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Relationship of Age, Body Mass Index, Wrist and Waist Circumferences to Carpal Tunnel Syndrome Severity

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Abstract

Carpal tunnel syndrome (CTS) has a multifactorial etiology involving systemic, anatomical, idiopathic, and ergonomic characteristics. In this study, an investigation of the relationship between the CTS degree established by electrophysiological measurements in patients with clinical CTS prediagnosis, and age, gender, body mass index (BMI), hand wrist circumference, and waist circumference measurements has been done. On 547 patients included in the study, motor and sensory conduction examinations of the median and ulnar nerve were done on one or two upper extremities thought to have CTS. In terms of CTS severity, the patients were divided into four groups (normal, mild, medium, and severe CTS). A total of 843 electrophysiological examinations were done consisting of 424 on the right hand wrist and 419 on the left hand wrist. When the age group of 18–35 years is taken as the reference group, the CTS development risk independent of BMI has been found to have increased by a factor of 1.86 for ages 36–64 years, and by 4.17 for ages 65 years and higher after adjustment for BMI. With respect to normal degree CTS group, the BMI were significantly different in groups with mild, medium, and severe CTS. The waist circumferences of groups with mild, medium, and severe CTS severity were found to be significantly higher in comparison to the normal reference group. When this value was corrected with BMI and re-examined the statistically significant differences persisted. The study identified a significant relationship between the CTS severity and age, BMI, waist circumference.

Key words: carpal tunnel syndrome, body mass index, wrist circumferences, waist circumferences

Introduction

Carpal tunnel syndrome (CTS) is the most frequently seen neuropathy of the upper extremities and it affects approximately 1–2.7% of the general population.[1,2] CTS is the clinical consequence manifested by the symptoms in the median nerve distribution area (thumb, pointing finger, middle finger) caused by the compression of median nerve beneath the flexor retinaculum at the hand wrist proximity.[1,3] At the hand area where the median nerve innervates; pain, numbness, paresthesia, increase of symptoms at night time or by repeated motion, comforting with hand position change or by waving, positive Tinel and/or Phalen signs, thenar atrophy, symptoms and findings such as hypoesthesia in the median nerve area are indicative of CTS.[4] CTS diagnosis is achieved with clinical findings and electrophysiological examinations. Conservative treatments may be helpful in some CTS patients, but ultimately surgical intervention is required in most patients.[5]

CTS has multifactorial etiology. Systemic, anatomical, idiopathic, and ergonomic factors could be significant in etiology. Some parameters such as age, gender, and body mass index (BMI) could be risk factors for CTS.[6,7] BMI is a good indicator of body fat and it is calculated by dividing weight (kilogram) with the square of height (meter).[8] When the BMI value is over 30, it is classified as obesity. Although there are some studies showing a relationship between the BMI and CTS,[7,9,10] its relationship with anthropometric measurements such as waist circumference and hand wrist circumference is not clear. Waist circumference is one of the anthropometric measurements identifying abdominal obesity.[4] Close relationship of abdominal obesity with some ailments has already been shown. Even if BMI < 30, waist line with 88 cm or higher identifies patient as obese.[11] There are reports which caution against abdominal obesity as a risk factor in women with CTS even if BMI is normal.[4]

In this study, an investigation of the relationship

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between the CTS severity evaluated by electrophysiological measurements in patients with clinical CTS prediagnosis, age, gender, BMI, hand wrist circumference, and waist circumference measurements have been aimed.

Materials and Methods

I. Patients

Five hundred and forty-seven patients with CTS diagnosed clinically referred to the neurology clinic electrophysiology laboratory between March 2011 and December 2011 were included into the research. Patients with complaints involving one or both extremities were assessed electrophysiologically. Among patients with diabetes mellitus (DM), only those without clinical and electrophysiological polyneuropathy were included in the study. Those who previously underwent CTS surgery, those with clinical and electrophysiological polyneuropathy, who received injections to the hand wrist, those with rheumatologic and thyroid diseases, pregnant women, and those with severe upper extremity trauma history were not included to the study. Research participation approvals were obtained from all patients. Age, gender, height, weight, additional co-morbidities (DM, rheumatoid arthritis, etc.), and upper extremities trauma history were documented. Patients were separated into three groups according to their ages (ages 18–35, ages 36–64, and ages 65 and above).

II. Electrophysiological studies

Neuropack M1 MEB-9200 (Nihon Kohden Corporation, Tokyo) ENMG equipment was used for motor and sensory conduction studies on the affected median and ulnar nerves of extremity or extremities of patients referred to the electrophysiology laboratory with CTS pre-diagnosis. All measurements were taken at room temperature and when skin heat was above 32°C. If only single upper extremity of patients were assessed, both median and ulnar nerve motor and sensory conduction studies were done. In patients whose bilateral upper extremities were examined, while median and ulnar nerve conduction of the right extremity studies were being done, only the median nerve study of the left extremity were done and ulnar nerve study was ignored. Median motor nerve conduction was recorded by a surface electrode placed at the center of abductor pollicis brevis muscle and through stimulation at the hand wrist and antecubital fossa. Distal motor latency and combined muscle action potential (CMAP) amplitude were measured and motor conduction velocity was calculated. The sensory nerve conduction study was done from the second finger and the mixed nerve conduction study was done from the palm by recording orthodromically from the wrist. Sensory nerve conduction velocity, sensory distal latency, and sensory nerve action potential (SNAP) amplitude was recorded and measured. Through electrophysiological assessment, patients were separated into the following four groups:

1st group (normal): Patients whose electrophysiological assessments are not compatible with CTS.

2nd group (CTS with mild severity): Patients whose median nerve sensory and mixed nerve conduction velocity at the second finger-wrist and palm-wrist segments are slower than 50 m/sec and/or median nerve motor distal latencies are longer than 4.1 msec.

3rd group (medium severity CTS): Patients with median nerve motor and sensory conduction velocity slower than 50 m/sec, median nerve CMAP amplitudes below 4 mV, SNAP amplitudes lower than 12 μV at the second finger-wrist segment, and those with less than 3 times the SNAP amplitude of the second finger-wrist segment at the palm-wrist segment (those with low CMAP and SNAP amplitudes and slow sensory and motor conduction velocity).

4th group (severe CTS): Those patients whose median nerve CMAP and/or SNAPs could not be recorded, with motor and sensory distal latencies overly extended, high degree of drop in CMAP and SNAP amplitudes, and with a high degree slowdown in sensory and motor conduction velocity.

III. Anthropometric measurements

Heights and weights of patients were measured with a sensitive scale as centimeters and kilograms. With a measure of 0.1 mm sensitivity both hand wrists and waist circumference at the umbilicus levels were measured. All measurements were taken by the same qualified nurse. Patients' BMI were calculated (kg/m^2) on the basis of height and weight measurements.

IV. Statistical analysis

Statistical analysis was done through Statistical Package for the Social Sciences (SPSS) 15.0 software package (SPSS, Inc., Chicago, Illinois, USA). Descriptive statistics were given as mean ± standard deviation, frequency, and percentages. BMI, age, gender, waist circumference, and wrist circumference measurements were compared with one-way analysis of variance (ANOVA) between the groups formed according CTS severities evaluated by electrophysiological examinations. Tukey post-hoc test were used for pair wise comparisons. Pearson chi-square test was used to compare categorical variables. Analysis of covariance (ANCOVA) was used to control the probable effect of BMI. Logistic regression analysis was used to calculate the odds ratios for CTS severity risk according to age groups. CTS assessments obtained from the right or left hand wrists of patients were accepted as separate and independent cases. For statistical significance, $p < 0.05$ value was accepted.

Results

Our research group consisted of 468 females (85.6%), 79 males (14.4%) who were all diagnosed for CTS by clinical evaluation and the characteristics of the group are summarized in Table 1. Mean age of the females was 46.5 ± 12.2, and males was 45.8 ± 12.1 and the mean age was not found to be statistically different (p = 0.62). There was no statistically significant difference in terms of gender distribution among groups separated according to CTS severity (p > 0.05) (Table 2).

Two hundred and ninety six (54.1%) out of 547 patients had bilateral clinical diagnosis of CTS, so electrophysiological studies were done on 843 hands consisting of 424 right hand wrists and 419 left hand wrists. In comparison of patient's age and CTS severity, CTS severity among the age group of 18–35 years were significantly lower compared to patients between the ages 36–64 and above 65 years. After the BMI correction, this significance continued. When the reference group of 18–35 years was taken, the CTS development risk was found to have increased 1.86 times for 36–64 age group (95% Cl [1.08–3.20], p = 0.025), and 4.17 times for age 65 and higher (95% CI [1.86–9.35], p = 0.001). According to these findings it was determined that aging increases CTS risk independent of BMI (Table 3).

According to CTS severities, the BMI values among the groups showed statistically significant difference. When compared to the group with normal CTS degree, the BMI in mild, medium, and severe CTS groups showed significant difference (Table 4).

In right hand studies, the comparison made between the hand-wrist circumference measurement, CTS severities, and the wrist circumference of the normal group were only found to be different than the wrists of those with severe CTS (p = 0.039). When this assessment was repeated after ANCOVA done to remove the probable distorting effect of BMI, no significant relationship was found between the hand wrist circumference and CTS severity (p = 0.083) (Table 5).

When the same assessment was done for the

Table 1 Patients' characteristics

	Patients' number	Percentage (%)	Mean age ± SD (years)
Patients	547	100	
Female	468	85.6	46.5 ± 12.2
Male	79	14.4	45.8 ± 12.1
Diabetes mellitus			
Absent	453	82.8	
Present	84	15.4	
Unknown	10	1.8	
Extremity studied electrophysiologically			
Right	424	50.3	
Left	419	49.7	
Total	843	100	

CTS: carpal tunnel syndrome, SD: standard deviation.

Table 2 Comparison of gender and CTS severity

Gender	CTS Severity: number (%)				P value
	Normal	Mild	Medium	Severe	
Female	422 (57.9)	117 (16.0)	132 (18.1)	58 (7.9)	0.863
Male	67 (58.8)	15 (13.2)	23 (20.2)	9 (7.9)	
Total	489 (58.0)	132 (15.7)	155 (18.4)	67 (7.9)	

CTS: carpal tunnel syndrome.

Table 3 Comparison of age and CTS severity

Age	CTS severity: number (%)				P value*
	Normal	Mild	Medium	Severe	
18–35 years	120 (75.5)	17 (10.7)	18 (11.3)	4 (2.5)	-
36–64 years	348 (55.6)	93 (14.9)	128 (20.4)	57 (9.1)	0.025
≥ 65 years	24 (40.4)	14 (24.1)	12 (21.7)	8 (13.8)	0.001
Total	492 (58.3)	124 (14.7)	158 (18.7)	69 (8.2)	

*P is the value of the comparison of the reference group of age 18–35 years and the other groups. CTS: carpal tunnel syndrome.

Table 4 BMI values of patients with respect to CTS severity

CTS group	Number of cases	BMI value mean ± SD	P value*
Normal	490	29.1 ± 5.6	-
Mild	125	30.5 ± 4.5	0.047
Medium	156	31.2 ± 5.8	< 0.001
Severe	71	33.2 ± 6.6	< 0.007
Total	842	30.0 ± 5.7	-

*Comparison with normal group. BMI: body mass index, CTS: carpal tunnel syndrome, SD: standard deviation.

left hand wrist circumference and CTS degrees, no differences were identified prior to or after the BMI correction. When the hand wrist circumferences of the normal and severe CTS groups were compared a value of $p = 0.926$, and after BMI correction a value of $p = 0.846$ were found (Table 5).

A significant relationship was identified when the waist circumference measurement and CTS severities were examined ($p < 0.01$). The waist circumferences of groups with mild, medium, and severe CTS were found to be significantly higher than that of the normal group. When this value was re-examined after the BMI correction, the statistical significance continued (Table 6).

Discussion

This study involved patients with CTS prediagnosis based on clinical findings. CTS assessments were done on these patients through electrophysiological examinations and the relationship of CTS severity to some anthropometric measurements was researched.

Majority of the subject group were females (85.6%) but no significant difference was identified when the relationship of CTS severity and gender was investigated. Compatible with the distribution of our subjects, generally in the studies[12,13] CTS is seen more frequently in the female gender. In some studies it has been reported that the female gender is an independent risk factor.[10,14] There is also a study which concluded that gender is not a risk factor in the prevalence of CTS in obese subjects.[14]

Our study demonstrated that there is a statistically significant relationship between age and CTS severity, and that as age increases so does the CTS risk. This finding is compatible with some other research.[9,15] There are statements with respect to potential CTS risk increase with the loss of axon, development of nerve conduction, and vascular abnormalities due to aging.[15–17] When we categorized our patients according to their ages as 35 and younger, 36–64, 65 and older, and evaluated them, the CTS development risk of 36–64 age group was seen to have increased by a factor of 1.86 in comparison to the age group of 35 and younger. Besides the CTS development risk of the age 65 and older group has increased with a factor of 4.167 in comparison to the 35 and younger group. This risk increase has been identified independent of the BMIs effect as a cause for CTS. It has been reported that the success of CTS treatment is substantially lower in older patients, and in particular, old age is a negative prognostic factor in CTS decompression.[18]

DM, thyroid disease, connective tissue diseases, diseases such as amyloidosis and acromegaly, and pregnancy are risk factors in CTS development.[15,19] For this reason patients with these conditions (with the exception of DM) and DM patients with neuropathy have not been included in our research.

Our findings support the results of research reporting that CTS development risk is related to BMI and weight increase.[20–22] In our study it has been observed that as the BMI increases so does the CTS severity.

Previously the relationship between BMI and CTS had been explained through the increased fat deposit in the carpal canal and increased hydrostatic pressure in the carpal tunnel of obese individuals.[7] In one study, with carpal canal pressure measurements and ultrasonic measurement of the area where the median nerve passes, the relationship between the obesity and median nerve conduction slowdown at the wrist has been shown without median nerve swelling or canal pressure increase.[23]

Table 5 Comparison of hand-wrist circumference measurement and CTS severity after removing the effect of BMI

CTS Severity	Number	Mean	SD	P value*
Right hand wrist				
Normal	244	17.1	1.26	0.083
Mild	64	17.0	1.02	
Medium	75	17.6	1.13	
Severe	41	17.7	1.99	
Left hand wrist				
Normal	244	17.6	1.58	0.846
Mild	61	17.4	1.23	
Medium	84	17.6	1.15	
Severe	30	18.0	1.27	

*Covariance analysis (ANCOVA). BMI: body mass index, CTS: carpal tunnel syndrome, SD: standard deviation.

Table 6 Waist circumferences of patients with respect to CTS severity

CTS group	Number of cases	Waist circumference Mean ± SD	P value*
Normal	464	95.8 ± 11.8	-
Mild	114	99.1 ± 11.7	0.043
Medium	158	100.0 ± 11.7	< 0.001
Severe	60	100.7 ± 11.8	0.018
Total	796	97.4 ± 14.6	-

*P values belong to ANCOVA (adjusted for BMI) analysis for comparisons with normal group. BMI: body mass index, CTS: carpal tunnel syndrome, SD: standard deviation.

In a study done in Turkey, both BMI and waist circumferences have been found to be related to CTS severity at significant levels among female patients with CTS.[4] This finding is similar to ours where the waist circumference has been observed to be wider in severe CTS groups as compared to the normal group. In some studies it has been reported that higher value BMI increases the CTS development risk but are unrelated to the severity of the CTS.[8,21] In our study, however, as the BMI increases so does the CTS severity.

In one study, the increase in weight, height, and hand wrist width was found to be in good relation to the presence of CTS.[24] Becker et al. found no distinct relationship between the severity of CTS and hand wrist circumference.[3] In contrast to that study, our findings identified a significant relationship between the CTS severity and hand-wrist circumference. But, when the statistical evaluation was repeated after the correction of BMI effect on hand-wrist circumference, no significant relationship was observed between the hand-wrist circumference and CTS severity. This finding suggests that weight increase has an effect on CTS severity but the increase at the hand-wrist circumference has no direct effect on CTS severity. Our finding supports that the measurement of the wrist circumference does not imply a smaller carpal tunnel area.[25]

One of the limiting factors of our study is that our research group consists of only patients referred to our electrophysiology laboratory for CTS confirmation. Since this group does not represent the characteristics of the general population, it may have been constrained in its effect to assess the CTS risk. Furthermore, since the pathological findings in electrophysiological assessment may not yet have been developed in patients with new or mild severity CTS,[14] conflicting results can occur in the evaluation of these patients' relationship with the BMI. Additionally, there doesn't seem to be a consensus on electro physiologic CTS diagnostic and severity quantification criteria in the literature.[9]

In conclusion, our study has identified a relationship between CTS severity and the age, BMI, and waist circumference. Further studies are required to make clear the effect of demographic and anthropometric parameters on the physiopathology of CTS development.

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Conflicts of Interest Disclosure

The authors declare that they have no actual or potential conflict of interest with regard to the manuscript submitted and have no financial and personal relationships with other people or organizations that could inappropriately influence their work.

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