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Factors affecting carpal tunnel syndrome severity: A regression analysis

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ABSTRACT

Aim: To establish links between carpal tunnel syndrome (CTS) severity and several key factors, including the age and gender of patients, which side was affected, the existence of other health conditions, outcomes from diagnostic evaluations, and measurements of wrist diameter.

Methods: This retrospective study analyzed medical records of patients who underwent CTS surgery, focusing on age, gender, affected side, comorbidities, diagnostic tests, and wrist diameter to assess CTS severity.

Results: This study included 75 patients diagnosed with CTS, with an average age of 52.9±11.8 years, comprising 28 males (37%) and 47 females (63%). Symptoms were predominantly on the right side (72%, 54 patients), followed by the left side (22.67%, 17 patients) and bilateral cases (5.33%, 4 patients). Occupation-wise, housewives were the majority (38.67%, 29 patients). Comorbidities were present in 61.3% (46 patients) of patients. Phallen's test and Tinnel's sign were positive in 88% (66 patients) and 77.3% (58 patients) respectively. The mean wrist diameter was 19.8±1.72 cm. No mild cases were reported, with 38.7% (29 patients) moderate and 61.3% (46 patients) severe. Binary logistic regression analysis indicated that the affected side, diabetes, menopause, rheumatological diseases, and wrist diameter over 21 cm were significant predictors of CTS severity.

Conclusions: This study highlights that a wrist diameter greater than 21 cm is a significant predictor of CTS severity.

Key words: Carpal tunnel syndrome, wrist diameter, nervus medianus, Phallen's test, Tinnel's sign.

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1. Introduction

Carpal tunnel syndrome (CTS) is considered the result of the compression of the median nerve in the carpal tunnel [1]. Characterized as a common neuropathy affecting the upper extremity, CTS has been increasingly observed in recent times, leading to considerable socio-economic repercussions. Sufferers of CTS often experience a spectrum of symptoms, ranging from pain and paraesthesia to sensory anomalies and reduced strength in the hand and wrist, significantly impacting their daily activities and quality of life [2]. Given the widespread prevalence of CTS, there is a critical need to determine the most effective treatment strategies. Although some cases of CTS can be traced back to specific secondary causes such as injuries, metabolic disorders, or infections, the majority of CTS cases are idiopathic [3-5].

In the United States, the incidence of CTS is reported to be between 1 and 3 individuals per 1000 each year, with a prevalence of about 50 per

1000, paralleling the incidence and prevalence rates in most developed countries [6]. The age range most commonly affected by CTS is between 40 and 60 years, and the syndrome is significantly more prevalent in females, being ten times more common than in males [7]. Occupational factors play a notable role in CTS, with higher incidence rates among individuals who engage in prolonged computer usage, work with vibration-intensive tools such as those in construction, and those in professions requiring frequent, repetitive movements [8].

Clinical practice guidelines suggest employing non-invasive treatment methods for individuals experiencing mild to moderate symptoms of Carpal Tunnel Syndrome (CTS) [9]. These primary non-surgical treatments encompass a variety of approaches such as the use of splints, administration of steroid injections, electrotherapy, and various forms of manual therapy [10]. The manual therapy techniques utilized for CTS patients cover a range of interventions. These include manual and instrumental techniques for mobilizing soft tissues, massage therapy, mobilizations or manipulations of bones, and neurodynamic techniques, which target either the skeletal system or soft tissues [11].

A significant aspect of the study was the risk factor analysis. This involved identifying and analyzing potential factors that could influence the severity of CTS in the patient population. The analysis aimed to draw connections between the severity of CTS and variables such as patient age, gender, affected side, presence of comorbidities, results from diagnostic tests, and wrist diameter measurements.

2. Materials and metods

2.1. Patients and design

In this study, we conducted a retrospective analysis of patients who underwent surgery for Carpal Tunnel Syndrome (CTS). The data collection process involved a thorough review of medical records, focusing on several key parameters including age, gender, the affected side (right, left, or bilateral), the presence of comorbidities, and specific diagnostic tests used for confirming CTS. Additionally, the diameter of each patient's wrist was measured, given its potential relevance to the severity of the condition.

Patients were categorized according to the severity of their CTS, which was likely determined based on factors such as the extent of nerve damage, duration of symptoms, and level of functional impairment. This classification was critical for assessing the correlation between the severity of CTS and various demographic and clinical variables.

Figure 1. Open carpal ligament excision and median nerve decompression via mini-incision.

2.2. Surgical technique

All patients underwent procedures under local anesthesia. A vertical incision of 2-3 cm was made between the 3rd and 4th fingers on the palm, not extending beyond the wrist crease. The skin and subcutaneous layers were incised using a number 15 scalpel, followed by the deepening of the incision with an automatic retractor. Encountered bands were initially coagulated with a bipolar cautery and then cut with tissue scissors. The bands were dissected to facilitate

deeper retraction, revealing the carpal ligament. A fine mosquito forceps was inserted beneath the carpal ligament, elevating it from the median nerve, and the ligament was then incised from proximal to distal using a number 15 scalpel. This incision, facilitated by tissue scissors, extended from proximal to distal across the entire breadth of the carpal ligament in full thickness, thereby releasing the median nerve (Figure 1).

2.3. Eligibility criteria

Inclusion criteria required participants to have a clinically and/or electrophysiologically confirmed diagnosis of CTS, be aged between 18 and 80 years, and have experienced symptoms of CTS for at least 1 year. Additionally, participants needed to provide informed consent and be available for all follow-up appointments during the study period. On the other hand, exclusion criteria were set to omit individuals who had undergone previous CTS surgery, had co-existing neuropathies such as diabetic neuropathy or radiculopathy, were pregnant, or suffered from severe systemic diseases like end-stage renal disease or uncontrolled diabetes. Those who had recently or were currently undergoing treatment with systemic corticosteroids or hormonal therapies were also excluded. Language barriers and mental incapacity that hindered informed consent or adherence to study protocols, as well as participation in other clinical trials that could interfere with the study outcomes, were additional exclusion factors.

2.4. Ethical approval

The study was approved ethically by non-interventional ethics committee of Sancaktepe Ilhan Varank Hospital (date: 08/11/2023 – No: 222). Written informed consents were obtained from all patients and/or their guardians.

2.5. Statistical analysis

The analysis involved creating descriptive statistics, calculating frequencies, and examining various factors across different categories. The quantitative data was presented as mean and standard deviation. The normality of the continuous variables was assessed using the Shapiro-Wilk and Kolmogorov-Smirnov tests. For continuous variables that followed a normal distribution, the Student's t-test was utilized. To identify the factors impacting the severity of CTS, a binary logistic regression analysis was conducted. The data processing was carried out using SPSS Statistics for Windows, Version 26.0 (IBM Corp., Armonk, NY, USA). Statistical significance was set at a two-tailed p-value of 0.05 or less.

3. Results

In this study, a total of 75 patients diagnosed with CTS were included. The average age of these patients was 52.9±11.8 years. The gender distribution included 28 males (37%) and 47 females (63%). Regarding the affected side, 72% (n=54) experienced symptoms on the right side, 22.67% (n=17) on the left, and 5.33% (n=4) presented with bilateral symptoms. Occupation-wise, the majority were housewives, accounting for 38.67% (n=29), followed by chefs and construction workers (each 9.33%, n=7), carpenters (8%, n=6), and various other professions (34.67%, n=26). When considering comorbidities, 46 participants (61.3%) had at least one comorbidity, while 29 participants (38.7%) had none. Notably, 29.33% (n=22) had a familial predisposition to CTS. Menopause was a contributing factor for 30.67% (n=23). Other medical conditions included rheumatological diseases in 13.33% (n=10), hypothyroidism in 22.67% (n=17), obesity in 30.67% (n=23), diabetes in 21.33% (n=16), and wound healing problems in 26.67% (n=20) (Table 1).

In clinical tests, the Phallen's test was positive in a significant 88% (n=66), and the Tinnel's sign

Table 1. Demographics.

Parameters	N or mean	% or SD
Age	52.9	11.8
Gender		
Male	28	37%
Female	47	63%
Side		
Right	54	72%
Left	17	22.67%
Bilateral	4	5.33%
Meslek		
Housewife	29	38.67%
Chef	7	9.33%
Construction worker	7	9.33%
Carpenter	6	8%
Other	26	34.67%
Comorbidity		
At least 1 comobidity	46	61.3%
No	29	38.7%
Familial predisposition (Yes)	22	29.33%
Menapause	23	30.67%
Rheumatological disease	10	13.33%
Hypothyroidism	17	22.67%
Obesity	23	30.67%
Diabetes	16	21.33%
Wound healing problem	20	26.67%
Phallen positive	66	88%
Tinnel positive	58	77.33%
Wrist diameter (cm)	19.8	1.72
Disease classification		
Mild	0	0%
Moderate	29	38.7%
Severe	46	61.3%

** mean±SD*

was positive in 77.33% (n=58). The mean wrist diameter was measured at 19.8±1.72 cm. In terms of disease classification, no participants fell into the 'mild' category, while 29 (38.7%) were classified as 'moderate', and 46 (61.3%) as 'severe' (Table 1).

Binary logistic regression analysis was conducted to identify factors influencing the severity of CTS. The analysis revealed that age, gender, the presence of wound healing issues, the existence of at least one comorbidity, hypothyroidism, and familial predisposition did not significantly impact the severity of CTS, with each of these factors showing a *p*-value greater than 0.05. On the other hand, the affected side, the presence of diabetes, menopause,

rheumatological diseases, and a wrist diameter greater than 21 cm were identified as significant predictors, playing a noteworthy role in determining the severity of CTS (Table 2).

Table 2. Binary logistic regression analysis of the predictors for severity of Carpal tunnel syndrome.

				95% Confidence Interval		
Predictor	**Estimate**	**SE**	***p***	**Odds ratio**	**Lower**	**Upper**
Intercept	-1.2243	2.5098	*0.626*	0.2940	0.00215	40.23
Age	0.0327	0.0350	*0.350*	1.0332	0.96474	1.10
Gender	0.2168	0.8307	*0.794*	1.2421	0.24382	6.32
Side	-2.1227	0.9721	*0.029*	0.1197	0.01781	0.80
Wound healing problem	1.5099	1.2022	*0.209*	4.5265	0.42901	47.75
At least 1 comorbidity	-2.5730	1.6594	*0.121*	0.0763	0.00295	1.97
Diabetes	-4.3884	2.0214	*0.030*	0.0124	2.36e-4	0.65
Obesity	3.8042	2.0008	*0.057*	44.8898	0.88940	2265.67
Hypothyroidism	-0.7831	1.3495	*0.562*	0.4570	0.03245	6.43
Menopause	3.3796	1.5744	*0.032*	29.3579	1.34156	642.45
Rheumatologic disease	4.0670	2.0260	*0.045*	58.3789	1.10078	3096.07
Familial predisposition	-0.5339	0.7480	*0.475*	0.5863	0.13535	2.54
Wrist diameter >21 cm	1.9989	0.9343	*0.032*	7.3812	1.18255	46.07

4. Discussion

The study aimed to elucidate the factors affecting the severity of CTS, a condition marked by the compression of the median nerve within the carpal tunnel. This comprehensive analysis, drawing on a patient cohort subjected to CTS surgery, reveals significant insights into the multifaceted nature of the syndrome, its demographic and clinical correlates, and its responsiveness to various treatment modalities.

One of the most common and well-researched entrapment neuropathies is carpal tunnel syndrome (CTS), which affects 4.0% to 5.0% of the middle-aged general population [12]. According to the pathophysiology of CTS, the narrow osteofibrous canal (carpal tunnel) compresses and damages the median nerve during its passage. Patients with CTS report that, of the wide range of symptoms that can arise, the most common ones are pain, paraesthesias (particularly at night) and dysaesthesias in the median nerve distribution (the first three and a half digits of the affected hand). All of the muscles innervated by the median nerve's branches—the flexor, abductor, and opponens pollicis—are atrophying and weakening as the pathophysiology of CTS develops, which contributes to the patient's decreased functionality. Regularly, a complete clinical examination (including Tinel, Phalen, and Durkan's tests) combined with a thorough patient history can lead to the diagnosis of CTS [12,13]. However, in certain patients, sophisticated

techniques (electrodiagnostic tests) like nerve conduction studies can be used for both diagnosis and treatment planning. Over time, numerous risk factors such as obesity, diabetes, hypothyroidism, pregnancy, lupus erythematosus, and Reynaud's phenomenon have been discovered [14]. Our findings indicate a notable demographic distribution, with a higher prevalence among females, reflecting the gendered disparity observed in CTS incidence. The age range most commonly affected, as identified in our study, aligns with the global observations in CTS demographics. The occupation-specific prevalence, particularly among housewives, chefs, construction workers, and carpenters, underscores the role of repetitive strain and occupational hazards in CTS etiology. In our study, we observed a unique occupational distribution among those affected by CTS. Housewives formed the largest group, comprising 38.67% of the cases (n=29). This was followed by chefs and construction workers, each category representing 9.33% (n=7), and carpenters at 8% (n=6). Additionally, a mix of other professions accounted for 34.67% of the cases (n=26). In contrast, Eslami et al. research highlighted a trend of homeworking becoming more prevalent across various jobs, though it didn't specify the impact on CTS [5]. Meanwhile, Ghasemi and colleagues focused on a broader demographic, studying 906 individuals split between manual workers and computer users. In their study, a higher incidence of CTS was noted among males [15]. This gender-specific finding contrasts with our study, where a significant proportion of the affected individuals were housewives.

Previous research has explored various factors to predict outcomes in CTS cases. These factors include age [16], existing health conditions [17], occupation [18], response to steroid injections before Surgery [19], duration of symptoms [20], and clinical features like nocturnal and bilateral pain, muscle weakness, or atrophy [21,22]. Additionally, elements like worker's compensation, misdiagnosis, and incomplete transverse carpal ligament release have been considered. Informing patients about these factors beforehand can help manage their expectations and reduce dissatisfaction [23,24]. However, a straightforward and quantifiable method for predicting surgical outcomes is still lacking. Several indicators, such as age, gender, smoking habits, occupation, underlying diseases, symptom duration, and muscle weakness or atrophy, have been proposed as potential predictors of outcomes following carpal release surgery [23-25]. In the study conducted by Alimohammadi et al., many of these variables did not significantly influence patient outcomes [25]. In contrast, our study identified specific predictors for the severity of CTS, including the side affected by CTS, presence of diabetes or rheumatological diseases, menopausal status, and a wrist diameter exceeding 21 cm. These findings provide new insights into factors that could influence the severity and treatment outcomes of CTS.

To our knowledge, this is the first study demonstrating that a wrist diameter greater than 21 cm is a predictor of CTS severity. However, it's important to acknowledge certain limitations. Future research should aim to increase the sample size to better represent the broader population and implement a longitudinal approach to monitor the long-term outcomes following surgery. Furthermore, conducting the study across multiple centers would improve the applicability of the results to diverse demographic and clinical contexts. Such advancements are crucial not only for validating our findings but also for deepening our understanding of the various factors that affect the severity of CTS. This, in turn, will assist in

crafting more effective and specific treatment strategies for those affected by this condition.

4.1. Conclusions

This study highlights that a wrist diameter greater than 21 cm is a significant predictor of CTS severity. This novel finding adds to the existing body of research on CTS, offering a new dimension for assessing risk factors. Future studies should focus on expanding the demographic representation and employing a longitudinal design across multiple centers to enhance the generalizability and applicability of these findings.

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