

SIGNIFICANCE OF EARLY DIAGNOSTIC OF CARPAL TUNNEL SYNDROME

TATJANA BUĆMA¹, IGOR SLADOJEVIĆ², MILKICA KOSANOVIĆ GLOGOVAC¹, OSTOJA SAVIĆ³

¹Institute of Physical Medicine and Rehabilitation "Dr Miroslav Zotović" Banja Luka, the Republic of Srpska, Bosnia and Herzegovina

²University of Banja Luka, Faculty of Medicine, the Republic of Srpska, Bosnia and Herzegovina.

³University Clinical Centre of the Republic of Srpska, Banja Luka, the Republic of Srpska, Bosnia and Herzegovina

Correspondence:

Tatjana Bućma, Institute of Physical Medicine and Rehabilitation "Dr Miroslav Zotović", the Republic of Srpska, Bosnia and Herzegovina, tatjana.bucma@gmail.com

Abstract: Carpal tunnel syndrome (CTS) is the most common compressive neuropathy. The conservative treatment remains the first therapeutic choice in the treatment of mild and moderate CTS. The aim of this paper was to examine the average age of female patients with CTS diagnosed by EMNG, the frequency of bilateral CTS and its correlation with the age, and to determine the grade of electrophysiological damage of the nerve when the CTS diagnosis is confirmed for the first time. The retrospective examination included 187 female patients, aged from 27 to 79, with complains on unilateral CTS. All patients underwent EMNG for confirmation of CTS and the degree of damage to median nerve. Statistical analysis was performed by methods of descriptive statistics, Kruskal-Wallis test, and the Student t-test. The value of $p < 0.05$ was considered statistically significant. The average age of the female examinees was 54.53 years. The bilateral CTS was confirmed in 67.9 %, most often of a moderate degree and more often on the right hand. No statistically significant difference was found in grades of CTS between the analysed age groups of patients that had the bilateral CTS ($p = 0.206$), nor there was a difference in years of life between the patients with unilateral and bilateral CTS ($p = 0.638$). Bilaterality of CTS, as well as the degree of the damage are not connected with age. The patients report timely for the first examination and diagnostics of CTS when there is still a possibility of the conservative treatment.

Key words: Carpal tunnel syndrome, Median nerve, Female.

INTRODUCTION

The carpal tunnel syndrome (CTS) represents a compressive neuropathy of median nerve at the level of the carpus, which is characterised by physiological proofs of the increased pressure in the carpal tunnel and decrease of nerve function at that level followed by resulting symptomatology (Graham, B., et al. 2016). Prevalence of CTS in the general population ranges from 3 % to 8 %, while in the group of women over forty years of age it is 6 % (Atroshi, I., et al 1999). If not observing the age, the prevalence is higher in women (0.7 % to 9.2 %), compared to 0.4 % to 2.1 % in men (Andersen, J. H., et al 2003). Women develop CTS 4-5 times more often than men with the peak of development between 50 and 59 years and after 80 years of age (Mondelli, M., et al. 2002). There are numerous risk factors among which are age, obesity, diabetes mellitus, rheumatoid arthritis, hypothyroidism and activities that require numerous repetitive movements in the wrist. Women who take contraceptive medications in menopause or use therapeutic oestrogen are also at high risk (Calandruccio, J. H., & Thompson, N. B. 2018).

Clinically, CTS may manifest on one or both hands, whereas the bilateral presentation is more often and ranges from 22 % to 87 %, an average of 69 % (Padua, L., et al. 1998). About half of patients with unilateral symptoms have electrodiagnostically proved bilateral CTS (Singjam, A., et al 2021). The factors that have been observed regarding the bilateral CTS are the age (45 to 65 years) and body mass index (BMI) that is higher than 29 (Zambelis, T., et al.2010; Kouyoumdjian J. A. 1999.). The occurrence of symptoms bilaterally is correlated with the length of the condition (Bagatur, A. E., & Zorer, G. 2001), whereas the occurrence of a stronger clinical presentation and earlier manifestation is on the dominant hand both in right and left-handed patients (Shiri, R., et al. 2007).

CTS is primarily a clinical diagnosis based on symptoms along with the utilisation of provocative tests primarily Tinel and Phalen's test. Electromyoneurographic examination is performed if there is a clinical suspicion of CTS and for deciding on surgical treatment. Nuclear magnetic resonance (NMR), computerised tomography (CT) and ultrasonography are not used in everyday work.

The treatment may be conservative or surgical. Most patients with a mild or moderate degree of CTS have positive responses to the an initial conservative treatment (Calandruccio, J. H., & Thompson, N. B. 2018), with the appli-

cation of orthosis (Hall, B., et al 2013) and local corticosteroid injection in the carpal tunnel (Atroshi, I., et al. 2013). However, other studies indicate a poorer outcome of treatment in patients that have initially received conservative treatment with a delay of the surgical treatment for 6 months than in patients that have initially received the surgical treatment (Cha, S. M., et al. 2016). There is strong evidence of higher treatment benefits after the surgical treatment of CTS after six and twelve months compared to the conservative forms, also orthosis, non-steroidal anti-inflammatory drugs (NSAIDs) and local corticosteroid injections (Graham, B., et al. 2016).

The research aims were to examine the average age of female patients who were electrodiagnostically determined with the presence of CTS, the frequency of the bilateral CTS and its correlation with the age as the risk factor. Also, aim was to determine the degree of electrophysiological damage to the nerve when the female patients receive the electroneurographic confirmation of CTS diagnosis.

METHODS

The research was carried out with the permission of the Ethics Committee of the Institute for Physical Medicine and Rehabilitation “Dr Miroslav Zotović” Banja Luka, the Republic of Srpska, Bosnia and Herzegovina (Decision No 116-01-3108-2/22). The data in the retrospective research were taken from the Cabinet for Electromyoneurography of the Department of Neurorehabilitation IIA of the Institute of Physical Medicine and Rehabilitation “Dr Miroslav Zotović” in Banja Luka. 374 findings of electroneurography were taken over in the period from 2010 to 2021 of female persons 27 to 79 years of age that have electrophysiological confirmation for the CTS diagnosis, and every second patient was included in this study. Therefore, total sample of the study was 187.

Non-inclusion criteria was: presence of systemic disease of the peripheral nervous system, ie injury of bone or soft tissue structures of the areas of carpal tunnel or an injury of median nerve (which would represent a basis for the secondary CTS), also pregnancy and women one year after childbirth.

The finding of electroneurography (ENG) was performed in all patients on device Nicolet EDX (*Natus medical Inc.*) by the same doctor. The electroneurographic finding is a part of the electromyoneurographic finding, which is performed as a routine diagnostic method for diseases of the peripheral nervous system and muscles, and it was conducted according to recommendations (Preston, D. C., & Shapiro, B. E. 2021).

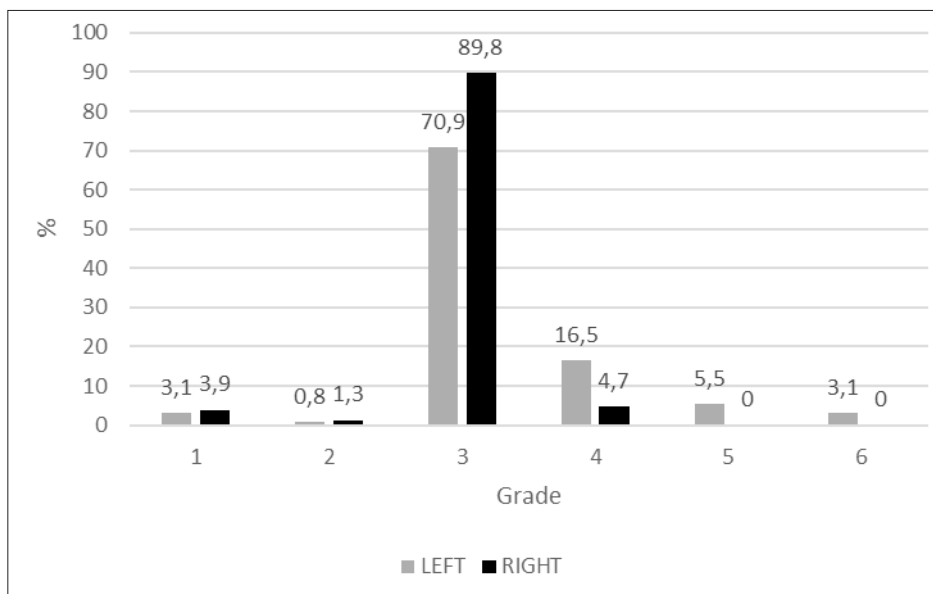
Data that were used in the processing were the age of a female patient, distal motor latency (DML) on both sides, conduction velocity of sensory nerves on both sides and the grade of damage according to the Padua et al scale (Padua, L., et al. 1997): grade 1- Extreme form of CTS: absence of motor and sensory response (SNAP and CMP); grade 2. Severe CTS: absence of the sensory response (SNAP) – a segment of carpus-finger and abnormal DML; grade 3. Moderate CTS: slow conduction (segment of carpus-hand) and abnormal DLM; grade 4. Mild CTS: slow conduction (segment of carpus-hand) and normal DLM; grade 5. Minimal CTS: “standardly negative” finding on hands with abnormal comparative or segmental (< 7-8 cm) tests; grade 6-Negative CTS: normal finding with all tests (including both comparative and segmental tests).

Statistical analysis was performed by the SPSS software, version 25, using methods of descriptive statistics, Kruskal-Wallis test, and the Student t-test.

RESULTS

In the research, data of 187 female patients were analysed and average age of patients was 54.53 years. Of the total of 187 patients that were analysed by ENG, 10.7 % had changes on the left hand, 21.4 % had changes on the right hand and most patients had bilateral CTS (67.9 %).

In cases where ENG proved the bilateral CTS, the changes were most often moderate, but the right hand had more expressed changes compared to the left (Graph 1).



Graph 1: Frequencies of changes on the right and left hand in bilateral carpal tunnel syndrome (CTS) that were confirmed by electroneurography (ENG)

When observing, in the whole sample, the hand that had more expressed symptoms, regardless of unilateral or bilateral localisation in most patients had a moderate symptom (Table 1).

Table 1. Frequency of certain grades (according to the scale of Padua and associates) of carpal tunnel syndrome (CTS) in the sample

Grade	1	2	3	4	5	6
%	1.6	0.5	68.3	19.4	6.5	3.8

Kruskal-Wallis test did not show a statistically significant difference in the grades of changes of median nerve in the carpal tunnel registered by ENG among analysed age groups of patients that had the bilateral carpal tunnel [Group 1 (31-40 years): N = 15, Group 2 (41-50 years): N = 25, Group 3 (51-60): N = 52, Group 4 (61-70 years): N = 22, Group 5 (≥ 71 years): N = 13] [$\chi^2(4, N = 127) = 5.909, p = 0.206$].

When analysing age and presence of unilateral/bilateral CTS, there was no significant difference (unilateral CTS: M = 53.97, SD = 12.44; bilateral: M = 54.8, SD = 10.76) (Student t-test: $t(185) = -0.471, p = 0.638$). The size of the difference in arithmetic means (difference in arithmetic means -0.836, CI: -4.338 to 2.665) was very small ($\eta^2 = 0.0011$).

DISCUSSION

The CTS, the focal attack on median nerve, represents the most common compressive neuropathy of a peripheral nerve. This is mostly a chronic form that develops for years and the symptoms often appear when there is already significant damage to the myelin sheath or even the reduction of the axon. Additional problem is that it affects the population that is still actively working. Therefore, the timely diagnostics and treatment, also the education of the population, play a significant role in maintaining the functionality, but also maintaining the working ability of the affected population.

The paper included female patients, considering that they are being affected by the disease in a significantly higher percentage. The average age of patients was 54.53 years of life, which is also confirmed by literature data (Padua, L., et al. 2016; Newington, L., et al. 2015; Atroshi, I., et al. 2011). A significant number of patients had bilateral CTS despite the exclusion of patients with systemic diseases, such as diabetes mellitus or rheumatoid arthritis. In this results, electrophysiologically 69.7 % of patients had bilateral changes, whereas 10.7 % of patients had changes that were found on the left hand and 21.4 % had changes on the right hand. Literature data state that the bilaterality is

sometimes present in 80.7 % of cases (Singjam, A., et al 2021), even though it is around 60 % in most studies (Padua, L., et al. 1998). There are different interpretations and assumptions for the development of the bilaterality in CTS. Some studies indicate the role of the systemic endocrine diseases (Papanas, N., et al. 2022; Oktayoglu, P., et al. 2015; Toesca, Aet al. 2008; Tang, H. C., et al. 2022), but a newer study denies such a relationship (Low, J., et al 2021). In this study, patients with systemic endocrine diseases were not included. Also, there are data in the literature that years of life impact the increase of bilateral CTS incidence (Werner, R. A., et al. 2004), which is also different from results in this study, where it was shown that age has no impact on the increase of bilateral CTS incidence. Bilaterality of CTS may be time-dependent and clinicians should be aware that patients who present with unilateral CTS are in risk of developing CTS in the contralateral hand (Bagatur, A. E., & Zorer, G. 2001).

Treatment of this disease may be conservative and surgical. A high level of evidence (Graham, B., et al. 2016) is in the successful application of orthosis, local application of corticosteroids in the treatment of CTS, as well as conservative methods, while the evidence is limited for some physical procedures such as ultrasound therapy and laser therapy. The evidence is also strong for the surgical treatment of CTS, which gives better results in 6 and 12 months compared to the application of immobilisation, NSAIDs and local administration of corticosteroids. Qualitative and quantitative analysis (Klokkari, D., & Mamais, I. 2018) are consistent with the results that the surgical treatment leads to better results in CTS treatment after six months and a higher improvement of neurophysiological parameters (distal motor latency and the speed of conduction of sensory fibres) compared to the conservative treatment. However, the results are not significantly better compared to the conservative therapy after 3 and 12 months. Many patients with a mild and moderate degree of CTS react to the conservative treatment, which is generally recommended as the initial one (Calandruccio, J. H., & Thompson, N. B. 2018), although there are results that show that patients who initially received the conservative treatment method and postponed the surgery up to 6 months in average had worse results compared to those who were initially treated by surgery (Cha, S. M., et al 2016). Even though there are advantages of the surgical treatment method, it is necessary to take into consideration possible complications of those as well. Therefore, conservative treatment remains the first line for the treatment of mild and moderate CTS (Multanen, J., et al. 2021). These facts were motivating for us to examine the degree of the median nerve damage at the moment when our patients report for the first time in order to electrodiagnostically confirm suspicions of CTS and if it is still possible to have the conservative treatment. In cases where it was electrophysiologically proved the presence of bilateral CTS, the changes were of mild degree most often, but the right hand had more expressed changes than the left one, although it was not statistically significant. When observing the hand that had more expressed symptoms, regardless of unilateral or bilateral localisation, again most patients had a mild degree of nerve damage. However, there was no statistically significant difference in the grades of electrophysiological findings for the registered changes of median nerve in the carpal tunnel between the analysed age groups of female patients, who had the bilateral carpal tunnel. This means that the years of life did not represent a factor that influenced the severity of changes on the nerve and the consequential clinical picture.

CONCLUSION

The degree on median nerve damage in CTS, as well as the presence of bilateral symptoms are not connected with age. The patients most often report with moderate degree of nerve damage, when there is still a possibility of the conservative treatment.

REFERENCES

- Andersen, J. H., Thomsen, J. F., Overgaard, E., Lassen, C. F., Brandt, L. P. A., Vilstrup, I., ... & Mikkelsen, S. (2003). Computer use and carpal tunnel syndrome: a 1-year follow-up study. *Jama*, 289(22), 2963-2969.
- Atroshi, I., Gummesson, C., Johnsson, R., Ornstein, E., Ranstam, J., & Rosén, I. (1999). Prevalence of carpal tunnel syndrome in a general population. *Jama*, 282(2), 153-158.
- Atroshi, I., Englund, M., Turkiewicz, A., Tägil, M., & Petersson, I. F. (2011). Incidence of physician-diagnosed carpal tunnel syndrome in the general population. *Archives of internal medicine*, 171(10), 943-944.
- Atroshi, I., Flondell, M., Hofer, M., & Ranstam, J. (2013). Methylprednisolone injections for the carpal tunnel syndrome: a randomized, placebo-controlled trial. *Annals of internal medicine*, 159(5), 309-317.
- Bagatur, A. E., & Zorer, G. (2001). The carpal tunnel syndrome is a bilateral disorder. *The Journal of bone and joint surgery. British volume*, 83(5), 655-658.
- Calandruccio, J. H., & Thompson, N. B. (2018). Carpal Tunnel Syndrome: Making Evidence-Based Treatment Decisions. *The Orthopedic clinics of North America*, 49(2), 223-229.

- Cha, S. M., Shin, H. D., Ahn, J. S., Beom, J. W., & Kim, D. Y. (2016). Differences in the Postoperative Outcomes According to the Primary Treatment Options Chosen by Patients With Carpal Tunnel Syndrome: Conservative Versus Operative Treatment. *Annals of plastic surgery*, 77(1), 80–84.
- Graham, B., Peljovich, A. E., Afra, R., Cho, M. S., Gray, R., Stephenson, J., et al (2016). The American Academy of Orthopaedic Surgeons Evidence-Based Clinical Practice Guideline on: Management of Carpal Tunnel Syndrome. *The Journal of bone and joint surgery. American volume*, 98(20), 1750–1754.
- Hall, B., Lee, H. C., Fitzgerald, H., Byrne, B., Barton, A., & Lee, A. H. (2013). Investigating the effectiveness of full-time wrist splinting and education in the treatment of carpal tunnel syndrome: a randomized controlled trial. *The American journal of occupational therapy : official publication of the American Occupational Therapy Association*, 67(4), 448–459.
- Klokkari, D., & Mamais, I. (2018). Effectiveness of surgical versus conservative treatment for carpal tunnel syndrome: A systematic review, meta-analysis and qualitative analysis. *Hong Kong physiotherapy journal : official publication of the Hong Kong Physiotherapy Association Limited = Wu li chih liao*, 38(2), 91–114.
- Kouyoumdjian J. A. (1999). Carpal tunnel syndrome. Age, nerve conduction severity and duration of symptomatology. *Arquivos de neuro-psiquiatria*, 57(2B), 382–386.
- Low, J., Kong, A., Castro, G., Rodriguez de la Vega, P., Lozano, J., & Varella, M. (2021). Association Between Diabetes Mellitus and Carpal Tunnel Syndrome: Results From the United States National Ambulatory Medical Care Survey. *Cureus*, 13(3), e13844.
- Mondelli, M., Giannini, F., & Giacchi, M. (2002). Carpal tunnel syndrome incidence in a general population. *Neurology*, 58(2), 289–294.
- Multanen, J., Uimonen, M. M., Repo, J. P., Häkkinen, A., & Ylinen, J. (2021). Use of conservative therapy before and after surgery for carpal tunnel syndrome. *BMC musculoskeletal disorders*, 22(1), 484.
- Newington, L., Harris, E. C., & Walker-Bone, K. (2015). Carpal tunnel syndrome and work. Best practice & research. *Clinical rheumatology*, 29(3), 440–453
- Oktayoglu, P., Nas, K., Kiliç, F., Tasdemir, N., Bozkurt, M., & Yildiz, I. (2015). Assessment of the Presence of Carpal Tunnel Syndrome in Patients with Diabetes Mellitus, Hypothyroidism and Acromegaly. *Journal of clinical and diagnostic research : JCDR*, 9(6), OC14–OC18.
- Padua, L., LoMonaco, M., Gregori, B., Valente, E. M., Padua, R., & Tonali, P. (1997). Neurophysiological classification and sensitivity in 500 carpal tunnel syndrome hands. *Acta neurologica Scandinavica*, 96(4), 211–217.
- Padua, L., Padua, R., Nazzaro, M., & Tonali, P. (1998). Incidence of bilateral symptoms in carpal tunnel syndrome. *Journal of hand surgery (Edinburgh, Scotland)*, 23(5), 603–606.
- Padua, L., Coraci, D., Erra, C., Pazzaglia, C., Paolasso, I., Loreti, C, et al. (2016). Carpal tunnel syndrome: clinical features, diagnosis, and management. *The Lancet Neurology*, 15(12), 1273–1284.
- Papanas, N., Stamatou, I., & Papachristou, S. (2022). Carpal Tunnel Syndrome in Diabetes Mellitus. *Current Diabetes Reviews*, 18(4), e010921196025.
- Preston, D. C., & Shapiro, B. E. (2021). *Electromyography and neuromuscular disorders: Clinical-electrophysiologic-ultrasound correlations*. Elsevier Health Science.
- Shiri, R., Varonen, H., Heliövaara, M., & Viikari-Juntura, E. (2007). Hand dominance in upper extremity musculoskeletal disorders. *The Journal of rheumatology*, 34(5), 1076–1082.
- Singjam, A., Charoentanyarak, K., & Saengsuwan, J. (2021). Prevalence and predictive factors for bilateral carpal tunnel syndrome by electrodiagnosis: A retrospective study. *Plos one*, 16(12), e0260578.
- Tang, H. C., Cheng, Y. Y., & Guo, H. R. (2022). Association between hormone replacement therapy and carpal tunnel syndrome: a nationwide population-based study. *BMJ open*, 12(1), e055139.
- Toesca, A., Pagnotta, A., Zumbo, A., & Sadun, R. (2008). Estrogen and progesterone receptors in carpal tunnel syndrome. *Cell biology international*, 32(1), 75–79.
- Werner, R. A., Jacobson, J. A., & Jamadar, D. A. (2004). Influence of body mass index on median nerve function, carpal canal pressure, and cross-sectional area of the median nerve. *Muscle & nerve*, 30(4), 481–485.
- Zambelis, T., Tsvigoulis, G., & Karandreas, N. (2010). Carpal tunnel syndrome: associations between risk factors and laterality. *European neurology*, 63(1), 43–47.

Primljen: 27. novembar 2022. / Received: November 27, 2022
Prihvaćen: 17. decembar 2022. / Accepted: December 13, 2022

