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The Prevalence and Patterns of Carpal Tunnel Syndrome and Their Associated Risk Factors Among Diabetic Population In South-West of Kingdom of Saudi Arabia

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ABSTRACT

Background: Carpal tunnel syndrome (CTS) is a constellation of symptoms and signs resulting from the local compression of the median nerve inside the carpal tunnel at the wrist. In advanced cases of CTS where the course is unnoticed, atrophy of the thenar muscles may occur, which can be irreversible.

Objective: The aim of the present study was to estimate prevalence and severity of CTS in patients with type 2 diabetes mellitus in South Western region of the Kingdom of Saudi Arabia (KSA) and to identify specific at risk groups within these populations by using nerve conduction study.

Methods: This cross-sectional study was conducted in Asir Central Hospital, Abha, KSA. The study randomly included all patients with type 2 diabetes mellitus with their place of birth and permanent residence being in Abha or Mohyel cities. History, physical examination, and laboratory data about fasting blood glucose, HbA1c, and lipid profile were collected. Additionally, nerve conduction study of both hands was performed.

Results: Out of 131 included subjects, 107 patients (81.7%) had CTS. Approximately one-third (35.1%) of the study subjects had unilateral CTS, and it affected both hands in 46.6% of them. In the majority of cases CTS was of very mild or mild severity (27.5% and 26.7% respectively). A significant association was found between gender, hypertension, hypothyroidism, ischemic heart disease and the development of CTS.

Conclusion: High prevalence of unilateral and bilateral CTS was found among patients with type 2 diabetes mellitus in South Western Saudi Arabia. Different grades of CTS were detected, but the severity of functional impairment was relatively mild. Development of CTS was associated with hypertension, ischemic heart disease, and hypothyroidism. Health care professionals should be aware of this high prevalence, and it will be useful to perform electrodiagnostic studies in diabetic patients in whom CTS is suspected.

Keywords: carpal tunnel syndrome; type 2 diabetes mellitus; electrodiagnostic study; prevalence; severity; risk factor; Saudi Arabia.

INTRODUCTION

Carpal tunnel syndrome (CTS) is a constellation of symptoms and signs resulting from the local compression of the median nerve inside the carpal tunnel at the wrist, which results in functional impairment and local ischemia of the nerve within the tunnel[(1)]. It is characterized clinically by the presence of sensory symptoms in the form of numbness, tingling, pain, and feeling of heaviness of one or both hands. Motor involvement and functional impairment of the hand functions can occur in more severe cases if the CTS release surgery is not done within reasonable time[(2)].

CTS diagnosis is based on characteristic symptoms and positive different provocative stress tests such as Phalen's test, Tinel's test, or hand elevation test on physical examination. It is confirmed by electrodiagnostic studies[(3)]. The prognosis and therapeutic measures are highly related to severity assessment of CTS using different nerve conduction studies[(4)]. The incidence rate of CTS ranges from 0.125% to 1%, and the prevalence rate is approximately 5% to 16% depending upon the criteria used for the diagnosis[(5)]. It is considered as an occupational disease with high prevalence rates among certain occupations[(6)]. The prevalence rate among adult general population ranges from2.7% to 5.8%[(7)]. Most cases of CTS are idiopathic, although the risk of its development appears partly to be associated with different local and systemic factors, including genetic, medical, social, vocational, and demographic, such as inflammatory diseases, for example, rheumatoid arthritis, and systemic conditions, such as diabetes mellitus, hypothyroidism, obesity, and pregnancy. Occupational risk factors in the form of repetitive, forceful flexion and extension of the wrist and fingers may also contribute to CTS symptoms[(8,9)].

In advanced cases of CTS, where the course is unnoticed, atrophy of the thenar muscles may occur and it can be irreversible[(1)]. Hence, the aim of the present study was to estimate prevalence and

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severity of CTS in high and low altitude populations with type 2 diabetes mellitus in South Western region of Saudi Arabia and to identify specific at risk groups within these populations by means of nerve conduction study.

METHODS

This cross-sectional study was conducted in Asir Central Hospital, Abha, KSA. The study randomly included all patients with type 2 diabetes mellitus (T2DM) with their place of birth and permanent residence being in Abha or Mohyel cities. Patients with type 1 diabetes mellitus were excluded. These cities constitute high and low altitude areas in South Western Saudi Arabia. Abha city is located at 2850-3000 m above sea level, whereas Mohyel city is located at relatively low altitude of 500 m above sea level[(10)]. Patients were interviewed at the outpatient clinic of the diabetic patients and after explanation of the study objectives and procedures a written consent was obtained from each of them.

The collected data included:

- Demographic characteristics: age, gender, place of birth and residence.
- Medical history and laboratory data: history of diabetes mellitus (type, duration, and management), fasting blood glucose, hemoglobin A1c (HbA1c) level and lipid profile.
- Physical examination: blood pressure, height, weight and body mass index (BMI).
- Nerve conduction study data: sensory conduction velocity (SCV), sensory nerve action potential (SNAP), compound muscle action potential (CMAP) and distal motor latency (DML).

Diagnosis of CTS and grading of its severity was done depending on nerve conduction study of both hands. Median-ulnar ring finger sensory study was performed by stimulation of the median and ulnar nerves at the wrist and antidromic sensory distal latencies recording the ring finger at an 11 to13 cm distance were compared. The difference in peak latencies of > .62 ms was considered as abnormal. This test is abnormal in 82% of the patients with CTS and was proposed to be more sensitive than other comparative studies[(11)]. Carpal tunnel syndrome was graded as follow: very mild [CTS detected only by palm wrist distal sensory latency difference (PWDSLD)]; mild [median DML<4.5 and SCV <40]; moderate [median DML>4.5 and <6.5 with preserved SNAP]; severe [median DML>4.5 and <6.5 with absent SNAP]; very severe [median DML>6.5 with CMAP>.2 mv][(4)].

Statistics: SPSS (Statistical Package for the Social Sciences) 20.0 software was used for statistical analysis. For categorical variables, frequencies and percentages were reported, and they were analyzed using Pearson Chi-Square tests (or Fisher's exact test for cells less than 5). Continuous data were not normally distributed, and they were expressed as medians and interquartile ranges (IQR) and analyzed using Mann-Whitney test. P values smaller than 0.05 were considered statistically significant.

The study was done after approval of ethical board of King Khalid university .

RESULTS

This study was conducted on 131 patient withT2DM, their ages ranged from 22 to 78 years with a median age of 60 (IQR=50-65). Males outnumbered females (63.4% versus 36.6% respectively). Most of the study population (75.6%) was residing in the high altitude Abha city. Only 7.6% of them were smokers. The past history of diseases, other than diabetes, was negative in 45.8% of participants, while 48 (36.6%) had hypertension as illustrated in **table 1**. Carpal tunnel syndrome was diagnosed in 107 patients with a prevalence rate of 81.70%.Unilateral CTS represented 35.10%, and it affected both hands in 46.60% of cases (**figure 1**). In the majority of cases CTS was very mild or mild (27.5% and 26.7% respectively), and it was of moderate severity in 17.6% of cases. Severe and very severe cases constituted only 5.3% and 4.6% respectively (**figure 2**).

Carpal tunnel syndrome was significantly higher among males compared to females (57.9% versus 42.1% respectively). A significant association was also detected between hypertension, hypothyroidism, ischemic heart disease and the development of CTS ($p<0.05$). On the other hand, neither age nor residence or smoking showed significant association with CTS ($p>0.05$) (**table 1**).

Patients with CTS had significantly higher median diastolic blood pressure compared to their counterparts (80 versus 79 respectively). Alternatively, no significant differences were detected between both groups as regards fasting blood glucose, HBA1c or the duration of diabetes. Moreover, the use of different antidiabetic drugs

whether oral tablets or insulin did not show an association with CTS (**table2**).

Comparison of lipid profile and body mass index in cases with and without carpal tunnel syndrome was demonstrated in **table 3**, patients with CTS had significantly lower median low density lipoprotein (LDL), high density lipoprotein (HDL) and serum triglycerides (TG) (LDL: 98 versus 117; HDL: 36.40 versus 42.50; TG: 140 versus 175) respectively. Median body mass index was higher among patients with CTS (31 versus 28) but this difference did not reach a significant level (p>0.05).

Table 1: Association between socio-demographic and co-morbid data and prevalence of carpal tunnel syndrome among the study population.

			Carpal tunnel syndrome			
			Yes N=107 (81.7%)	No N=24 (18.3%)	Total N=131 (100%)	P value
Age	Range		33.0-78.0	22.0-76.0	22.0-78.0	0.116
	Median		59	62	60	
	Interquartile range		50.0-64.0	60.0-65.0	50.0-65.0	
	Mean rank		63.54	76.96		
Sex	Male	N	62	21	83	0.007*
		%	57.9	87.50%	63.40%	
	Female	N	45	3	48	
		%	42.1	12.50%	36.60%	
Residence	High altitude	N	79	20	99	0.328
		%	73.8	83.30%	75.60%	
	Low altitude	N	28	4	32	
		%	26.2	16.70%	24.40%	
Smoking	Yes	N	7	3	10	0.39
		%	6.5	12.50%	7.60%	
	No	N	100	21	121	
		%	93.5	87.50%	92.40%	
Co-morbid	No	N	50	10	60	0.003*
		%	46.7	41.70%	45.80%	
	Hypertension	N	39	9	48	
		%	36.4	37.50%	36.60%	
	IHD	N	6	0	6	
		%	5.6	0.00%	4.60%	
	Hypothyroidism	N	6	0	6	
		%	5.6	0.00%	4.60%	
	Hypertension + IHD	N	3	0	3	
		%	2.8	0.00%	2.30%	
	Hypertension + hypothyroidism	N	3	0	3	
		%	2.8	0.00%	2.30%	
	IHD + hypothyroidism	N	0	5	5	
		%	0	20.80%	3.80%	
	All	N	0	0	0	
		%	0	0.00%	0.00%	

*significant at p<0.05; IHD: ischemic heart disease

Table 2: Comparison between cases with and without carpal tunnel syndrome as regards blood pressure, fasting blood glucose and HbA1c levels, and duration of diabetes mellitus.

			Carpal tunnel syndrome			
			Yes N=107 (817%)	No N=24 (18.3%)	Total N=131 (100%)	P value
SBP	Range		110.0-194.0	100.0-150.0	100.0-194.0	0.154
	Median		136.0	136.0	136.0	
	Interquartile range		130.0-144.0	110.0-140.0	130.0-144.0	
	Mean rank		68.23	56.06		
DBP	Range		60.0-100.0	65.0-91.0	60.0-100.0	0.004*
	Median		80.0	79.0	80.0	
	Interquartile range		80.0-90.0	70.0-80.0	78.0-89.0	
	Mean rank		70.49	46.00		
Drugs	No	N	65	10	75	0.088
		%	60.7	41.7	57.3	
	Antihypertensive	N	42	14	56	
		%	39.3	58.3	42.7	
FBG	Range		88.00-350.00	106.0-350.0	88.00-350.00	0.256
	Median		163.00	140.50	152.00	
	Interquartile range		140.00-198.0	125.50-157.0	127.00-190.00	
	Mean rank		67.79	58.04		
HbA1c	Range		8.00-13.60	8.25-10.50	8.00-13.60	0.574
	Median		5.70	6.10	5.70	
	Interquartile range		6.90-9.50	7.20-10.00	7.00-9.50	
	Mean rank		65.12	69.94		
Duration of DM	Range		2.00-40.00	5.00-21.00	2.00-40.00	0.879
	Median		13.00	14.00	13.00	
	Interquartile range		5.00-20.00	6.00-17.50	6.00-20.00	
	Mean rank		65.76	67.06		
Anti-diabetic drugs	hypoglycemic drugs	N	45	12	57	0.363
		%	42.1	50.0	43.5	
	Insulin	N	34	9	43	
		%	31.8	37.5	32.8	
	Both	N	28	3	31	
		%	26.2	12.5	23.7	

*significant at $p<0.05$; SBP: systolic blood pressure; DBP: diastolic blood pressure; FBG: fasting blood glucose; HbA1c: hemoglobin A1c; DM: diabetes mellitus

Table 3: Comparison of lipid profile and body mass index in cases with and without carpal tunnel syndrome

		Carpal tunnel syndrome			
		Yes N=107 (817%)	No N=24 (18.3%)	Total N=131 (100%)	value
Total cholesterol	Range	94.00-312.00	86.00-223.00	86.00-312.00	0.910
	Median	160.00	152.50	160.00	
	IQR	128.00-188.00	116.00-210.00	128.00-190.00	
	Mean rank	66.18	65.21		
LDL	Range	41.00-223.00	86.00-151.00	41.00-223.00	0.005*
	Median	98.00	117.00	102.00	
	IQR	64.00-131.00	102.00-148.00	70.00-135.00	
	Mean rank	61.55	85.83		
HDL	Range	27.80-59.60	21.00-89.00	21.00-89.00	0.012*
	Median	36.40	42.50	36.50	
	IQR	31.00-40.00	36.05-43.00	31.00-41.00	
	Mean rank	62.07	83.54		
TG	Range	60.00-295.00	118.00-305.00	60.00-305.00	0.004*
	Median	140.00	175.00	141.00	
	IQR	100.00-190.00	123.00-205.00	105.00-194.00	
	Mean rank	61.44	86.31		
BMI	Range	22.00-41.70	24.60-36.50	22.00-41.70	0.737
	Median	31.00	28.00	29.56	
	IQR	25.70-34.50	26.44-35.80	25.80-34.50	
	Mean rank	66.53	63.65		

*significant at p<0.05; IQR: interquartile range; LDL: low density lipoprotein; HDL: high density lipoprotein; TG: triglycerides; BMI: body mass index

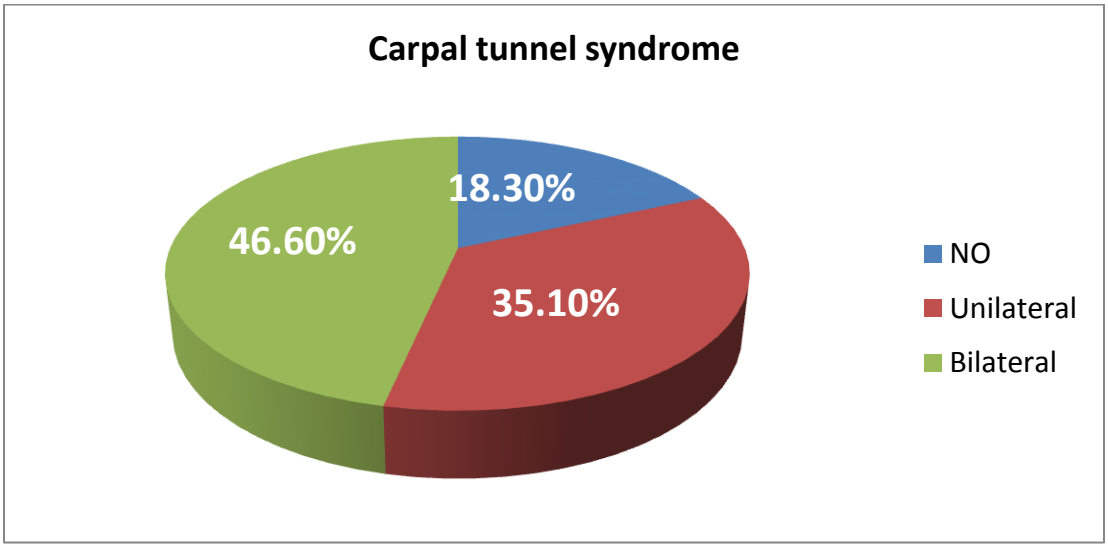

Figure 1: Distribution of unilateral and bilateral carpal tunnel syndrome among patients with type 2 diabetes mellitus.

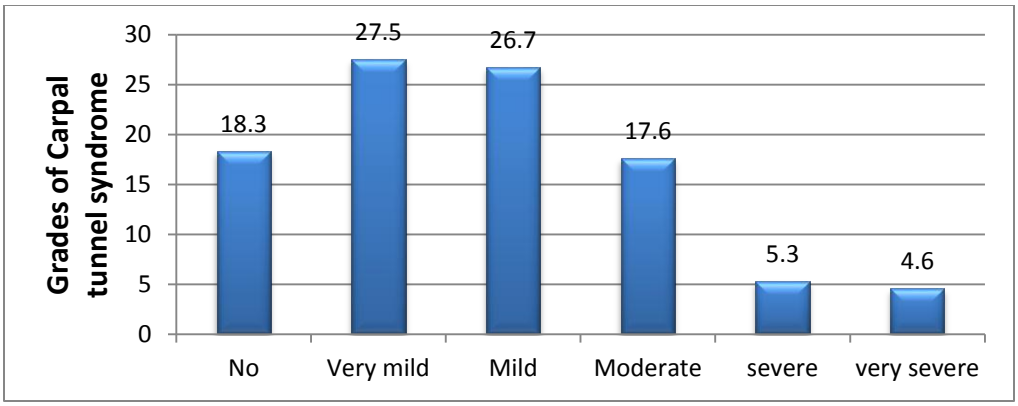

Figure 2: Grades of carpal tunnel syndrome among patients with type 2 diabetes mellitus according to nerve conduction study

DISCUSSION

The present study was conducted among 131patients with T2DM, and it has found that 81.7% were suffering from CTS according to median-ulnar distal sensory latency difference on electrodiagnostic study. Consistent with this finding, **Oktayoglu *et al.*[12]** reported higher rate of CTS (71.2%) among patients with T2DM compared to healthy control subjects. The detected prevalence in this study is much higher than that detected among diabetics at Thanjavur (19.8%), and at Turkey (16%)[13,14]. This variation in prevalence may be attributed to the chosen criteria to define the cases as CTS[4]. In our study, a more sensitive electrodiagnostic criterion that compares differences between distal median and ulnar distal sensory latencies was adopted[11]. This technique improves sensitivity and specificity and helps to control other confounding variables such as temperature, age, height, and other patient-specific variabilities[3]. Additionally, **Akulwar *et al.*[15]** reported that CTS rate positively correlates with the duration of disease and age. The relatively high prevalence found in the current study might also be explained by the long duration of diabetes mellitus and the older age of patients compared to those studies. Diabetes mellitus is a chronic systemic disease with a wide range of complications, including complications in the musculoskeletal system[16]. It is one of the major risk factors for CTS and it has been estimated that a lifetime risk of symptomatic CTS in type I diabetes might be as high as 80%[17]. **Pasnoor *et al.*[18]** reported that focal and multifocal neuropathies in diabetic patients were mainly attributed to vascular derangements, such as hypoxia or ischemia, caused by chronic hyperglycemia, whereas the symmetrical polyneuropathies were mainly caused by metabolic disorders in those patients.

In this study, no significant differences were detected between diabetic patients with and without CTS as regards fasting blood glucose, HBA1c levels or the duration of diabetes. Moreover, the use of different antidiabetic drugs whether oral tablets or insulin did not show an association with CTS. **Paranthakan and Govindarajan[13]** found that uncontrolled diabetes is a risk factor for carpal tunnel syndrome where CTS was found more in uncontrolled diabetics, but they did not find any relation between the duration of the diabetes and occurrence of CTS. In contrast, **Akulwar *et al.*[15]** has observed an increased rate of CTS with longer duration of diabetes.The occurrence of CTS was observed in this study more in males than in females. This disagrees with findings of **Akulwar *et al.*[15]** and **Paranthakan and Govindarajan[13]**. Moreover, **de Krom*et al.*[8]** reported that CTS is nearly ten times more common in women than in men. The dominance (63.4%) of male participants in our study might explain this difference. The study also revealed that residence of patients, whether in Abha or Mohyel cities, did not show significant association with occurrence of CTS.

In the current study, a significant association was detected between hypothyroidism, hypertension, and ischemic heart disease and the development of CTS. High percentages of patients with CTS had one or more of these diseases. This finding might explain the reported high rate of CTS among the studied patients. In consistence with this, **Oktayoglu *et al.*[12]** reported higher incidence (32.5%) of CTS in hypothyroid patients compared to healthy control. Additionally, **Kececi and Degirmenci[19]** demonstrated CTS in 37.5% of 44 patients who were

newly diagnosed with hypothyroidism and were not on hormone replacement therapy. **Gulbun *et al.*[20]** demonstrated that the median motor and sensory nerves were more affected compared to other nerves among 22 hypothyroid patients according to the electrophysiological study findings.

In the present study comparison between patients with and without CTS revealed significantly higher diastolic blood pressure in patients with CTS, but BMI did not show this significant difference. Moreover, lipid profile including LDL, HDL, and serum TG were significantly lower in those with CTS. Compared to this **Yurdakul *et al.*[21]** reported that CTS appears to be more severe in patients with metabolic syndrome including abdominal obesity, hypertension, dyslipidemia, and hyperglycemia compared to patients with diabetes alone.

In conclusion, these findings indicate high prevalence of unilateral and bilateral CTS among patients with type 2 diabetes mellitus in South Western Saudi Arabia. Different grades of CTS were detected, but the severity of functional impairment was relatively mild. Carpal tunnel syndrome was associated with hypertension, ischemic heart disease, and hypothyroidism. Health care professionals should be aware of this high prevalence, and it will be useful to perform electrodiagnostic study in diabetic patients in whom CTS is suspected.

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