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The Factors Associated with Carpal Tunnel Syndrome Severity

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ABSTRACT

AIM: To evaluate the effects of factors, which are associated with carpal tunnel syndrome (CTS) prevalence, on disease severity.

MATERIAL and METHODS: This retrospective study included 206 patients who were treated surgically for either moderate or severe CTS. Patients were grouped into moderate and severe CTS then compared regarding to age, gender, BMI, and presence of occupational factors as well as systemic diseases that are associated with CTS.

RESULTS: Patients with moderate and severe CTS did not differ in age, gender, occupational risk factors, and most of the systemic diseases, including DM, hypothyroidism, rheumatoid arthritis, cardiovascular disease, renal insufficiency, and folate deficiency. The severe CTS group had a significantly higher BMI than the moderate CTS group. Moreover, vitamin B12 deficiency was significantly more common in the severe CTS group than in the moderate CTS group.

CONCLUSION: Patients with severe CTS are more inclined toward surgery than those with moderate CTS. Controlling BMI and preventing vitamin B12 deficiency may help keep alleviate complaints related to CTS with less invasive treatment modalities.

KEYWORDS: Carpal tunnel syndrome, Severity, Grade, Body mass index, Vitamin B12 deficiency

INTRODUCTION

Carpal tunnel syndrome (CTS) is the most common peripheral entrapment neuropathy, which accounts for 90% of entrapment neuropathies (26). CTS results from compression of the median nerve in the carpal tunnel at the wrist (3,17), which is usually a chronic process. Symptoms include paresthesia, especially during sleep, tingling and dull pain in the hand and forearm, and motor weakness and muscle atrophy in severe cases (17). Any volumetric increase in the contents of the canal or a decrease in the canal volume results in CTS (38).

Several factors such as middle age, female sex, rheumatoid arthritis (RA), diabetes mellitus (DM), hypothyroidism, and high body mass index (BMI) were found to be associated with the development of CTS (7,17). Although several studies have investigated factors associated with CTS prevalence (1,4,7,8,12, 15,17,22,24,30,36,41), much fewer studies have investigated factors that affect the severity of CTS (2,10,18,19,25). However, a study revealed that patients with more severe CTS were more inclined toward surgery when the decision was left to the patients (14).

Despite debates over the efficacy of electrodiagnostic tests in the diagnosis of CTS, they have a sensitivity of >85% and specificity of >95% (17). Following the release of Clinical Practice Guidelines by the American Academy of Orthopaedic Surgeons, the use of electrodiagnostic studies increased among hand surgeons (14).

With the above background, this study aimed to evaluate the effects of factors, which are associated with CTS prevalence, on the severity of CTS.

MATERIAL and METHODS

This retrospective study included patients with CTS who underwent surgery in our department between January 2010 and September 2013. During the study period, the institution had no ethical committee and an ethical committee approval was not required for retrospective studies according to the

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national regulations. Formal approval was granted by the head of the institution. All patients have given consent for the use of their data for scientific investigations.

Although a positive nerve conduction study (NCS) was not necessary to perform surgery in the presence of strong clinical findings, only patients with CTS that was confirmed by electrodiagnostic studies and aged >18 years were included. The exclusion criteria were as follows: pregnancy, previous fracture or surgery in the affected extremity, and cervical radiculopathy, with more than one missing parameter. The database search yielded 219 patients who underwent surgery for CTS. Of these, 206 patients were eligible for the study.

The NCS was performed by a devoted staff under the supervision of a neurologist in our institute. The severity of CTS was graded as mild, moderate, or severe according to American Association of Electrodiagnostic Medicine recommendations (39).

Data were collected from patients' records, including age, gender, BMI (calculated using the recorded weight and height of the patient), occupational risk factors, DM, thyroid function disorders, renal insufficiency, vitamin B12 and folate deficiency, and CTS grade. Age and BMI were recorded as continuous variables, while others were recorded as categorical variables. For occupational risk factors, association of declared occupation with CTS was determined based on the literature. Hence, jobs considered associated with CTS were farming, dairy farming, office jobs, agricultural work, floor cleaning, butchery, and dentistry (1,8,27,33,34,40).

Statistical Analysis

Results are presented as mean + standard deviation for continuous variables and as percentages for categorical variables. The distribution pattern of continuous parameters was tested by the Kolmogorov–Smirnov test. Student's t-test and Mann–Whitney U test were used for variables with and without normal distribution, respectively. Frequencies between groups were analyzed by Chi-square test.

RESULTS

A total of 206 patients were included in the study. Age showed normal distribution and was analyzed by Student's t-test. Since BMI was not normally distributed, the Mann–Whitney U test was used for the analysis. The prevalence of investigated factors across groups is summarized in Table I.

The moderate CTS group consisted of 64 patients (8 men and 56 women; mean age, 51.05 ± 9.97 years), and the severe CTS group consisted of 142 patients (22 men and 120 women; mean age, 53.46 ± 12.23 years). No difference was found in age and gender distributions between the groups (p=0.137 and p=0.573, respectively).

Both groups differed significantly in terms of BMI. However, the mean BMI in the moderate CTS group was approximately 2.5 units lower than those in the severe CTS group, and this difference was significant (p<0.001) (Table II).

Occupational factors were present in 53.1% of moderate CTS cases and 65.5% of severe CTS cases; however, this difference was not significant.

Although DM frequency was higher in the severe CTS group than in the moderate group (42.8% vs 29.7%, respectively), the difference did not reach significance.

Rheumatoid disorders, renal insufficiency, cardiovascular disorders, thyroid gland disorders, and folate deficiency also showed no significant difference between the groups (Table II).

Vitamin B12 deficiency was significantly higher in the severe CTS group than in the moderate CTS group (p<0.001).

The results of the univariate analyses are shown in Table II.

DISCUSSION

Many reports have evaluated the association of age with CTS regarding prevalence, degree, and surgical success. Phalen reported that more than 80% of their patients with CTS were older than 40 years, and Katz and Simmons found a peak incidence of CTS in the sixth decade (15,32). However, Werner et al. and de Saboya Lenzi et al. have found that age did not affect CTS prevalence (5,41). Conversely, studies have reported that the severity of CTS increases with age (2,10,19). Regarding the response to surgical treatment, Ibrahim et al. found no association with age, and others reported a higher success rate in younger patients and lesser improvement at 6 months postoperatively in older patients (11,13,42). The overall mean age was 52.71 ± 11.61 (range, 21–83) years, which was similar to the literature (Table I). By contrast, age was not significantly different between patients with moderate and severe CTS, which is different from the literature. Arslan et al. and Gunes et al. have included patients with idiopathic CTS in their studies, but we included those with predisposing factors. This may be a reason for the difference between our findings (2,10).

CTS is more commonly seen in women (24,41). Phalen reported that 65%–75% of patients diagnosed with CTS were women (32). This can be a consequence of women having smaller volumes in the carpal tunnel than that of men (35). However, a report found no difference between genders (4). In our study, 85% (n=176) of our study population consisted of women. Despite these studies that have evaluated the relationship between gender and CTS prevalence, studies regarding the effect of gender on CTS severity are scarce. In the present study, gender was not significantly associated with CTS grade.

BMI is an independent risk factor for CTS prevalence (24,31,36). People with obese status were found to have a 2.5 times higher risk to have CTS than people with lean body frame (41). Another study revealed that a one-unit increase in BMI increases the risk of CTS by 6% (30). Werner et al. hypothesized that this was caused by the increased fat deposition or hydrostatic pressure in the carpal tunnel, which consequently impairs nerve conduction at the wrist (41). Kurt et al. found that losing weight results in an improvement in nerve conduction velocity, which supports the aforementioned

Table I: Demographic Data of Each Group and Overall Study Population

	Parameters	Moderate	Severe	Overall
Age (years), mean ± SD		51.05 ± 9.97	53.46 ± 12.23	52.71 ± 11.61
BMI, mean ± SD		26.34 ± 1.57	28.778 ± 1.77	28.02 ± 2.05
BMI, categorical				
	Normal, n (%)	5 (7.8)	0 (0.0)	5 (2.4)
	Overweight, n (%)	59 (92.2)	96 (67.6)	155 (75.2)
	Obese, n (%)	0 (0.0)	46 (32.4)	46 (22.3)
Sex (n = 206)				
	Male, n (%)	8 (12.5)	22 (15.5)	30 (14.6)
	Female, n (%)	56 (87.5)	120 (84.5)	176 (85.4)
Occupational Factors (n=206)				
	Present, n (%)	34 (53.1)	93 (65.5%)	127 (61.6)
Diabetes mellitus (n=204)				
	Present, n (%)	19 (29.7)	60 (42.8)	79 (38.7)
Rheumatoid arthritis (n=205)				
	Present, n (%)	9 (14.3)	12 (8.4)	21 (10.2)
Renal insufficiency (n=206)				
	Present, n (%)	0 (0.0)	6 (4.2)	6 (2.9)
Cardiovascular disease (n=205)				
	Present, n (%)	0 (0.0)	2 (1.4)	2 (1.0)
Hypothyroidism (n=204)				
	Present, n (%)	14 (21.9)	26 (18.8)	40 (19.6)
Vitamin B12 deficiency (n=206)				
	Present, n (%)	1 (1.6)	17 (20.0)	18 (8.7)
Folate deficiency (n=205)				
	Present, n (%)	2 (3.1)	5 (3.5)	7 (3.4)

BMI: *Body mass index.*

hypothesis (21). Moreover, low BMI was found to have a positive relationship with postoperative improvement (11). Reports regarding BMI and CTS severity are conflicting. Several studies have found a correlation between high BMI and CTS severity (10,18). In the studies by Mondelli et al. and Kouyoumdjian et al., BMI was not associated with CTS severity, but BMI was associated with CTS prevalence in the latter study (19,25). In the present study, all patients in the severe CTS group were either overweight or obese, and none of the patients in the moderate CTS group was obese (Table I). As regards mean BMI, a significant difference was found between patients with moderate CTS and those with severe CTS (Table II). Although the mean values of both groups were close (difference between means was approximately 2.5 kg/m^2), this shows that even a mild to moderate increase in BMI can affect the CTS grade. This finding is consistent with those of Kurt et al. and Werner et al. (21,41). According to Werner et al., this might be due to compression of the median nerve by the increased fatty tissue in the carpal tunnel (41).

Some diseases that affect human metabolism or soft tissue composition are known to increase the development of CTS. Among these, DM is known to be an important risk factor for CTS (7,17,24,30,35,38). Hypothyroidism is another important disorder that causes CTS (9). Moreover, cardiovascular diseases, RA, and renal insufficiency were shown to be associated with CTS (6,16,37). By including DM and hypothyroidism in the analysis, we did not find an association of these disorders with CTS severity. However, our study had very few patients with cardiovascular diseases, which

Table II: Comparison of Moderate and Severe CTS Groups Regarding Factors Associated with Carpal Tunnel Syndrome

	Parameters	Moderate	Severe	p
Age (years), mean ± SD		51.05 ± 9.97	53.46 ± 12.23	0.137
BMI, median (min–max)		25.85 (23.40–29.60)	28.90 (25.10–32.30)	**<0.001***
Sex, n (%)				0.573
	Male	8 (12.5)	22 (15.5)	
	Female	56 (87.5)	120 (84.5)	
Occupational factors, n (%)				0.091
	Present	34 (53.1)	93 (65.5)	
	Absent	30 (46.9)	49 (34.5)	
Diabetes mellitus, n (%)				0.073
	Present	19 (29.7)	60 (42.8)	
	Absent	45 (70.3)	80 (57.2)	
Rheumatoid arthritis, n (%)				0.204
	Present	9 (14.3)	12 (8.4)	
	Absent	54 (85.7)	130 (91.6)	
Renal insufficiency, n (%)				0.095
	Present	0 (0.0)	6 (4.2)	
	Absent	64 (100)	136 (95.8)	
Cardiovascular disease, n (%)				0.338
	Present	0 (0.0)	2 (1.4)	
	Absent	64 (100)	139 (98.6)	
Hypothyroidism, n (%)				0.581
	Present	14 (21.9)	26 (18.8)	
	Absent	50 (78.1)	114 (81.2)	
Vitamin B12 deficiency, n (%)				**0.014***
	Present	1 (1.6)	17 (20.0)	
	Absent	63 (98.4)	125 (80)	
Folate deficiency, n (%)				0.878
	Present	2 (3.1)	5 (3.5)	
	Absent	62 (96.9)	136 (96.5)	

** Statistically significant,* ***BMI:*** *Body mass index.*

may have resulted in false-negative findings. Unfortunately, we could not find a study that investigated the relationship between predisposing diseases and CTS severity that would allow us to compare our results.

Vitamin deficiencies (vitamin B12 and folate) can cause peripheral neuropathy (12,22). However, we did not find a study regarding a direct association of vitamin B12 and/or folate deficiency with CTS development in the English literature. However, vitamin B12 treatment was reported to improve peripheral neuropathies, including CTS (28,29). These studies did not specifically include patients with vitamin B12 deficiency, but enrolled patients with CTS. Thus, they only demonstrated the therapeutic effect of vitamin B12 in CTS, not its association with disease prevalence or severity. In the present study, vitamin B12 deficiency was found to be associated with more severe CTS. Although we cannot state

that vitamin deficiency increases the risk for CTS development, which was beyond the scope of this study, we assume that the median nerve becomes more susceptible to compression in the presence of vitamin B12 deficiency, resulting in a higher CTS grade. Moreover, considering the spread of vegan and vegetarian diets among people and the increased use of proton pump inhibitors and H2 receptor blockers, vitamin B12 deficiency will expectedly increase among the population (20,23).

Some occupations, especially those that require repeated extension of the wrist and movement of forearm muscles, have been associated with CTS (1,8,27,33,34,40). However, we did not find that having an occupation that puts the worker at risk for CTS increases the severity of CTS. There may be several work-related factors, such as duration or intensity of work, which were not evaluated in this study.

The study is not devoid of limitations. First, owing to the retrospective study design, not all factors were controlled properly. Second, the population included only patients who received surgical treatment. However, since we evaluated the pretreatment grade of CTS and having conservative or surgical treatment would not have affected the pretreatment grade, we do not think that it is a major limitation. Third, since patients with mild CTS were not included in the study, study findings cannot be generalized to this group of patients. Fourth, the frequency of some factors was relatively low in the study population, which may have caused false-negative results, and with a larger population, they may be related to the CTS grade. Finally, only two factors were significant in the univariate analysis, so a regression analysis was not made.

CONCLUSION

CTS severity not only increases patient's discomfort but also makes them lean toward surgery. Controlling CTS severity may help keep symptoms manageable with conservative means. In this regard, as BMI and vitamin B12 deficiency increase the CTS grade, patients with CTS should keep their weights under control and carefully choose their diets to prevent vitamin B12 deficiency.

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AUTHORSHIP CONTRIBUTION

Study conception and design: FT, SB

Data collection: FT

Analysis and interpretation of results: SB

Draft manuscript preparation: SB

Critical revision of the article: FT

Other (study supervision, fundings, materials, etc...): SB, FT

All authors (FT, SB) reviewed the results and approved the final version of the manuscript.

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