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ORIGINAL ARTICLE

The Relationship Between Clinical, Physical, Electrophysiological, Functional Findings and Body Mass Index in Patients with Idiopathic Carpal Tunnel Syndrome

İdiyopatik Karpal Tünel Sendromlu Hastalarda Klinik, Fiziksel, Elektrofizyolojik, Fonksiyonel Bulgular ve Vücut Kitle İndeksi Arasındaki İlişki

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ABSTRACT

Purpose: This study aims to research the relationship between clinical, physical, electrophysiological, functional findings and body mass index (BMI) in patients with idiopathic carpal tunnel syndrome (CTS).
Method: This study comprised 105 (48 bilateral, 9 unilateral) idiopathic CTS patients. Demographic and clinical findings and tinel, phalen, reverse phalen and carpal compression findings were evaluated and recorded. Patients with a BMI ≥ 30 were evaluated as obese. Boston Symptom Severity and Functional Capacity Scale was applied to evaluate the patients' functions. The patients were staged according to clinical and electrophysiological examinations.
Results: The mean age of the patients was 44.09 ± 10.97 years. While there was no statistically significant difference between electrophysiological staging and age, gender, functional capacity and symptom severity, there was a significant correlation between tinel test positivity and severe CTS and between the clinical stage and CTS. The symptom severity and functional capacity were significantly higher in the obese patient group than in the non-obese group. When the electro physiological characteristics of the obese and non-obese group were compared, the median nerve sensory amplitude of the obese group was significantly lower than the non-obese group.
Conclusion: Patients with obese CTS have a higher rate of loss of function and symptoms of severity than non-obese patients and this shows the importance of weight control in the treatment of these patients. In cases where the severity of the clinically obtained severity and the electrophysiological severity are not proportional, we believe that a careful examination will provide information about the severity of the disease and also the effectiveness of the treatment and the follow-up of the patients. Again, we think that stimulant tests are important in the evaluation of the disease especially in the loss of function and severity symptoms and should be routinely included in our examination.

Keywords: Carpal tunnel syndrome, electrophysiological stage, Body Mass İndex, Obesity

ÖZ

Amaç: Bu çalışmada idyopatik karpal tünel sendromu (KTS) tanısı almış hastalarda klinik, fiziksel, elektrofizyolojik, fonksiyonel bulgular ve vücut kitle indeksi (VKİ) arasındaki ilişkiyi araştırmak amaçlanmıştır.
Method: Çalışmaya toplam 105 (48 bilateral, 9 unilateral) idyopatik KTS'li el katıldı. Hastaların demografik ve klinik bulguları ve tinel, phalen, ters phalen, karpal kompresyon bulguları değerlendirilerek kaydedildi. VKİ ≥ 30 olan hastalar obez olarak değerlendirildi. Hastaların fonksiyonlarını değerlendirmek amacıyla Boston Semptom Şiddet ve Fonksiyonel Kapasite Skalası uygulandı. Hastalar klinik ve elektrofizyolojik incelemelerine göre evrelendirildiler.
Bulgular: Hastaların yaş ortalaması 44.09 ± 10.97 idi. Elektrofizyolojik evreleme ile yaş, cinsiyet, fonksiyonel kapasite ve semptom şiddet derecesi arasında istatistiksel olarak anlamlılık saptanmazken, provakatif testlerden tinel testi pozitifliği ile ağır KTS arasında ve klinik evreleri ile KTS derecesi arasında anlamlı bir ilişki saptandı. Semptom şiddeti ve fonksiyonel kapasitesi, obez hasta grubunda, obez olmayan gruba göre anlamlı olarak daha yüksek bulundu. Obez ve obez olmayan grubun elektrofizyolojik özellikleri karşılaştırıldığında obez grubun median sinir duysal amplitüd değeri anlamlı olarak obez olmayan gruba göre düşük saptandı
Sonuç: Obez KTS'li hastaların fonksiyon kaybı ve şiddet semptomlarının, obez olmayanlara göre daha fazla olması, bu hastalarının tedavisinde kilo kontrolünün önemini göstermektedir. Klinik bulgu ile elektrofizyolojik bulguların birbirini desteklemediği durumlarda, dikkatli bir muayene ile hastalık şiddeti hakkında bilgi edinilebileceği, ayrıca tedavinin etkinliğinin değerlendirilmesi ve hastaların takibinde yararlı olacağını düşünüyoruz. Yine hastalık takibinde özellikle fonksiyon kaybının ve şiddet semptomların değerlendirilmesinde uyarıcı testlerinin önemli olduğunu ve muayenemizde rutin olarak yer alması gerektiğini düşünmekteyiz.

Anahtar kelimeler: Karpal Tünel Sendromu, Elektrofizyolojik Evre, Vücut Kitle İndeksi, Obezite

Introduction

Carpal tunnel syndrome (CTS) results from the compression of the median nerve inside the carpal tunnel in the wrist. It is the most common entrapment neuropathy of the upper extremity (1,2,3). Its incidence increases in the third and fifth decades in women. Its population prevalence is reported as 10% (1,2). Various secondary causes such as endocrinological disorders (diabetes mellitus, hypothyroidism), rheumatological disorders, infections, anatomic variations, tumoral and traumatic states, amyloidosis, obesity, alcoholism may also be responsible for CTS etiology (4,5). However, the most common form is the

idiopathic CTS, in which no etiological cause can be found.

The main symptom in CTS is nighttime pain and numbness in a region corresponding to the innervation zone of the median nerve. As the disease progresses, the signs and symptoms start to appear all day long and may even progress to thenar atrophy. Nighttime symptoms are typical for CTS. Carpal tunnel syndrome is diagnosed with clinical presentation, provocation tests, and electromyography.

Among provocation tests, Phalen's test, reverse Phalen's test, Tinel's test, and carpal compression test are the most commonly used ones in clinical practice (6). These tests increase the pressure on the median nerve, causing symptoms to appear. There are conflicting views on the sensitivity and specificity of these tests performed during physical examination (6-8). They mostly produce false negative results in mild CTS. Electrodiagnostic studies are used for the definitive diagnosis of patients with clinical presentation of CTS and its differentiation from other neuropathies (9). This study aimed to examine the relationship between body mass index (BMI), age, sex, provocation tests, functional capacity, symptom severity, clinical staging, and electrophysiological staging.

Materials and method

Our study was approved by Harran University Faculty of Medicine ethics committee with the decision number of E.8254. It enrolled a total of 105 patients with idiopathic CTS (48 bilateral, 9 unilateral) who were under follow-up at Harran University Faculty of Medicine Department of Physical Medicine and Rehabilitation outpatient clinic.

Patients with secondary CTS were excluded. The patients' demographic data such as age, sex, and symptom duration were recorded. Their height and weight were measured, and BMI was calculated in terms of kg/m2. Those with BMI ≥ 30 kg/m2 were recorded as obese. Provocation tests included Phalen's test, reverse Phalen's test, Tinel's test, and carpal compression test and recorded as either positive or negative. In Phalen's test, the dorsa of both hands were kept in contact with each other with both wrists fully flexed for 60 seconds (10). Appearance of pain or numbness in the median nerve innervated zone was recorded as a positive response. Reverse Phalen's test was performed with both wrists in full extension so that both palms were in contact with each other for 60 seconds (11). Appearance of pain or numbness in the median nerve innervated zone was recorded as a positive response. Tinel's test was performed by tapping a total of six times from the distal of the transverse carpal ligament to the proximal wrist line. Presence of tingling sensation, paresthesia, or sense of electric shock along the distribution of the median nerve was considered positive test (12). Carpal compression test was performed by applying pressure on the median nerve coursing under the transverse carpal ligament with two thumbs for 30 seconds. Pain, numbness, and tingling sensation along the distribution of the median nerve was considered positive (13).

Boston Carpal Tunnel Questionnaire (BCTQ) composed of a severity scale and a functional scale was used to determine CTS severity. BCTQ consists of a total of 19 questions. The symptom severity scale contains 11 questions, and the functional capacity scale contains 8 questions. The answers consist of five options, and each question is given a minimum of one and a maximum of five points. One point corresponds to the mildest symptom or the best functional state, and five points to the severest symptom or the worst functional state. Higher mean scores indicate that CTS is severe, or the functional capacity is low (14). The validity and reliability of BCTQ's Turkish version were demonstrated by Sezgin et al. in 2006 (15). The patients were staged according to their clinical and electrophysiological evaluations. Clinically, they were categorized as follows: 1. Nighttime numbness only, 2. Nighttime and daytime numbness, 3. Sensory loss, 4. Atrophy or weakness of the thenar muscles innervated by the median nerve, 5. Plegia of the thenar muscles innervated by the median nerve (16). Stage 1 included groups 1 and 2; Stage 2 included group 3; and Stage 3 included groups 4 and 5.

Electrophysiological testing was performed using Dantec-Keypoint Ver 2,32 EMG system. The following categories of severity were defined for CTS: Mild CTS: Sensory nerve conduction velocity of the median nerve is reduced but distal motor latency is normal (<47 m/s); Moderate CTS: Sensory nerve conduction velocity of the median nerve is reduced, and its distal motor latency is prolonged (> 4 msn). Severe CTS: absence of compound sensory action potential and/or reduced amplitude (<10μV) in sensory conduction studies and/or reduced compound muscle action potential amplitude or absent response (<5μV) or excessive prolongation of latency (>6.0ms) in motor conduction study.

The relationship between age, sex, BMI, provocation tests, functional capacity, symptom severity grade, and electrophysiological staging was examined.

Statistical analysis

Statistical analyses were carried out using "Statistical Package for Social Sciences for Windows version 22.0 (SPSS, Chicago, IL, USA)" software package. Descriptive statistics were expressed as mean ± standard deviation, minimum-maximum, median values as well as frequency and percentage. Normality of distribution of continuous variables was tested using Kolmogorov-Smirnov test. Independent groups were compared using independent samples t-test or Mann-Whitney U test for quantitative variables with normal distribution, and one-sided analysis of variance (ANOVA) or Kruskal Wallis test for quantitative variables having non-normal distribution. Chi-square test was used to compare categorical variables. Correlation between continuous variables was tested using Pearson's correlation test. Level of significance was set at $P<0.05$.

Results

The mean age of the patients was 44.09 ± 10.97 years. Out of 105 patients, 97 (% 92.4%) were women and 8 (7.6%) were men. Forty-eight (92.4%) patients had bilateral CTS, and 9 (7.6%) patients had unilateral CTS. Carpal tunnel syndrome affected right hand in 54.3% of patients and left hand in 45.7%. While there was no significant difference between electrophysiological staging and age, sex, functional capacity, and symptom severity, there was a significant correlation between Tinel's test positivity and severe CTS (P=0.018) (Table 1). A significant correlation was observed between clinical stage and CTS grade (p<0.001) (Table 2).

Table 1: Relationship between electrophysiological staging and age, gender, functional capacity, symptom severity, and provocative symptoms

	Mild CTS (n=47)	Medium CTS (n=41)	Severe CTS (n=17)	*P*	*P1*	*P2*	*P3*
Age	44.24 ± 11.13	45.39 ± 11.34	40.41 ± 9.26	0.65	0.17	0.9	0.35
BMI	29.24 ± 5.05	28.82 ± 3.81	30.25 ± 5.26	0.66	0.5	0.32	0.73
Tinel's sign							
Negative	20 (%42.6)	17 (%41.5)	1 (%5.9)	0.55	0	0.01	0.02
Positive	27 (%57.4)	24 (%58.5)	16 (94.1)				
Phalen's sign							
Negative	16 (%34.0)	7 (%17.1)	3 (%17.6)	0.06	0.17	0.62	0.14
Positive	31 (%66.0)	34 (%82.9)	14 (%82.4)				
Reversed Phalen's sign							
Negative	14 (%29.8)	12 (%29.3)	4 (%23.5)	0.57	0.44	0.46	0.88
Positive	33 (%70.2)	29 (%70.7)	13 (%76.5)				
Carpal compression test							
Negative	14 (%29.8)	13 (%31.7)	5 (%29.4)	0.51	0.62	0.56	0.98
Positive	33 (%70.2)	28 (%68.3)	12 (%70.6)				
Functional capacity							
(Mean ± SD)	2.68±0.87	2.87 ± 0.77	3.14 ± 0.81	0.33	0.06	0.18	0.15
symptom severity							
(Mean ± SD)	2.45 ± 0.80	2.72 ± 0.74	2.74 ± 0.77	0.11	0.2	0.92	0.23

Mean±sd: mean±standard deviation, P: Relationship between Mild Carpal Tunnel Syndrome (CTS) and moderate CTS; P1: The relationship between mild CTS and severe CTS; P2: The relationship between Moderate CTS and Severe CTS; P3: Relationship between mild-moderate-severe CTS groups

Table 2. The relationship between clinical stages and the degree of CTS

	Mild CTS	Medium CTS	Severe CTS	P	P1	P2	P3
stage 1	38 (%59.4)	24 (%37.5)	2 (%3.1)	0.076	0	0	0
stage 2	7 (%20.6)	16 (%47.1)	11 (%32.4)				
stage 3	2 (%28.6)	1 (%14.3)	4 (%57.1)				

CTS: Carpal Tunnel Syndrome P: Relationship between mild CTS and moderate CTS; P1: The relationship between mild CTS and severe CTS; P2: The relationship between moderate CTS and severe CTS; P3: Relationship between Mild-Moderate and Severe CTS

Symptom severity and functional capacity were significantly higher in obese patients than the non-obese group (P=0.001, P=0.001) (Table 3). There was a positive correlation between total functional and severity scores (p<0.001, r=1).

A comparison between the electrophysiological findings of the obese and non-obese groups showed that the obese group had a significantly lower median nerve sensory amplitude than the non-obese group (p=0.044). A negative correlation was found between symptom severity score and median nerve sensory potential amplitude (p=0.032, r=- 0.209).

Table 3. Analysis of the difference between symptom severity and functional capacity and BMI

	obese (n=44)	non-obese (n=61)	*p*
Age (Mean±SD)	45.61 + 8.89	43.00 + 12.21	0.060[1]
symptom severity score (MV (min–max))	3 (1.09-4.0)	2.3 (1.09-3.90)	0.001[2]
Functional capacity score (MV (min–max))	3 (1.25-4.37)	2.62 (1- 4.25)	0.020[2]

SD; Standard deviation; MV (min–max): Median value (min–max); [1]; independent samples t-test; [2]: Mann-Whitney U test

Discussion

Carpal tunnel syndrome is the most common entrapment neuropathy. It is more common in women, in the third and fifth decades (1,2,17). In line with previous studies, this study found that CTS patients had a mean age of 44.09 years, and its prevalence was higher in women (92.4%). Its symptoms are usually bilateral, with the dominant hand being more severely affected. Among our patients, 92.4% had bilateral CTS and 53.4% had right hand disease.

Increased BMI has been described as a risk factor for CTS among individuals younger than 63 years of age (18). In a meta-analysis, Shiri et al. concluded that every 1-unit increase in BMI increased the risk of CTS by 7.4% (19). They reported a significant correlation between CTS stage and BMI values, and patients with severe CTS had higher BMI values (20,21). Our study did not reveal any significant correlation between BMI and CTS severity but found higher mean functional capacity and symptom severity scores in obese

patients than non-obese ones. Naik et al., in a study on healthy obese individuals, reported prolonged latency and reduced amplitude of motor nerves of the upper and lower extremities examined (22). The compressive effect of hydrostatic pressure secondary to fluid retention as a metabolic complication of fatty tissue in the carpal tunnel or obesity may lead to CTS (17). Fat is an important component of nerves; malnutrition and an excessive increase in adipose tissue can cause neural dysfunction (23,24). A significant negative correlation between increased BMI and nerve amplitude has been reported in the literature (25). Likewise, a comparison of the electrophysiological properties of the obese and non-obese groups showed a significantly reduced median nerve sensory amplitude levels in the obese group compared with the other group (p=0.044).

Tinel's test has a sensitivity of 60% and a specificity of 67% (26). In a study by Güney et al., where clinical, electrophysiological, and quantitative MR studies of idiopathic CTS patients were evaluated, a significant correlation was found between Tinel's and Phalen's test positivity and clinical, electrophysiological stage (27). Our study did not demonstrate any significant correlation between the tests other than Tinel's test and CTS severity.

Although electrophysiology is the gold standard for the diagnosis, it provides us with objective data. However, some patients may have normal electrophysiological findings despite having CTS clinically (28). This is a result of the existence of unaffected nerve fibers. Our study found a significant correlation between the clinical findings and electrophysiological findings of our patients.

Conclusion

More severe functional loss and symptoms in obese CTS patients compared with their non-obese counterparts indicates the importance of weight loss in the treatment of CTS patients.

There may be no correlation between electrophysiological severity and clinical severity. A good physical examination may provide information about CTS severity. We believe that this would be useful for assessing treatment efficacy and patient follow-up. We think that provocation tests are important particularly for the assessment of symptoms and functional loss during follow-up and should be routine part of physical examination.

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