Diagnostic Significance of Ultrasonography in Carpal Tunnel Syndrome and Comparison with Electrodiagnostic Tests

Karpal Tünel Sendromu'nda Ultrasonografi'nin Tanısal Değeri ve Elektronöromyografik Testlerle Karşılaştırılması

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Summary

Objective: The purpose of this study was to compare the diagnostic sensitivity of ultrasonographical and electrophysiological parameters in carpal tunnel syndrome, and investigate their association with clinical symptoms and data.
Materials and Methods: A total of 100 wrists of 54 patients clinically pre-diagnosed with carpal tunnel syndrome and 45 wrists of 25 healthy individuals were evaluated in this present study. Both groups underwent electroneuromyographical and ultrasonographical investigation. Scores were established in the patient group by utilizing symptom severity and functional status scales.
Results: No significant correlation was established between the duration of the symptoms and electrophysiological and ultrasonographical parameters. Of the 100 symptomatic wrists, 80 wrists had pathology in at least one electrophysiological parameter indicating carpal tunnel syndrome. Ultrasonographical examination revealed that the median nerve cross-sectional area was above the normal range in 19% of the patients at the radioulnar level, in 33% of the patients at the pisiform level and in 18% of the patients at the hamate hook level. No significant correlation was observed between electrophysiological and ultrasonographical parameters in general.
Conclusion: The data obtained in this study indicated that the diagnostic sensitivity of ultrasonographical parameters was considerably lower than that of the electrophysiological parameters in patients with carpal tunnel syndrome. *Turk J Phys Med Rehab 2009;55:13-8.*
Key Words: Carpal Tunnel Syndrome, ultrasonography, electrophysiological parameters

Özet

Amaç: Karpal tünel sendromunda ultrasonografik ve elektrofizyolojik parametrelerin tanısal duyarlılığını karşılaştırmak, klinik semptom ve bulgularla ilişkilerini araştırmaktır.
Gereç ve Yöntem: Çalışmada klinik olarak karpal tünel sendromu ön tanısı alan 54 hastanın 100 el bileği ve 25 sağlıklı gönüllü bireyin 45 el bileği incelendi. Her iki grupta da elektronöromiyografik ve ultrasonografik inceleme yapıldı. Hasta grubunda semptom şiddet skalası ve fonksiyonel durum skalası skorları kaydedildi.
Bulgular: Hastaların şikayet süreleri ile elektrofizyolojik ve ultrasonografik parametreler arasında anlamlı bir ilişki bulunamadı. Semptomatik 100 el bileğinden 80'inde karpal tünel sendromunu destekleyen elektrofizyolojik parametrelerden en az birinde patoloji saptandı. Ultrasonografik incelemede median sinir kesit yüzey alanının radioulnar düzeyde %19, pisiform düzeyde %33 ve hamat çengel düzeyinde %18 olguda normal sınırların üzerinde yer aldığı görüldü. Genel olarak elektrofizyolojik ve ultrasonografik parametreler arasında anlamlı bir ilişki saptanmadı.
Sonuç: Bu çalışma verileri ultrasonografik parametrelerin karpal tünel sendromu olgularındaki tanısal duyarlılığının, elektrofizyolojik parametrelere oranla çok daha düşük olduğu yönündedir. *Türk Fiz Tıp Rehab Derg 2009;55:13-8.*
Anahtar Kelimeler: Karpal Tünel Sendromu, ultrasonografi, elektrofizyolojik parametreler

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Introduction

Carpal tunnel syndrome occurs as a result of chronic compression of the median nerve in the carpal tunnel whose dorsal medial and lateral walls are formed by carpal bones and whose volar surface is formed by deep transverse carpal ligaments (1). Carpal tunnel syndrome is the most common form of peripheral nerve entrapment (2). Carpal tunnel syndrome is observed primarily among people between the ages of 40 and 60 and it is 2 to 5 times more prevalent among women than men (3). About 50-87% of the cases are bilateral. Although several diseases may lead to Carpal tunnel syndrome, over 50% of carpal tunnel syndrome cases are idiopathic (4). Carpal tunnel syndrome is generally diagnosed by means of clinical data. Electrophysiological studies are consulted for confirming the diagnosis as well as for differential diagnosis. However, they provide no information regarding median nerve morphology and possible etiological factors (5). The Ultrasonographical approach may be an alternative in Carpal tunnel syndrome diagnosis. Several investigators have published the results of their studies on utilizing sonography in the diagnosis of carpal tunnel syndrome, particularly after 1999 (6).

This present study aimed to evaluate the carpal tunnel ultrasonographically in healthy volunteers and patients with clinical symptoms and data, to investigate diagnostic consistency and the correlation between ultrasonographical and electrophysiological parameters while comparing their diagnostic sensitivity.

Materials and Methods

A total of 100 symptomatic wrists of 54 women patients (46 patients bilateral, 8 patients unilateral) clinically pre-diagnosed with carpal tunnel syndrome and 45 wrists of 25 healthy women (23 left and 22 right wrists) were evaluated prospectively. While the age range for the patient group was 42-79 years with a mean age of 55.2±8.1 years, the age range for the controls was 37-70 years with a mean age of 49.6±6.7 years. Individuals with another disease involving peripheral nervous system or those on a drug regimen, which can have an impact on it, those with a history of wrist surgery or wrist fracture, were excluded.

The intensity of the symptoms in the patient group was assessed by using "Symptom Severity Scale" while "Functional Status Scale" was utilized for the impact on daily activities (7,8). These two scales when combined together are also called "the Levine questionnaire" composed of 19 questions and used to evaluate symptom severity and functional status in carpal tunnel syndrome patients. There are 11 questions in the symptom severity scale and each question is answered by assigning a value ranging from 1 to 5, eventually reaching a mean score (sum total of the scores/11). It has a maximum score of five. Higher scores indicate more intense symptoms. Functional Status Scale questions the degree of difficulty encountered in carrying out eight different daily activities (7,8). Each question is answered by assigning a value ranging from one to five, eventually reaching a mean score (sum total of the scores/8). It has a maximum score of five. Higher scores indicate higher disability (7,8). All patients were administered with Tinel, Phalen and Buda tests as well, and were established to be positive or negative.

Nerve conduction studies: Electroneuromyographic examinations were performed by a physiatrist? Motor and sensory nerve conduction studies were carried out by using conventional methods both for the patient and the control groups. Median and ulnar nerve motor conduction velocity, distal motor latency, amplitude of compound muscle action potential, median and ulnar nerve antidromic sensory conduction velocity, distal sensory latency and amplitude of sensory action potential, median nerve palm-to-wrist segment mixed orthodromic sensory conduction velocity, radial nerve antidromic sensory conduction velocity and amplitude of sensory action potential were established. Furthermore, median-2nd lumbrical/ulnar-1st palmar, 2nd dorsal interosseal motor latency difference and fourth digit median-ulnar nerve antidromic sensory latency difference were established as well.

Electrophysiological parameters were assessed according to the normal values determined by our laboratory. A minimum room temperature of 25°C and extremity distal skin temperature of >32°C was maintained for all electrophysiological measurements. A Medelec® Synergy Multimedia EMG/EP (Oxford Instruments) was used for performing the measurements.

Wrist ultrasonography: Ultrasonographic examinations were performed by a single radiologist, blinded to the diagnostic and electrophysiologic data, without querying the subject regarding clinical status. An ultrasonography system equipped with linear-array transducer at VFX 13.5 MHz (Siemens-Antares) was used. Patients were examined while the forearm flexor compartment was facing up with their wrists in neutral posture, and the transducer at a right angle to the wrist by exerting minimum compression. Hypoechoic median nerve and hyperechoic tendons were differentiated in the longitudinal (sagittal) imaging plane. Synovial fluid presence, as well as median nerve and tendon echogenity in the carpal tunnel were assessed in this plane. As it was difficult to differentiate the median nerve because of the tendon and/or median nerve echogenity in certain patients, they were asked to flex their fingers to observe the movement of the tendons to differentiate the median nerve. The long axis (transverse diameter) and the short axis (anteroposterior diameter) of the median nerve, were evaluated on axial (transverse) plan evaluated on milimetric measurement of proximal (distal radioulnar joint level, RU), medium (pisiform bone level, P) and distal (level of the hamate hook, H) parts of the carpal tunnel and the flattening ratio was established for each plane (by dividing long axis with short axis). Furthermore, cross-sectional area was calculated as cm^2 at these levels by manually establishing the borders of the median nerve in the axial plane. Median nerve swelling ratio was calculated by dividing the cross-sectional area of the median nerve at the pisiform level by the cross-sectional area at the distal radioulnar level. The distance of the midpoint of the line drawn from trapezial tubercule to the hamate hook to the flexor retinaculum at the level of the distal carpal tunnel (bowing of the flexor retinaculum) was also calculated. Patients with bifid median nerve were excluded in order to avoid inconsistencies in measurements. The values, which were 2 standard deviations above or below the data obtained from the healthy volunteers, were considered to be pathologic.

This present study was approved by the local ethics committee of the Baskent University Hospital and informed consents were obtained from the subjects.

Statistical Analysis

Mean values, standard deviations, and prevalence were calculated for all the variables investigated. Pearson correlation coefficient was used in investigating the correlation between continuous data. Student-t test was utilized for evaluating inter-group differences. McNemar chi-square test was used for testing the differences between the diagnostic sensitivity of electrophysiological tests and ultrasonographical parameters. Cohen kappa value was calculated by using kappa statistics for assessing consistency between the methods. A value of $p<0.05$ was considered to indicate a statistically significant difference.

SPSS for Windows 11.0 software was used for conducting the statistical analyses.

Results

The symptom duration was between 2-264 months in the patient group (mean 54.84±63.99). Tinel, Phalen and Buda tests were positive in 22%, 33%, and 29% of wrists respectively. Furthermore, Symptom Severity Scale scores in the patient group ranged between 1 and 4.45 (mean 2.26±0.7), while functional status scale scores ranged between 1 and 4.25 (mean 2.14±0.8).

Symptom duration and age and symptom severity scale scores were not observed to be correlated significantly. However, symptom duration and functional status scale scores were established to have a weak but positive correlation (p=0.012, r=0.25). On the other hand, functional status scale and symptom severity scale scores were observed to have a positive linear correlation (p=0.000, r=0.69).

Nerve conduction studies: In 80 wrists at least one impaired electrophysiological parameter indicating carpal tunnel syndrome was found. Ratios of pathological findings regarding electrophysiological parameters in the patient group are given in Table 1, while electrophysiological parameters for both groups can be observed in Tables 1 and 2.

Functional status scale was observed to be moderately correlated with median nerve distal motor latency (p=0.000, r=0.36), and weakly correlated with median distal sensory latency (p=0.029, r=0.22). Similarly, there was a weak positive correlation between symptom severity scale scores and median distal motor latency (p=0.004, r=0.28). The other electrophysiological parameters were not significantly correlated with functional status scale and symptom severity scale scores.

Table 1. Number of pathologies observed in peripheral nerve conduction studies.

	Number of hands with abnormality	Sensitivity (%)	Criteria for abnormality
MMDL	53/100	53	>4 msec
MSDL	65/100	65	>3.41 msec
MPWCV	58/100	58	<35.9 mm/sec
amp PWAP	46/100	46	<32.4μV
IV. SLD	60/100	60	>0.5 msec
LILD	71/100	71	>0.5 msec

MMDL: Median motor distal latency, MSDL: Median sensory distal latency, MPWCV: Median mixed palm-wrist conduction velocity, amp PWAP: Amplitude of palm-to-wrist segment mixed nerve action potentials, IV. SLD: Fourth digit median-ulnar sensory latency difference, LILD: Lumbrical-interosseal median ulnar motor latency difference

Results of the ultrasonographical examination: Ultrasonographical examination revealed a cyst in one wrist and synovial fluid elevation in three wrists. The number of wrists with at least one abnormal ultrasonographical parameter in the patient group was 47. Ratios of pathological findings regarding ultrasonographical parameters in the patient group are given in Table 3, while ultrasonographical parameters for both groups can be found in Table 4. Increased median nerve cross-sectional area at radioulnar and pisiform levels for the patient group can be observed in figures 1 and 2.

Except for the weak correlation between certain parameters, electrophysiological and ultrasonographical parameters were not observed to be correlated significantly (Table 5). McNemar chi-square test, used to assess to compare the diagnostic sensitivity of electrophysiological and ultrasonographical parameters, revealed significant differences between the sensitivity of all electrophysiological and ultrasonographical parameters and non-random consistency coefficients of the methods were found to be low (Table 6).

Table 2. Electrophysiological parameters.

	Patient group	Control group	p
MMDL (msn)	4.14±1.26	2.99±0.3	0.000
MSDL (msn)	3.86±0.86	2.89±0.2	0.000
MPWCV	34.6±7.71	45.1±4.06	0.000
amp PWAP	37.6±24.5	42.9±11.8	0.085
LILD (msn)	1.04±0.9	0.18±0.1	0.000
IV. SLD (msn)	1.06±0.9	0.10±0.2	0.000
amp SNAPs (μV)	44.4±24.9	61.7±23.1	0.000
amp CMAPs (μV)	8.1±3.0	10.20±2.0	0.000

MMDL: Median motor distal latency, MSDL: Median sensory distal latency, MPWCV: Median mixed palm-wrist conduction velocity, amp PWAP: Median amplitude of palm-to-wrist segment mixed nerve action potentials, LILD: Lumbrical-interosseal median ulnar motor latency difference, IV. SLD: Fourth digit median-ulnar sensory latency difference, amp SNAPs: Amplitude of antidromic sensory nerve action potential, amp CMAPs: Amplitude of compound muscle action potentials

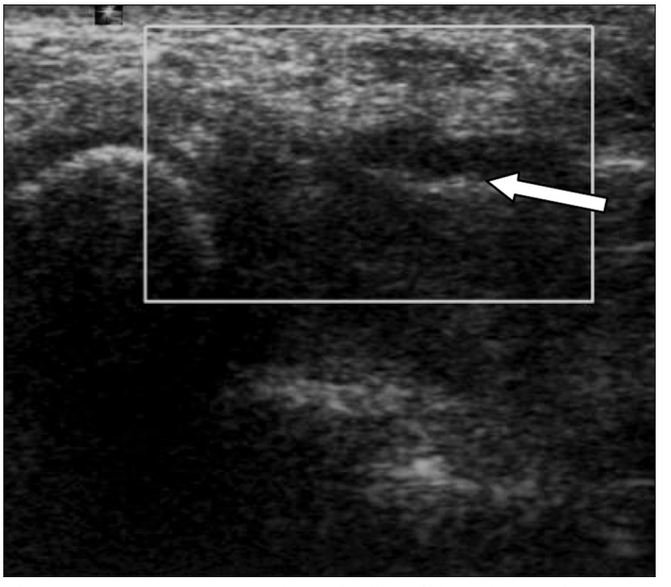

Figure 1. Transverse ultrasound examination of the wrist showing an enlarged median nerve at level of pisiform bone (arrow).

Discussion

This present study demonstrated that ultrasonographical parameters were significantly less sensitive when compared with electrophysiological parameters in the diagnosis of patients clinically pre-diagnosed with carpal tunnel syndrome and that non-random consistency coefficients between the parameters of the two approaches were low. Furthermore, ultrasonographical parameters were not correlated significantly with functional assessment or with clinical assessment results based on symptom severity.

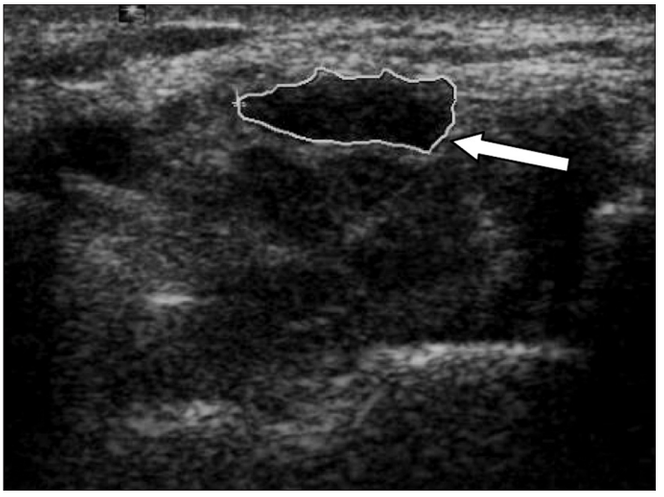

Figure 2. Transverse ultrasound examination of the wrist showing an enlarged median nerve at level of distal radioulnar joint (arrow).

Carpal tunnel syndrome patients can be diagnosed based on their clinical symptoms and findings. Electrodiagnostic tests are helpful in confirming the diagnosis and also in evaluating the pathogenetic process and the level of neuropathy (9). The major limitations of electrodiagnostic tests are their inability to provide information regarding median nerve morphology and possible etiological factors and pain during the tests conducted. Therefore, diagnostic ultrasonography, due to its noninvasive and practical administration and ability to provide anatomical and etiological information, has become increasingly common.

Diagnostic ultrasonographical parameters in carpal tunnel syndrome demonstrated in previous studies can be listed as increased bowing of the flexor retinaculum, increased flattening ratio or above normal cross-sectional area of the median nerve in the carpal tunnel proximal (inlet), middle section, and outlet (distal) (10). Different characteristics of study groups, variations in measurement methods (direct-indirect) and instruments used (equipment specifications) have led to differences in normal range definitions, diagnostic sensitivity as well as specificity. While diagnostic sensitivity has been reported to be about 76.5% in methods using indirect measurement, direct approaches have reported diagnostic sensitivity of up to 82.4% (2).

Table 3. Number of pathologies observed in the three levels.

	Number of hands with abnormality	Sensitivity (%)	Sensitivity criteria
CARUJ	19/100	19	>14 mm
MNAP	33/100	33	>14 mm
MNAH	18/100	18	>14 mm
FRRU	6/100	6	>4
FRP	2/100	2	>4
FRH	2/100	2	>4
MNSR	6/100	6	>1.5
BFR	2/100	2	>3:5 mm

CARUJ: Median nerve cross-sectional area at the radioulnar joint level, MNAP: Median nerve cross-sectional area at the level of the pisiform, MNAH: Median nerve cross-sectional area at the level of the hamate hook, FRRU: Flattening ratio at the radioulnar joint level, FRP: Flattening ratio at the level of the pisiform, FRH: Flattening ratio at the level of the hamate hook, MNSR: Median nerve swelling ratio, BFR: Bowing of the flexor retinaculum

Table 4. Ultrasonographical parameters.

	Patient group	Control group	p
CARUJ	0.15±0.1	0.09 ±0.02	0.000
MNAP	0.16±0.1	0.10±0.02	0.000
MNAH	0.14±0.1	0.09±0.02	0.005
FRRU	2.7±0.7	2.7±0.7	0.911
FRP	2.6±0.6	2.5±0.7	0.404
FRH	2.6±0.6	2.5±0.7	0.401
MNSR	1.13±0.2	1.09±0.2	0.382
BFR	2.03±0.8	1.6±0.8	0.007

CARUJ: Median nerve cross-sectional area at the radioulnar joint level, MNAP: Median nerve cross-sectional area at the level of the pisiform, MNAH: Median nerve cross-sectional area at the level of the hamate hook, FRRU: Flattening ratio at the radioulnar joint level, FRP: Flattening ratio at the level of the pisiform, FRH: Flattening ratio at the level of the hamate hook, MNSR: Median nerve swelling ratio, BFR: Bowing of the flexor retinaculum

Table 5. Correlations between ultrasonographical and electrophysiological parameters.

	CARUJ	MNAP	MNAH	FRRU	FRP	FRH	MNSR	BFR
MDML	r:-0.119	r:-0.032	r:-0.109	r:-0.046	r:0.047	r:0.028	*r:0.240	r:0.130
MSDL	r:-0.128	r:-0.018	r:-0.129	r:0.004	r:0.035	r:-0.092	*r:0.212	*r:0.240
MPWCV	r:0.159	r:0.022	r:0.119	r:0.051	r:-0.053	r:0.077	*r:-0.226	*r:-0.258
Amp PWAP	*r: 0.369	*r: 0.360	*r: 0.416	r:0.047	r:-0.075	r:-0.055	*r:-0.235	r:-0.048
IV. SLD	r:-0.129	r:-0.060	r:-0.090	r:-0.074	r:-0.052	r:-0.096	r:0.063	*r:0.323
LILD	r:-0.174	r:-0.092	r:-0.171	r:-0.070	r:-0.085	r:-0.067	r:0.173	r:0.081

*p<0.05

CARUJ: Median nerve cross-sectional area at the radioulnar joint level, MNAP: Median nerve cross-sectional area at the level of the pisiform, MNAH: Median nerve cross-sectional area at the level of the hamate hook, FRRU: Flattening ratio at the radioulnar joint level, FRP: Flattening ratio at the level of the pisiform, FRH: Flattening ratio at the level of the hamate hook, MNSR: Median nerve swelling ratio, BFR: Bowing of the flexor retinaculum, MMDL: Median motor distal latency, MSDL: Median sensory distal latency, MPWCV: Median mixed palm-wrist conduction velocity, amp PWAP: Median amplitude of palm-to-wrist segment mixed nerve action potentials, LILD: Lumbrical-interosseal median ulnar motor latency difference, IV. SLD: Fourth digit median-ulnar sensory latency difference

However, the median nerve cross-sectional area calculated at different levels has generally been regarded as the most sensitive and specific ultrasonographical parameter in carpal tunnel syndrome diagnosis (2,4,5,11-13).

According to the data obtained in this present study, median nerve cross-sectional area was observed to be increased in only 19% of the patients at the distal radioulnar joint level, in 33% of the patients at the level of the pisiform and in 18% of the patients at the level of the hamate hook. Bowing of the flexor retinaculum was high only in 2% of the patients. The percentages calculated in this present study are significantly lower than those reported in the literature. Several factors may be listed to explain this inconsistency. The first and most important one is the fact that the normal range observed in the control group was above average values. Previous studies have reported the maximum mean median nerve cross-sectional area to be 9-11 mm^2 and bowing of the flexor retinaculum to be between 2.5 and 4 mm (2,4,11,13-15). Our results revealed mean median nerve cross-sectional area upper limit at the radioulnar, pisiform and hamate hook levels to be 14 mm_ and the bowing of the flexor retinaculum to be 3.5 mm, which were considerably higher than the values reported in the literature. This particular range significantly decreased the number of subjects in the patient group, which could be considered pathological. In fact, if we had taken the upper limits reported in previous studies, the number of ultrasonographical parameters, which could be considered pathological, would have increased significantly. Therefore, this inconsistency may be explained by the characteristics of the individuals forming the control group.

Table 6. The diagnostic sensitivity of electrophysiological and ultrasonographical parameters.

	McNemar test			
	χ^2	p	Cohen Kappa	p
MMDL-CARUJ	24.8	0.000	0.152	0.045
MSDL-CARUJ	36.2	0.000	0.06	0.38
PWCV-CARUJ	27.3	0.000	0.036	0.613
LILD-CARUJ	39.4	0.000	0.05	0.40
IV. SLD-CARUJ	33	0.000	0.02	0.75
MMDL-MNAP	9	0.002	0.216	0.019
MSDL-MNAP	21.8	0.000	0.201	0.013
MPWCV-MNAP	14.8	0.000	0.260	0.003
LILD-MNAP	25.4	0.000	0.06	0.46
IV. SLD-MNAP	20.9	0.000	0.1	0.22

MMDL-CARUJ: Median motor distal latency-Median nerve cross-sectional area at the radioulnar joint level, MSDL-CARUJ: Median sensory distal latency-Median nerve cross-sectional area at the radioulnar joint level, MPWCV-CARUJ: Median mixed palm-wrist conduction velocity-Median nerve cross-sectional area at the radioulnar joint level, LILD-CARUJ: Lumbrical-interossei median ulnar motor latency difference- Median nerve cross-sectional area at the radioulnar joint level, IV. SLD-CARUJ: Fourth digit median-ulnar sensory latency difference-Median nerve cross-sectional area at the radioulnar joint level, MMDL-MNAP: Median motor distal latency-Median nerve cross-sectional area at the level of the pisiform, MSDL-MNAP: Median sensory distal latency-Median nerve cross-sectional area at the level of the pisiform, MPWCV-MNAP: Median mixed palm-wrist conduction velocity-Median nerve cross-sectional area at the level of the pisiform, LILD-MNAP: Lumbrical-interossei median ulnar motor latency difference-Median nerve cross-sectional area at the level of the pisiform, IV. SLD-MNAP: Fourth digit median-ulnar sensory latency difference-Median nerve cross-sectional area at the level of the pisiform

It has been reported that in some cases local ischemia occurring as a result of depressed endoneural blood support due to chronic compression on the median nerve may be responsible for neuropathy. Therefore, typical ultrasonographical findings of edema and increased cross-sectional area may not be observed (4). Consequently, the pathogenetic process, which has an impact on the median nerve, is critical in the carpal tunnel syndrome. Paranodal demyelination, edema in the nerve, is more pronounced in histopathologically early stage patients. This is followed by complete segmental demyelination, which develops into complete degeneration in the chronic and late stages. As a result, the cross-sectional area of the nerve may be smaller in the presence of axonal degeneration in chronic and late-stage patients when compared with that of the earlier stage patients. The duration of illness in this present study was significantly longer than similar patient groups investigated in the literature. In other words, our study population consisted of patients that are more chronic. This may have resulted in lower percentages of pathological data and, thus, diagnostic sensitivity in ultrasonography.

Technical specifications are another issue of importance. Previous studies have utilized 7-13 MHz linear probes (2,5,10,11,12,13,15). An ultrasound probe of 13.5 MHz was used in this present study. The use of indirect measurement methods has been more common in calculating the mean median nerve cross-sectional area in previous studies. A study used the direct method as well as the indirect method and compared the two methods in mean median nerve cross-sectional area calculation (2). It was reported that the direct method was more sensitive than the indirect approach. We also used the direct method to calculate the mean median nerve cross-sectional area in this present study. Therefore, the inconsistencies observed in this present study cannot be attributed to the technical specifications of the ultrasound device and the method used in calculating the cross-sectional area.

Ultrasonographical examination of the carpal tunnel and the median nerve is not a routine procedure for many healthcare centers. In fact, the same was also true for the radiology clinic where this present study was conducted. Sensitive measurements, such as calculating the diameter and cross-sectional area of a peripheral nerve at different levels, require a certain type of experience. Therefore, our lack of experience in doing so may have led to inconsistent results regarding sensitivity.

Electrodiagnostic study data were used as the standard measurement method in our study and diagnostic sensitivity of ultrasonographical parameters were compared with ENMG. It may be suggested that a possible deviation or error in electrophysiological examination methods may have also led to miscalculations regarding the sensitivity of ultrasonography. However, this does not seem very likely, as the electrophysiological data obtained were highly consistent with the extensive data available in this field in medical literature.

Studies comparing the correlation between electrophysiological and ultrasonographical parameters in carpal tunnel syndrome are few. In general, both approaches have been reported to have high diagnostic sensitivity. However, varying levels of correlations have been reported between ultrasonographical data and ENMG results. While certain investigators reported weak or moderate linear correlation between the two approaches, certain investigators failed to establish any

correlation at all (4,5,15). In fact, the results obtained in this present study also established no significant correlation between the parameters of these two methods.

Many studies have also reported that clinical parameters and electrophysiological parameters did not correlate very well in carpal tunnel syndrome. The same is also true for ultrasonographical examinations (5). Similarly,the Levine questionnaire and other clinical parameters were not observed to correlate significantly with electrophysiological and ultrasonographical parameters in this present study, either.

In conclusion, the results of this present study demonstrated that the diagnostic sensitivity of ultrasonographical parameters was significantly lower than that of the electrophysiological parameters in Carpal tunnel syndrome. Therefore, it seems highly unlikely for ultrasonographical approaches to replace electrophysiological ones for this particular condition. Increased cumulative data on ultrasonographical examinations in the literature may lead to more objective assessments on the issue. Ultrasonography may b e particularly useful in examining carpal tunnel syndrome patients in the acute or subacute stage. Moreover, it may be used as an alternative non-painful, non-invasive, and cheaper approach in cases where electrophysiological examination cannot be tolerated or when etiological information is also of importance. Conduction of the examination by an experienced radiologist and using an appropriate probe with a high frequency transducer will lead to increased diagnostic sensitivity.

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