HAYDARPAŞA NUMUNE MEDICAL JOURNAL

DOI: 10.14744/hnhj.2022.69376
Haydarpasa Numune Med J 2023;63(2):168–173

ORIGINAL ARTICLE

Evaluation of Patients with Electrophysiologically More Advanced Carpal Tunnel Syndrome in Their Nondominant Hands

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Abstract

Introduction: Carpal tunnel syndrome (CTS) usually occurs bilaterally and in the dominant hand. This study aims to compare the patients with electrophysiologically more advanced CTS in their nondominant hand with patients with more advanced CTS in their dominant hand.

Methods: The files of patients with a diagnosis of CTS, verified with electromyography (EMG), registered to EMG laboratory which is a third-level health institute, were scanned retrospectively between October 2021 and December 2021. Missing data were completed by contacting the patients on the phone. The patients included in the study were separated into two groups according to their electrophysiological findings the ones with more advanced CTS in the nondominant hand forming Group 1 and the ones with more advanced CTS in the dominant hand forming Group 2.

Results: 124 CTS patients (105 female patients, Group 1 n=58 and Group 2 n=66 patients) were included in the study. The average ages of the patients were 50.7±12 (27–78) in Group 1 and 50.4±10.3 (22–69) in Group 2 (p=0.86). No differences were detected between Group 1 and Group 2 in terms of sex, occupation, smoking, body mass index, and CTS provocation test results. The disease duration was longer in Group 1 CTS patients than in Group 2 (p=0.037). CTS complaints were observed more in the dominant hand in Group 1 patients and were detected more bilaterally in Group 2 patients (p=0.001). Drug use frequency was detected as being higher in Group 1 CTS patients due to hyperlipidemia (p=0.039).

Discussion and Conclusion: The reason of visiting a doctor to take longer despite the electrophysiologically more advanced CTS of the nondominant hand might be due to the fact that the complaints with the nondominant hand have a lesser effect in daily lives. Investigation of local reasons with more advanced electrophysiological CTS in the nondominant hand is extremely crucial and therefore, physicians should be vigilant to seek for local reasons. As a result of there is a need for more detailed studies of the local, regional, and systemic causes, with a larger number of patients.

Keywords: Carpal tunnel syndrome; disease duration; dominant hand; electromyography; hyperlipidemia; non-dominant hand.

Carpal tunnel syndrome (CTS), occurring due to the entrapment of the median nerve at the wrist level is the most frequently observed entrapment neuropathy[1]. Patients with CTS suffer significant numbness, tingling and burning in the first 3 fingers of the hand generally during the nights or when they wake up[2]. The prevalence of CTS varies between 1 and 6%[3]. It is mostly observed in females between 40 and 60 years old, and the frequency increases

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Submitted Date: 26.01.2022 **Revised Date:** 20.04.2022 **Accepted Date:** 23.06.2022

with age[4]. The mechanism involved in the pathophysiology of CTS is thought to be ischemic entrapment of the median nerve due to the increased pressure in the carpal tunnel, and myelin and axonal damage resulting from disruption of intraneural microcirculation[5,6]. While most patients do not present a specific etiological factor, it may occur due to local causes such as cysts, regional causes such as rheumatic diseases, or systemic diseases such as diabetes[3]. It is also more common in occupational groups where repetitive wrist movements are performed more frequently[5].

Phalen's maneuver and Tinel test, which are provocation tests performed in patients with typical CTS complaints in the anamnesis, help the diagnosis[7]. However, the golden standards in the diagnosis of CTS are nerve conduction studies (NCS) and electromyography (EMG)[8]. While the sensitivity of EMG in the diagnosis of CTS is 56%–85%, its the specificity is around 94–99%[8]. When entrapment neuropathy develops after myelin and axonal destruction in the median nerve due to chronic entrapment, pathological findings can be detected on the EMG[9].

It is known that the use of the hand is an important factor in the etiology of CTS and the disease due to occupational exposure is observed bilaterally and mostly in the dominant hand[10,11]. This study aims to compare the patients with electrophysiologically more advanced CTS in their nondominant hand with patients with more advanced CTS in their dominant hand.

Materials and Methods

The files of patients with a diagnosis of CTS, verified with EMG, and registered to EMG laboratory which is a third-level health institute, were collected between October 2021 and December 2021 after the approval of the local ethics board was obtained (2022/3). The patient files were examined retrospectively. The study was conducted in line with the Helsinki Declaration.

Inclusion criteria were being the age of 18 years and having CTS diagnosis verified with EMG. Exclusion criteria were: (1) presence of another entrapment neuropathy in the upper extremity, such as ulnar neuropathy, (2) presence of polyneuropathy, (3) presence of brachial plexopathy, (4) presence of cervical discopathy, (5) history of upper extremity trauma, (6) additional neurological disease such as Motor Neuron Disease, Multiple Sclerosis, (7) having undergone surgery due to CTS, and (8) presence of rheumatological disease, (9) pregnancy, and (10) incomplete patient data.

Age, sex, disease duration of the patients included in the study (time from the onset of CTS clinical complaints of the patients to the time they were included in the study (months) based on the history), the hand with the complaint (right, left or bilateral according to the patient's statement), parameters such as body mass index (BMI), occupation, smoking, concomitant diseases (hypertension, diabetes mellitus, thyroid diseases, asthma), and drug use histories were recorded from patient files, and missing data were obtained by contacting the patients on the telephone. BMI was calculated as weight/height^2 (kg/m^2)[12].

The Tinel test and Phalen maneuver, which are provocation tests used in the diagnosis of CTS, were performed on all patients and the presence of thenar atrophy was recorded[13]. Phalen's test is considered positive if there is pain and numbness in the median nerve distribution regions after the hands are kept in full wrist flexion for a minute. The Tinel test is considered positive if there is pain and numbness when hitting the carpal tunnel along the nerve trace from proximal to distal in the median nerve distribution area. In addition, the presence of atrophy in the thenar region, which occurs as a result of axonal damage and is observed more frequently in patients with advanced CTS, was also recorded among the examination findings[14].

EMG examinations were performed on all patients in the morning and bilaterally by the same neurologist (NCU). The hand surface temperature of all patients was >34°C during the test. Motor and antidromic sensory NCS for bilateral median nerve were performed with Nihon Kohden Neuropack 9104 device. CTS classification was made in accordance with the American Association of Electrodiagnostic Medicine guidelines[15]. The patients were divided into two groups according to the hand with more advanced electrophysiological findings. Electrophysiologically, patients with more advanced CTS in the nondominant hand were named as Group 1 and patients with more advanced CTS in the dominant hand were named as Group 2.

Statistical Analysis

The statistical analysis was performed through SPSS for Windows (version 22.0). Descriptive analyses were presented by mean±standard deviation. Quantitative data distribution was tested with Shapiro–Wilk test and the data distribution was proper for non-parametric test. Mann–Whitney U test was used for the quantitative comparison of two independent groups. The chi-square test was used to compare qualitative data. Fischer's exact and Chi-square test was used for cases where the number of observations in the Chi-square test was <5. Any p value level below <0.05 was accepted as statistically significant.

Results

In total, 124 CTS patients (105 femaleS and 19 maleS) were included in the study. There were 58 patients in Group 1 and 66 patients in Group 2. The average ages of the patients were 50.7±12 (27–78) in Group 1 and 50.4±10.3 (22–69) in Group 2 (p=0.86) and no significant difference was determined between the two groups. Bilateral CTS was detected in 81.4% (n=101) of the patients, while unilateral CTS was detected in 18.6% (n=23). The dominant hand of only two patients was the left hand and the dominant hand of the other patients.

The most common occupation in both groups was homemaker (n=42 in Group 1, n=44 in Group 2). Other occupations in Group 1 were workers (n=5), farmers (n=3), nurses (n=2), student (n=1), business owner (n=1), crane operator (n=1), tailor (n=1), laboratory technician (n=1), shoemaker (n=1); in Group 2, they were workers (n=6), farmers (n=4), civil servants (n=4), accountants (n=2), cooks (n=2), teacher (n=1), auto mechanic (n=1), baker (n=1), policeman (n=1), technician (n=1), and tradesman (n=1).

There was no difference between the groups in terms of the number of cases without concomitant diseases (group 1 n=20, group 2 n=22, p=0.89). Although the patients in Group 1 had more complaints in the dominant hand, the patients in Group 2 had more bilateral complaints (p=0.001). The duration of disease in patients in Group 1 was found to be longer than the patients in Group 2 (39.4±39.5 months vs. 23.6±22.5 months) (p=0.030). When the two groups were compared in terms of drug use, only the use of drugs due to hyperlipidemia was detected to be significantly higher in patients in Group 1 (n=6) compared to patients in Group 2 (n=1) (p=0.039). There was no statistical difference in terms of other demographic data. Detailed demographic characteristics of the patients are shown in Table 1.

The sensory nerve action potential (SNAP) and compound muscle action potentials (CMAPs) data of the median nerve in the EMG examination of the CTS patients included in the study are shown in Table 2. Comparison of Group 1 and Group 2's right-hand EMG result, respectively are SNAP latency 3.23 (0–3.2) ms compared to 2.7 (0–4.8) ms (p<0.01), SNAP amplitude 13.4 (0–22.6) uV compared to 20.2 (0–34.3) uV (p=0.01), SNAP conduction velocity 41.1 (0–58.9) m/s compared to 48.9 (0–52.3) ms (p<0.01), CMAP latency 4.7 (0–11.5) ms compared to 4.0 (0.06–7.88) ms (p<0.01), CMAP distal amplitude 5.9 (0–11.8) mV compared to 7.3 (0.6–13.8) mv (p=0.01), CMAP proximal amplitude 6.0 (0–12.2) mV compared to 7.3 (2.3–13.1) mV (p=0.01), and the CMAP conduction velocity was 50.8 (0–67.7) m/s compared to 53.0 (43.3–66.7) m/s (p=0.01). No significant difference was detected between Group 1 and Group 2's left-hand EMG results (p>0.05). The number of patients according to

Table 1. General demographic data of patients with carpal tunnel syndrome are shown

	Non-domain hand CTS (n=58)	Domain hand CTS (n=66)	p
Age (year)	50.7±12.0 (27–78)	50.4±10.3 (22–69)	0.86[1]
Sex (Female/Male)	51/7	54/12	0.34[2]
Smoking Yes/No	9/49	11/55	0.86[2]
Occupation homemaker/other occupations (n)	42/16	44/24	0.48[2]
Domaintly hand Left/Right (n)	0/58	2/64	
Body Mass Index (kg/m^2)	30.9±5.7	30.3±5.7	0.581
Duration of disease (month)	39.4±39.5	23.6±22.5	0.03[3]
Unilateral CTS n)	7	16	0.08[2]
Bilateral CTS (n)	51	50	0.07[2]
Hand with a complaint (Right/Left/Bilateral) (n)	30/4/24	8/28/29	0.001[2]
Patients with positive Tinel Test (n)	25	22	0.26[2]
Patient with positive Phalen Test (n)	37	44	0.73[2]
Patient with Tenar atrophy (n)	11	10	0.57[2]
Hypertension (n)	17	22	0.63[2]
Diabetes Mellitus (n)	12	9	0.29[2]
Thyroid Disease (n)	7	12	0.34[2]
Use of drug for hyperlipemia disease (n)	6	1	0.039[4]
Asthma (n)	1	5	0.13[4]

[1]Chi-square test; [2]Student t-test; [3]Mann–Whitney U test; [4]Fisher's exact test. CTS: Carpal tunnel syndrome.

Table 2. EMG findings of patients with carpal tunnel syndrome are summarized

	Group 1	Group 2	p*
R M SNAP latency (ms)	3.23 (0–3.2)	2.7 (0–4.8)	<0.01
L M SNAP latency (ms)	2.27 (0–5.3)	2.8 (0–4.7)	0.33
R M SNAP amplitude (uV)	13.4 (0–22.6)	20.2 (0–34.3)	0.01
L M SNAP amplitude (uV)	22.3 (0–33.4)	20.2 (0–35.2)	0.40
R M SNAP conduction velocity (m/s)	41.1 (0–58.9)	48.9(0–52.3)	<0.01
L M SNAP conduction velocity (m/s)	47.9(0–65.2)	45.9 (0–61.3)	0.14
R M CMAP latency (ms)	4.7 (0–11.5)	4.0 (0.06–7.88)	<0.01
L M CMAP latency (ms)	4.08 (0–10.4)	4.1 (0–13.1)	0.79
R M CMAP proximal amplitude (mV)	6.0 (0–12.2)	7.3 (2.3–13.1)	0.01
L M CMAP proximal amplitude (mV)	7.1 (0–11.0)	6.2 (0–10.2)	0.06
R M CMAP distal amplitude (mV)	5.9 (0–11.8)	7.3 (0.6–13.8)	0.01
L M CMAP distal amplitude (mV)	6.9 (0–10.3)	6.1 (0–10.9)	0.23
R M CMAP conduction velocity (m/s)	50.8 (0–67.7)	53.0 (43.3–66.7)	0.01
L M CMAP conduction velocity (m/s)	53.6 (0–63.8)	51.6 (0–61.1)	0.20

*Mann–Whitney U Test; EMG: Electromyography; R: right; L: left; M: Median; SNAP: Sensory nerve action potential; CMAP: Compound muscle action potential; CTS: Carpal tunnel syndrome. Gruop 1: Patients with electrophysiologically more advanced CTS in the nondominant hand, Gruop 2: Patients with electrophysiologically more advanced CTS in the dominant hand.

Table 3. The number of patients according to the stages of carpal tunnel syndrome is shown

	Group 1	Gruop 2
Stage 0 (n)	7	2
Stage 1 (n)	1	0
Stage 2 (n)	18	23
Stage 3 (n)	29	39
Stage 4 (n)	2	0
Stage 5 (n)	1	2

the stages of CTS is shown in Table 3, and the highest number of patients in both groups was found as Stage 3 (n=29 in Group 1, n=39 in Group 2).

Discussion

It was determined that when patients with more advanced electrophysiological CTS in the nondominant hand were compared with more advanced CTS in the dominant hand, the duration of the disease was longer and the frequency of use of drugs due to hyperlipidemia was higher.

CTS is frequently observed in the bilateral and dominant hand[10,11]. While there were symptoms of CTS in the dominant hand, electrophysiological anomalies of CTS were also detected in the asymptomatic nondominant hand[10]. The study by Padua et al.[16] shows that the time taken for bilateral CTS to be observed is longer than for unilateral CTS. Another study determined that the average time for conversion of unilateral CTS to bilateral CTS was 3.2 years[10]. Lewanska's study, which examined the duration of the disease in CTS patients, showed that the frequency of detection of bilateral CTS increased with the increase in the disease's duration, and the most important risk for the emergence of CTS was repetitive hand movements[10]. The current study determined that the duration of disease is longer in patients with electrophysiologically more advanced CTS in the non-dominant hand. The reason of visiting a doctor to take longer despite the more advanced CTS of the non-dominant hand might be due to the fact that the complaints with the non-dominant hand have a lesser effect in daily lives. The fact that the complaints of Group 1 patients were mostly in the dominant hand in our study also supports this fact.

In the study of Chompooopong et al.[17] when patients with more advanced CTS in the non-dominant hand were examined by neuromuscular ultrasound, it was found that 44.7% of the patients had structural findings or anatomical variations[17]. In the mentioned study, the CTS symptoms in the nondominant hand to be more severe, to be limited to the nondominant hand, and the BMI to be <30 kg/m^2 were found to be warning signs for further examination for structural anomalies. This information highlights the importance of investigating local causes in patients with electrophysiologically more advanced CTS in the non-dominant hand.

The results of studies examining the relationship between CTS and hyperlipidemia in the literature are contradictory[18-20]. Bischoff et al.[18] the hyperlipoproteinemia level in 115 female CTS patients to be similar to the control group suggesting that hyperlipoproteinemia was not the cause of CTS[18]. The study by Mitake et al.[19] concluded that trigger finger and obesity, as well as hyperlipidemia, were not risk factors for CTS, but hypertension, diabetes, and hemodialysis were risk factors for CTS in men[19]. The study of Nakamichi et al.[20] showed that the prevalence of CTS increased depending on the LDL level and the dose. The same study also concluded that obesity is also a risk factor for CTS, but high LDL is a stronger risk factor, but although NCS was performed bilaterally, the dominant side of CTS was not specified. In our study, although BMI was similar in both groups, hyperlipidemia drug use was found to be higher in nondominant hand CTS patients. The high rate of drug use due to hyperlipidemia in patients with more advanced CTS in the nondominant hand suggests that systemic causes may affect the dominant hand.

There are limited number of studies in the literature examining CTS patients with CTS being more advanced in the non-dominant hand[21,22]. No difference was found in our study between patients with electrophysiologically advanced CTS in the nondominant hand, when compared to patients with more advanced CTS in the dominant hand in terms of age, occupation, smoking, BMI, CTS provocation test status, hand dominance, bilateral CTS frequency, and unilateral CTS frequency. It was determined that all electrophysiological parameters obtained on the right hand between groups 1 and group 2 were more progressive (worsen), and there was no difference between the two groups for the left hand when electrophysiological findings were compared. This may explain the poor right-hand electrophysiological data due to the fact that most patients are right-handed and due to the bilateral nature of the disease.

Conclusion

The fact that the duration of disease of the patients with prominent CTS in the nondominant hand is longer, and complaints are mainly bilateral may be due to being part of a slowly progressive process. It is seen that local causes must be meticulously examined in addition to the systemic causes in case prominent CTS is manifested in the nondominant hand. The reason is that studies demonstrate anatomic variations or structural abnormalities may exist in addition to systemic causes such as hyperlipidemia.

Limitation

The retrospective study design, the small number of patients, the patients to have undergone only a single assessment, the inability to detect patients with hyperlipidemia who do not use drugs because only the drug use due to hyperlipidemia was questioned from the patients without taking into consideration their blood lipid levels, the inability to perform additional examinations for local reasons in patients with more advanced CTS in the non-dominant hand were the limitations of this study.

Ethics Committee Approval: Health Sciences University Kanuni Training and Research Hospital Clinical Research Ethics Committee (2022/03 - 03.01.2022).

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

Financial Disclosure: The authors declared that this study received no financial support.

References

1. Olney RK. Carpal tunnel syndrome: Complex issues with a "simple" condition. Neurology 2001;56:1431–2. [CrossRef]
2. Padua L, Coraci D, Erra C, Pazzaglia C, Paolasso I, Loreti C, et al. Carpal tunnel syndrome: Clinical features, diagnosis, and management. Lancet Neurol 2016;15:1273–84. [CrossRef]
3. Mondelli M, Giannini F, Giacchi M. Carpal tunnel syndrome incidence in a general population. Neurology 2002;58:289–94.
4. Kozak A, Schedlbauer G, Wirth T, Euler U, Westermann C, Nienhaus A. Association between work-related biomechanical risk factors and the occurrence of carpal tunnel syndrome: An overview of systematic reviews and a meta-analysis of current research. BMC Musculoskelet Disord 2015;16:231. [CrossRef]
5. Chouhan D, Ansari MT, Goyal D, Mridha AR. Unilateral carpal tunnel syndrome: An unusual presentation of nodular fasciitis. BMJ Case Rep 2020;13:e236142. [CrossRef]
6. Aboonq MS. Pathophysiology of carpal tunnel syndrome. Neurosciences (Riyadh) 2015;20:4–9.
7. Newington L, Harris EC, Walker-Bone K. Carpal tunnel syndrome and work. Best Pract Res Clin Rheumatol 2015;29:440–53. [CrossRef]
8. Practice parameter for electrodiagnostic studies in carpal tunnel syndrome: Summary statement. American Association of Electrodiagnostic Medicine, American Academy of Neurology, American Academy of Physical Medicine and Rehabilitation. Muscle Nerve 1993;16:1390–1. [CrossRef]
9. Mediouni Z, de Roquemaurel A, Dumontier C, Becour B, Garrabe H, Roquelaure Y, et al. Is carpal tunnel syndrome related to computer exposure at work? A review and meta-analysis. J Occup Environ Med 2014;56:204–8. [CrossRef]
10. Lewańska M. The bilaterality of idiopathic carpal tunnel syndrome among manual workers. Int J Occup Med Environ Health 2020;33:151–61. [CrossRef]

11. Franklin GM, Haug J, Heyer N, Checkoway H, Peck N. Occupational carpal tunnel syndrome in Washington State, 1984-1988. Am J Public Health 1991;81:741–6. [CrossRef]
12. Nageeb RS, Shehta N, Nageeb GS, Omran AA. Body mass index and vitamin D level in carpal tunnel syndrome patients. Egypt J Neurol Psychiatr Neurosurg 2018;54:14. [CrossRef]
13. Brüske J, Bednarski M, Grzelec H, Zyluk A. The usefulness of the Phalen test and the Hoffmann-Tinel sign in the diagnosis of carpal tunnel syndrome. Acta Orthop Belg 2002;68:141–5.
14. Padua L, Padua R, Lo Monaco M, Aprile I, Tonali P. Multiperspective assessment of carpal tunnel syndrome: A multicenter study. Italian CTS Study Group. Neurology 1999;53:1654–9.
15. Gazioglu S, Boz C, Cakmak VA. Electrodiagnosis of carpal tunnel syndrome in patients with diabetic polyneuropathy. Clin Neurophysiol 2011;122:1463–9. [CrossRef]
16. Padua L, Padua R, Nazzaro M, Tonali P. Incidence of bilateral symptoms in carpal tunnel syndrome. J Hand Surg Br 1998;23:603–6. [CrossRef]
17. Chompoopong P, Preston DC. Neuromuscular ultrasound findings in carpal tunnel syndrome with symptoms mainly in the nondominant hand. Muscle Nerve 2021;63:661–7. [CrossRef]
18. Bischoff C, Isenberg C, Conrad B. Lack of hyperlipidemia in carpal tunnel syndrome. Eur Neurol 1991;31:33–5. [CrossRef]
19. Mitake T, Iwatsuki K, Hirata H. Differences in characteristics of carpal tunnel syndrome between male and female patients. J Orthop Sci 2020;25:843–6. [CrossRef]
20. Nakamichi K, Tachibana S. Hypercholesterolemia as a risk factor for idiopathic carpal tunnel syndrome. Muscle Nerve 2005;32:364–7. [CrossRef]
21. Zyluk A, Walaszek I. The effect of the involvement of the dominant or non-dominant hand on grip/pinch strengths and the Levine score in patients with carpal tunnel syndrome. J Hand Surg Eur Vol 2012;37:427–31. [CrossRef]
22. Shiri R, Varonen H, Heliövaara M, Viikari-Juntura E. Hand dominance in upper extremity musculoskeletal disorders. J Rheumatol 2007;34:1076–82.