, but, the best method for diagnosis, determining severity, and ruling out other causes with similar symptoms is the electro-diagnostic tests [5]. Currently, electro-diagnostic tests are considered as the gold standard for the diagnosis of suspected cases of carpal tunnel syndrome [6].

So far, researchers have identified several factors that may cause or contribute to the development of CTS. These factors include working conditions, such as the frequent use of hand; and health conditions including non-inflammatory synovial fibrosis, diabetes, metabolic syndrome, pregnancy, menopause and rheumatoid arthritis as well as personal factors such as obesity, female sex, heredity, age, smoking and alcohol. But already, the general agreement is that the main cause of CTS is unknown [5].

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Metabolic disorders are closely associated with CTS. Metabolic syndrome is characterized by abdominal obesity, high blood pressure, elevated blood sugar and blood fats and is often associated with the presence of carpal tunnel syndrome. The incidence of metabolic syndrome is more in patients with CTS, and CTS in patients with metabolic syndrome is more severe [2, 7].

Different definitions of metabolic syndrome have been proposed and are currently used [8]. There are no single accepted criteria for the diagnosis of the syndrome. Currently, most studies use the Adult Treatment Panel criteria (ATPIII) to identify subjects with metabolic syndrome [9]. The International Diabetes Federation (IDF) presented a definition for diagnosing people with metabolic syndrome that is applicable for different ethnic populations [10].

The metabolic syndrome is highly prevalent in patients with type 2 diabetes [11]. In Iran, the prevalence of this syndrome in diabetic patients according to ATPIII and IDF criteria were 73.1% and 69.4%, respectively [12]. According to a study in UK, the prevalence of the syndrome among diabetics was 91.70% and 87.60% in males and 94.80% and 94.20% in females based on ATPIII and IDF criteria respectively [13].

As diabetic patients and people with metabolic syndrome are at risk for CTS, this study aimed to determine the prevalence of the disease in diabetic patients with and without metabolic syndrome and by different diagnostic criteria.

MATERIAL AND METHODS

In this cross-sectional study, 439 diabetic patients that participated in the study of risk factors for coronary artery disease in Kerman were enrolled. In this study data was gathered in Kerman city and its suburbsin 2013. We called diabetic patients (439) from the Physiology Research Center in Kerman and those with positive symptoms of carpal tunnel syndrome (including numbness, burning, tingling in the fingers and palm of the hand, wrist pain, hand and forearm pain, decreased grip strength, weakness in the thumb, and positive Boston's questionnaire) (138) were referred to a neurologist for further diagnosis in the Neurology Research Center in Kerman. In this study, any neurological disease which could affect the median nerve, such as uremic neuropathy or any fracture which can lead to deformity or denervation, as well as patients with obvious neuropathy or a diagnosis of this disease during electro-diagnostic tests, were excluded.

Demographic and basic metabolic information (BMI, systolic blood pressure, diastolic blood pressure, cardiovascular disease, fasting blood sugar, cholesterol, HDL, LDL) as well as information related to the diagnosis of metabolic syndrome, was obtained from the study of risk factors for coronary artery disease in Kerman [14]. Measurement of the median nerve indications (median nervemotor distal latency, median nerve motor amplitude, median nervemotor conduction velocity, median nerve sensory onset latency, median nerve sensory amplitude, median nerve sensory conduction velocity) and wrist dimensions was measured by a neurologist.

For the diagnosis of metabolic syndrome, the three criteria ATPIII [15], IDF [16] and new criteria in Kerman [17] were used (Table **1**).

To diagnose CTS, an electro-diagnostic test using EMG neon made in Japan was used. This test was performed at 32-34°C on skin surface and at room temperature. The test was conducted as following: The receiving location of median nerve's motor potential was the Abductor Pollicis Brevis muscle and the stimulation location of the median nerve was located in the wrist and with 6.5 cm distance from the location of the receiving stimulation. The position for assessing the sensory stimulation of median nerve was the wrist horizontal creases, and the receiving location for the sensory potential was the proximal of the index finger, located at 13 cm of the stimulation receiving place. Table **2** shows the classification of disease severity.

Inclusion criteria to study included: diabetic patients with positive symptoms of carpal tunnel syndrome and exclusion criteria was a neurological disease that affects the median nerve, included Uremic neuropathy or nerve injury leading to deformity or denervation, as well as patients who had obvious neuropathy.

Also the dimensions of the wrist were measured by using a calipers with 1mm measurement accuracy. Anterior-posterior size and the median lateral size of the wrist are defined as AP and ML, respectively. We can obtain the dimension of the wrist by dividing AP to ML and its normal measure is considered as 0.7 and less.

Data were analyzed by independent t-test and chi square test in SPSS20.

Table 1: Diagnosis of Metabolic Syndrome as Per Different Criteria

ATPIII	IDF	NEW
Presence of ≥3 of the following: (*i*) Waist circumference (>90 cm in men, >80 cm in women) (*ii*) SBP ≥130 mmHg and/or DBP ≥85 mmHg or medical treatment of previously diagnosed hypertension (*iii*) TG≥150 mg/dl (*iv*) HDL-C <40 mg/dl in men, <50 mg/dl in women (*v*) Fasting glucose >110 mg/d	Presence of central obesity with waist circumference >90 cm (men) and >80 cm (women) plus any 2 of the following: (*i*) TG >150 mg/dl or specific treatment for this lipid abnormality (*ii*) HDL-C <40 mg/dl (men), <50 mg/dl (women) or specific treatment for this lipid abnormality (*iii*) SBP >130 mmHg and/or DBP >85 mmHg or medical treatment for previously diagnosed hypertension (*iv*) Fasting plasma glucose (>100 mg/dl) or previously diagnosed type 2 diabetes	Presence of central obesity with waist circumference >86 cm (men) and >83 cm (women) plus any 2 of the following: (*i*) TG >150 mg/dl or specific treatment for this lipid abnormality (*ii*) HDL-C <40 mg/dl (men), <50 mg/dl (women) or specific treatment for this lipid abnormality (*iii*) SBP >130 mmHg and/or DBP >85 mmHg or medical treatment for previously diagnosed hypertension (*iv*) Fasting plasma glucose (>100 mg/dl) or previously diagnosed type 2 diabetes

ATPIII: Adult Treatment Panel III, IDF: International diabetes federation, NEW: New criteria for Kerman.

Table 2: Neurophysiological Classification of CTS

Extreme CTS	Absence of median motor and sensory responses
Severe CTS	Absence of sensory response, abnormal distal motor latency
Moderate CTS	Abnormal Distal sensory latency, abnormal distal motor latency
Mild CTS	Abnormal Distal sensory latency, normal distal motor latency

RESULTS

Among 439 Patients with type 2 diabetes, 224 subjects (55.6%) were female and 196 subjects (44.4%) were male. The mean age of the participants was 56.12±11.25 (54.70±10.41 for females and 57.70±12.06 for males). Among the participants, 138 subjects had clinical signs of CTS, but only 105 subjects visited the neurologist. Based on electrophysiological findings, 81 subjects had CTS. Table **3** shows the demographic and initial metabolic information in patients with and without clinical signs. There was a significant difference between sex and systolic blood pressure in patients with and without clinical signs of CTS, but there is no significant difference in other variables in these patients. Also a significant difference was observed in the age and dimension of right hand wrist variables in true patients (patients with positive electro-diagnostic tests) and healthy people (based on electro-diagnosis tests), but there was no significant differences in other variables (Table **4**).

The prevalence of CTS in diabetic patients was 24.23%. The prevalence of the disorder in male and female patients was 16.21% and 30.65%, respectively.

The prevalence of the disease in patients with and without metabolic syndrome was estimated based on the 3 diagnostic criteria for all subjects and sex subgroups. The results showed that there is no significant difference in the prevalence of carpal tunnel syndrome in people with and without metabolic syndrome, according to the 3 criteria as well as sex subgroups (Table **5**).

Table **6** shows the prevalence of CTS according to different criteria. In all groups the prevalence of carpal tunnel syndrome in patients with metabolic syndrome was more than patients without metabolic syndrome, but these differences were not significant in any group.

The frequency of carpal tunnel syndrome based on disease severity, left and right hand, and the 3 different diagnostic criteria of metabolic syndrome, was calculated. There was no significant difference in disease severity in patients with and without metabolic syndrome based on the 3 criteria in each hand.

DISCUSSION

In this study, the prevalence of carpal tunnel syndrome in diabetic patients was 24.23%. According to a study by Perkins *et al*. in Toronto General Hospital

Table 3: The Frequency of Study Variables in 439 Diabetic Patients

	Those with signs of CTS	Those without signs of CTS	P-Value
Age (years)	55.31 (9.27)	56.50 (10.24)	0.30
Male (frequency)	41.00 (29.70)	154.00 (51.20)	0.001*
Duration of diabetes (months)	64.84 (55.45)	68.00 (60.46)	0.72
Weight (kg)	72.69 (14.02)	74.33 (13.72)	0.25
BMI (kg/m^2)	28.01 (5.46)	27.54 (4.57)	0.36
Systolic Blood pressure (mmHg)	126.03 (20.94)	130.55 (20.26)	0.03*
Diastolic Blood pressure (mmHg)	80.85 (10.50)	81.95 (10.04)	0.29
Cardio-vascular disease	35.00 (25.43)	63.00 (20.90)	0.30
Fasting Blood Sugar (mg/dl)	168.58 (73.75)	158.60 (62.20)	0.114
Cholesterol (mg/dl)	209.21 (55.02)	201.83 (47.73)	0.155
TG (mg/dl)	199.11 (136.37)	184.83 (117.75)	0.27
HDL (mg/dl)	36.97 (11.02)	37.22 (17.29)	0.88
LDL (mg/dl)	134.46 (42.74)	128.23 (37.73)	0.125
ATPIII	97.00 (70.30)	216.00 (71.80)	0.75
IDF	94.00 (68.10)	188.00 (62.50)	0.25
NEW	103.00 (74.60)	222.00 (73.80)	0.84

Qualitative variables are mentioned as frequency (percent) and Quantitative variables are reported as mean (standard deviation).

Table 4: The Frequency of Study Variables in 105 Paients Reffered to Neurologist

	Those affected by CTS	Those without CTS	P-VALUE
Age (years)	59.13(8.79)	52.29 (10.24)	0.004*
Male (percent)	22 (27.20)	6 (25)	0.83
Duration of diabetes (months)	94.41(72/79)	71.00(58.45)	0.156
Previous history of wrist fraction	4(3.70)	0	0.999
Dimensions of the right hand's wrist (ratio)	0.68(0.05)	0.66(0.04)	0.039*
Dimensions of the left hand's wrist (ratio)	0.70 (0.11)	0.67(0.04)	0.067
Weight (kg)	75.27 (14.73)	75.02(13.61)	0.94
BMI (kg/m^2)	29.17 (5.88)	29.14 (4.83)	0.98
Systolic Blood pressure (mmHg)	131.01 (17.84)	122.71 (21.78)	0.063
Diastolic Blood pressure (mmHg)	81.63 (10.11)	80.83 (11.74)	0.719
Cardio-vascular disease	24 (29.60)	4 (16.70)	0.214
Fasting Blood Sugar (mg/dl)	185.86(79.08)	151.71(54.53)	0.056
Cholesterol (mg/dl)	209.38 (49.40)	206.25 (45.15)	0.78
TG (mg/dl)	194.23(100.96)	189.21(91.94)	0.83
HDL(mg/dl)	37.25 (9.46)	35.45 (7.60)	0.39
LDL (mg/dl)	136.93(44.94)	135.26(39.96)	0.86
ATPIII	68 (84)	19 (79.20)	0.69
IDF	58 (71.60)	20 (83.30)	0.24
NEW	61(75.30)	19(79.20)	0.58

Qualitative variables are mentioned as frequency (percent) and Quantitative variables are reported as mean (standard deviation).

Table 5: The Prevalence of Carpal Tunnel Syndrome in People with and without Metabolic Syndrome Based on the 3 Criteria with Sex Subgroups

	in females	P-value	in males	P-value	Overall prevalence	P-value
ATPIII Criteria						
with MS	30.95	0.776	14.71	0.341	24.43	0.845
without MS	29.30		19.27		23.70	
IDF Criteria						
with MS	30.84	0.883	15.07	0.636	25.70	0.251
without MS	32.38		17.21		21.57	
New Criteria						
with MS	30.66	0.992	15.19	0.488	23.89	0.752
without MS	30.61		18.61		25.05	

Table 6: The Prevalence of Carpal Tunnel Syndrome in Patients with and without Metabolic Syndrome Based on Combination of Two and all Criteria

Criteria	ATPIII*IDF	ATPIII*NEW	IDF*NEW	ATPIII*IDF*NEW
With metabolic syndrome	24.68	24.42	24.28	24.37
Without metabolic syndrome	22.38	23.30	24.09	23.56

from June 1998 to August 1999the prevalence of metabolic syndrome in diabetics without polyneuropathy was 14% [18]. In other studies, the prevalence of this syndrome was reported 20% in diabetic patients [19]. In the present study the prevalence of metabolic syndrome was higher than these studies. This fact might show the worse situation of diabetic patients in our study, not diagnosing the disease in early stages or faster disease progression in our population.

The prevalence of carpal tunnel syndrome in the general population is about 2.7 percent [2, 20]. It has been mentioned in other references that the prevalence of carpal tunnel syndrome in diabetic patients is much higher than the general population and indicates that diabetic patients are at a higher risk for developing carpal tunnel syndrome. Other studies also confirm that diabetes is a risk factor for carpal tunnel syndrome [4, 5, 21, 22].

In the present study, the prevalence of carpal tunnel syndrome in diabetic men was 16.21 percent and in diabetic women was 30.65 percent. The results showed that there is significant difference in the prevalence of carpal tunnel syndrome in men and women. According to studies conducted in the general population, the prevalence of carpal tunnel syndrome in women is much higher than men, and women are 3 to 10 times more susceptible to acquiring carpal tunnel syndrome [1, 3, 6, 23]. This probably means that some sex-related risk factors might play a role in the pathogenesis of carpal tunnel syndrome.

A study done in Kerman city, showed females were 4 times more likely than males to acquire carpal tunnel syndrome [24].

Researchers have suggested that the higher incidence of carpal tunnel syndrome in females may have been caused by the specific anatomical structure of the wrist as well as the higher activity of the upper extremities in women [25].

Our results showed that there is no significant difference in the prevalence of carpal tunnel syndrome in people with and without metabolic syndrome. However even after extensive searching, we could not find any similar study to compare our results. However, studies on people with carpal tunnel syndrome done by Balci and Ander in Turkey show a higher frequency of metabolic syndrome among people with carpal tunnel syndrome [7, 26]. A large number of studies have shown that metabolic syndrome is a risk factor for carpal tunnel syndrome [6-8, 27-29]. But in the present

study no significant difference was seen between the prevalence of carpal tunnel syndrome in diabetic patients with and without metabolic syndrome. However, we cannot conclude that metabolic syndrome is not a risk factor for carpal tunnel syndrome, because the other studies about carpal tunnel syndrome and metabolic syndrome have been conducted in the general population, but the present study was conducted among a population of patients with type 2 diabetes whom a high percentage (nearly 70%) already had metabolic syndrome [30]. Therefore it is necessary to conduct more studies on nondiabetics, to be able to find more conclusive results.

The present study found that there is no significant difference in carpal tunnel syndrome severity in diabetic patients with and without metabolic syndrome. However, there is no perfect gold standard for carpal tunnel syndrome diagnosis. Some believe that the combination of electro diagnostic study findings and symptom characteristics will provide the most accurate information for classification of carpal tunnel syndrome [31]. In this study we also used a combination of clinical findings and electro diagnostic data to diagnose carpal tunnel syndrome.

There is limited information about the severity of the disease in people with and without metabolic syndrome in the general population; however few studies have shown more severity in people with metabolic syndrome [7, 26]. The fact that we did not observe significant differences in the severity of disease in the present study can be due to investigating this syndrome in diabetic patients, whereas, other studies have investigated the severity of the disease in non-diabetic people.

CONCLUSION

The present study shows that the prevalence of Carpal tunnel syndrome in people with type 2 diabetes is very high in Kerman. But there is no significant difference in the prevalence of carpal tunnel syndrome in diabetic patients with and without metabolic syndrome. Therefore more studies are needed in this field.

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CONFLICT OF INTEREST

None declared.

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