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Evaluation of Wrist Range of Motion and Hand Grip Strength in Women with the Diagnosis of Carpal Tunnel Syndrome: A Controlled Study

Karpal Tünel Sendromu Tanısı Almış Kadınlarda El Bilek Eklem Hareket Açıklığının ve El Kavrama Gücünün Değerlendirilmesi: Kontrollü Çalışma

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ABSTRACT Objective: Carpal tunnel syndrome (CTS) is the most common entrapment neuropathy in the community. When diagnosed early, it can be easily treated by pharmacological and non-pharmacological methods. The aim of this study was to evaluate wrist range of motion (ROM) and grip strength in women diagnosed with carpal tunnel syndrome and to compare the results with those of the controls. **Material and Methods:** Twenty-eight women with bilateral CTS were included in this cross-sectional study. The control group consisted of 41 healthy age and gender matched volunteers who had right hand dominancy. Wrist range of motions (ROM) were measured by goniometer. For the intrarater and interrater reliability studies, wrist ROM measurements were performed in 10 healthy volunteers at the beginning of the study. Intraclass correlation coefficient (ICC) values were calculated. Grip strength was measured by hydraulic hand dynamometer. **Results:** Wrist extension values in the CTS and control groups were 62.66±15.56° and 77±9.9°, respectively. Wrist flexion values were 57.66±11.89° in the CTS and 67.38±4.7° in the control groups. The mean grip strength values in the patient and control groups were 15.32±7.27 kg and 40.40±7.80 kg, respectively ($p<0.001$). The ICC values were between 0.61-0.98 for the intrarater reliability, ICC values were between 0.76-0.97. Wrist flexion, extension, radial, ulnar deviation and hand grip strength were significantly lower in the CTS group than the control group ($p<0.00$). **Conclusion:** Wrist ROM and hand grip strength of patients with CTS resulted in decreased wrist movements and hand grip strength when they were compared with the healthy control group. Evaluating wrist ROM and hand grip strength are measurable parameters that can be used in CTS assessment.

Keywords: Carpal tunnel syndrome; wrist; range of motion measurement; hand grip strength

ÖZET Amaç: Karpal tünel sendromu (KTS) toplumda en sık görülen tuzak nöropatidir. Erken tanı konulduğu zaman farmakolojik ve farmakolojik olmayan yöntemlerle kolayca tedavi edilebilir. Bu çalışmanın amacı karpal tünel sendrom tanısı almış kadınlarda el bileği hareket açıklığı ve kavrama kuvvetini değerlendirmek ve kontrol grubu ile karşılaştırmak idi. **Gereç ve Yöntemler:** Kesitsel çalışmamıza elektrofizyolojik olarak hafif- orta şiddette bilateral karpal tünel sendromu tanısı almış 28 kadın dahil edildi. Kontrol grubu yaş ve cinsiyet eşitliği sağlanmış sağ el dominant olan sağlıklı 41 gönüllüden oluşuyordu. El bileği eklem hareket açıklığı (EHA) gonyometre ile ölçüldü. Uygulayıcılar arası ve test uygulamaları arası güvenilirlik çalışmaları için, çalışmanın başında 10 sağlıklı gönüllüde bilek EHA ölçümleri yapıldı. Sınıf içi korelasyon katsayısı (SKK) hesaplandı. El kavrama kuvveti, hidrolik el dinamometresi ile ölçüldü. **Bulgular:** KTS ve kontrol grubunda el bileği ekstansiyon derecesi sırasıyla 62,66°±15,56°ve 77°±9,9° idi. El bileği fleksiyon derecesi KTS'e 57,66°±11,89°, kontrol grubunda 67,38°±4,7° idi. Hasta ve kontrol grubundaki ortalama kavrama kuvveti sırasıyla 15,32±7,27 kg ve 40,40±7,80 kg idi ($p<0,001$). SKK değerleri uygulamalar arası güvenilirliği için 0.61-0.98 arasındaydı, SKK değerleri 0.76-0.97 arasındaydı. KTS grubundaki el bileği fleksiyonu, ekstansiyonu ve radial, ulnar deviasyon derecesi ve el kavrama kuvveti kontrol grubundan anlamlı derecede düşük olarak değerlendirildi ($p<0.00$). **Sonuç:** KTS'li hastalar, sağlıklı kontrol grubu ile karşılaştırıldığında el bilek hareketlerinde ve el kavrama kuvvetinde azalma görülebilir. El bileği EHA ve el kavrama kuvvetini değerlendirmek, KTS değerlendirmesinde kullanılabilecek ölçülebilir parametrelerdir.

Anahtar Kelimeler: Karpal tünel sendromu; el bileği; eklem hareket açıklığı; el kavrama kuvveti

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Carpal tunnel syndrome (CTS) is the most common compression neuropathy, which is estimated to occur up to 4% in the general population.[1-3] If recognized early, it is readily treatable in pharmacological and non-pharmacological methods.[4] CTS is caused by median nerve compression due to increased pressure in the canal.[5,6] Interstitial fluid pressure rises due to intrinsic or extrinsic factors leading to median nerve compression.[6] Local ischemia with mechanical compression plays a role in the development of CTS. Pathological changes occur in the flexor tendons and median nerve in the carpal tunnel of the people that exposed to repetitive hand and finger movements.[7] The amount of increase in the pressure depends on how forcefully the hand and fingers are used.[3] There are some changes in the vascular morphology and elastin distribution in the subsynovial connective tissues of the tendon sheath in patients with CTS.[8] Although clinical presentation can be different, the most frequent symptom is paresthesia, followed by pain and weakness in the fingers those are innervated by the median nerve.[9,10] Pain and immobilization due to using splint may cause decreased wrist range of motion (ROM) in CTS. ROM is a measurable parameter that gives information about the functional status of hand.[11] However, in CTS wrist ROMs are not a component of routine examination.

Measuring motor functions can give useful information about the disease severity in CTS. Hand grip strength can be measured easily by the hand dynamometers and shows motor status of upper extremities.[12] Muscle testing of thenar muscles by a dynamometer is helpful for the follow-up of the patients with CTS.[2] Both wrist ROM and hand grip strength are important parameters for the functional status of hand.

The aim of this study was to investigate the wrist ROMs and hand grip strength in women with CTS and compare the results with those of healthy volunteers.

MATERIAL AND METHODS

First of all intratester and intertester reliability studies for wrist ROM measurements were performed in this study.

For wrist flexion measurement, the goniometer was placed on the radial side as its movement axis on the styloid. While the elbow was at 90º flexion, the wrist was in the neutral position. As the wrist was flexed, the fixed arm of the goniometer was held on the radius, while the mobile arm was moving parallel to the second metacarpal bone.

For extension measurement, wrist and goniometer positions were similar. As the wrist was going to extension position, passive flexion movements for the fingers were allowed.

Radial deviation measurement was performed while the forearm was kept on the table at pronated position and the goniometer was placed on the dorsal side. At point zero, the wrist was kept in the neutral position. The fixed arm of the goniometer was placed on the forearm midline and the moving arm was placed on the third metacarpal bone. While the wrist deviated radially, the arm of the goniometer over the third metacarpal bone was moved and the angle was measured. For ulnar deviation the goniometer was positioned in the same as radial deviation measurement and this time the wrist was moved to the ulnar direction.[13]

INTRARATER AND INTERRATER RELIABILITY STUDIES FOR THE WRIST ROM

For the intrarater reliability, wrist ROM measurements were performed in 10 healthy volunteers to compare the measurements on different times. The investigator measured the wrist ROM twice with one week interval. Intraclass correlation coefficient (ICC) values were calculated for the intrarater reliability. Correlation coefficient was between 0.61-0.98 for the intrarater reliability (Table 1). The correlation coefficients were higher than 0.96 except the lowest value for radial deviation. ICC values between 0,69-0,98 are considered as acceptable reliability.[14]

Interrater reliability, was studied in 10 healthy volunteers to compare the measurement results of two investigators. Wrist flexion/extension and radial-ulnar deviation ranges of 10 healthy subjects were measured by two investigators in the same day. The ICC was calculated for the interrater reliability, ICC values were between 0.76-0.97 for the interrater reliability (Table 2).

TABLE 1: Intrarater reliability results for wrist range of motion measurements.

Intrarater reliability	r (ICC)	p
Flexion	0.981	0.000
Extension	0.980	0.000
Radial deviation	0.693	0.057
Ulnar deviation	0.968	0.000

ICC: Intraclass Correlation Coefficient.

TABLE 2: Interrater reliability results for wrist range of motion measurements.

Interrater Reliability	r (ICC)	p
Flexion	0.971	0.000
Extension	0.897	0.002
Radial deviation	0.934	0.000
Ulnar deviation	0.764	0.028

ICC: Intraclass Correlation Coefficient

Twenty-eight women with bilateral CTS who admitted to the outpatient clinic between January 2009 and April 2009 were included consecutively in this study. Median nerve pathology was confirmed with nerve conduction studies in the patient group. All the patients had mild to moderate CTS as shown electrophysiologically. Patients who had rheumatologic diseases, hand and wrist deformities, previous fractures, surgical intervention for CTS, splint, injections or nonsteroidal anti-inflammatory drug treatment for CTS in the last 3 months, severe CTS with distal motor latency ≥6.5 ms were excluded. Routine blood biochemical studies were performed. Control group consisted of sex and age matched 41 healthy volunteers. Some of the women in control group were hospital employees. Dominant hands were all right in the patient and control groups. Active wrist range of motion and hand grip strength were measured by the two clinicians in both groups.

Hand grip strength was measured with Jamar hydraulic hand dynamometer (Sammon Preston Inc., Il, USA). Three consecutive measurements were taken and mean values were recorded.

The patients completed the Boston Questionnaire Functional Status Scale (BQ-FSS). The BQ was developed by a group of hand surgeons, rheumatologists and patients to assess the carpal tunnel syndrome-related pain, paresthesia, numbness, weakness, nocturnal symptoms and general functional status by Levine et al.[15] The BQ consisted of two scales: Symptom Severity Scale and Functional Status Scale. The FSS evaluates 8 usual daily activies as writing, holding a book, buttoning up, holding a phone, opening a jar, doing carrying shopping bags, doing house work, bathing and dressing. Every item has a score between 1-5 (1= without difficulty 5=not possible). Higher scores show higher disability level related with the activity. The reliability and validity of the Turkish version of the BQ have been studied.[16]

This study was approved by the ethics committee of the hospital. Informed consent was obtained from the participants.

STATISTICAL ANALYSIS

The results are expressed as mean±standard deviation. Mann-Whitney U test was used for comparison of demographic data, wrist ROM and hand grip strength values of the groups. A p value of <0.05 is considered as statistically significant.

RESULTS

Fifty-six hands with CTS and 82 hands of the control subjects were evaluated in the study. Clinical characteristics of the patients with CTS and control groups are shown in Table 3. There was no statistically significant difference between the ages of the study groups (p>0.05). On the other hand, body mass index (BMI) values were significantly higher in the CTS group than that of the controls (p<0.05).

Wrist flexion/extension and radial-ulnar deviation values in the CTS group were significantly lower than that of the controls (p<0.00). Hand grip strength was also significantly lower in the CTS group as compared to the controls (p<0.00).

In the CTS group, wrist extension and ulnar deviation values were negatively correlated with age (p:0.047 r:-0.379; p:0.022 r:-0.432). Hand grip strength did not correlate with age, BMI, wrist flexion/extension and radial-ulnar deviation and FSS (p>0.05).

TABLE 3: Clinical characteristics.

Parameters	CTS group Mean±SD (min-max)	Control group Mean±SD (min-max)	p value
Age (years)	53.04±11.94 (23-70)	51.05±12.2 (31-85)	0.50
BMI (kg/m²)	32.23±4.50 (23.04-41.20)	28.62±5.73 (18.66-50.44)	0.005*
Hand ROM (°)			
Flexion	62.66±15.57 (24-86)	77.00±9.97 (20-90)	0.001*
Extension	57.66±11.89 (38-80)	67.38±4.70 (52-80)	0.001*
Radial deviation	18.34±4.15 (10-30)	21.20±3.48 (12-30)	0.001*
Ulnar deviation	27.25±7.87 (10-43)	31.98±3.70 (20-43)	0.001*
Grip strength (kg)	26.29±13.15 (5-59)	70.00±13.76 (45-83)	0.001*
BQ FSS	2.07±0.75 (1-5)	1.00±0 (1-5)	0.001*

*p<0.05.

CTS: Carpal Tunnel Syndrome; BMI: Body mass index; ROM: Range of motion; BQ FSS: Boston Questionnaire Functional Symptom Score; SD: Standard deviation; Min: Minimum; Max: Maximum.

DISCUSSION

Wrist flexion/extension and radial-ulnar deviation values in CTS group were significantly decreased compared to the control group in this study.

Local hyperplasia and fibrosis around the median nerve and flexor tendons in the canal has been documented in CTS.[17] The synovial connective tissue in the carpal tunnel has highly specialized function which includes providing a bed for tendon gliding, while serving as a source of tendon nutrition.[18] Synovial hypertrophy occurs in the carpal tunnel and mechanical properties and mobility of the synovial hypertrophy are altered in the patients with CTS.[18,19] These pathologies involving the joint may lead to limitation in the wrist ROM.[17] Franco et al., suggested that significant functional limitation occurs after progressive limitation of wrist motions with splinting in healthy people.[20] We excluded the patients with CTS who had used splint in the last 3 months before this study, to avoid immobilization effect of the splint.

Another important finding is that hand grip strength in CTS group was significantly lower than that of the controls in this study. Hand grip strength was 26.29±13.15 in CTS, however, it was 70.00±13.76 in control group. Baker et al. concluded that hand grip strength was 42.00±17.68 in the women with CTS before treatment. After 4-week lumbrical splint and stretching exercises, the authors reported an increase in the hand grip strength in the same study.[21] Fernandes et al. reported that hand grip strength was 12.56±4.30 in the patients who had thenar atrophy due to CTS.[22] Because the patients with CTS had electrophysiologically mild to moderate nerve compression severity, hand grip strength values were higher in our study.

It is noteworthy that hand grip strength usually decreases in CTS, even though there is no thenar atrophy. It is suggested that pinch strength was more specific for CTS in a previous study, however, hand grip strength was reported more responsible than pinch strength to the changes after carpal tunnel surgery in another study.[2,23] Nevertheless pinch strength evaluates thenar region muscles specifically, the first carpometacarpal joint osteoarthritis is a common problem with advancing age that can interfere with the pinch strength.[23]

In this study, hand functions did not correlate with the wrist motions in CTS. Wrist flexion/extension values were 62/57˚, radial-ulnar deviation values were 18-27˚ in CTS group. Although wrist motions in all directions were limited in CTS group, ROM was enough to perform the daily living activities. Brumfield and Champoux reported that 10˚ wrist flexion and 35˚ extension were enough for activities of daily living.[24] According to the other studies 5-40˚ wrist flexion, 30-40˚ extension, 10˚ radial deviation and 15-30˚ ulnar deviation are essential to perform most activities.[25,26] Only extension and ulnar devia-

tion of wrist correlated negatively with aging in CTS group in this study. Walker et al., reported that ROM of wrist was decreased by aging in women.[11]

This study has some strengths. To our knowledge, this is a study in which the wrist ROM in the patients with CTS was measured and the comparison of the results with that of the controls was performed. Moreover, the intrarater and interrater reliability studies of wrist ROM measurement have been done in the study. Lastly all measurements were performed by the same two physicians. The limitation of this study is the absence of follow-up of the wrist motion and hand grip strength values after treatment due to the cross-sectional design of the study.

In conclusion, wrist motions and hand grip strength decreased in the patients with CTS compared to the control group. Wrist ROM and hand grip strength measurement seem useful in assessing CTS.

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