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Arch Basic Clin Res 2024; 6(1): 27-31 • DOI: 10.5152/ABCR.2024.23163

Original Article

Evaluation of the Prognostic Value of Preoperative Electromyography in Patients Who Underwent Carpal Tunnel Release Surgery

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Cite this article as: Yurten H, Koçkara N, Özcan S. Evaluation of the prognostic value of preoperative EMG in patients who underwent carpal tunnel release surgery. *Arch Basic Clin Res.* 2024;6(1):27-31.

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ABSTRACT

Objective: Carpal tunnel syndrome is a condition caused by the compression of the median nerve within the carpal tunnel, resulting in clinical symptoms in the area innervated by the nerve. The role of electromyography in surgical planning for carpal tunnel syndrome is controversial. The current study aimed to compare the clinical results of patients who underwent carpal tunnel release surgery based on their preoperative electromyography grading.

Methods: We examined 102 patients who underwent carpal tunnel release surgery between 2015 and 2018. All patients were evaluated by electromyography preoperatively and 2-year postoperatively and completed the Boston Questionnaire. Based on the Bland classification for electromyography grades, the patients were divided into 2 groups: group 1 (grades 1-3) and group 2 (grades 4-6). Changes in scores were analyzed after carpal tunnel release surgery for each group.

Results: When considering the results for all patients irrespective of group, both scores showed significant improvement after surgery. Group 2 exhibited greater improvement in the functional status scale score and electromyography grade compared to group 1, while similar changes were observed in the symptom severity scale scores.

Conclusion: Both the symptom severity scale and functional status scale scores improved significantly after surgery for all patients. However, group 1 consistently had lower scores than group 2 across all evaluation periods. The evaluation of the improvement in the electromyography grade (ΔEMG) indicated that group 2 had better improvement than group 1.

Level of Evidence: III

Keywords: Bland, Boston, carpal tunnel syndrome, electromyography

INTRODUCTION

Carpal tunnel syndrome (CTS) is the most common entrapment neuropathy in the upper extremity, with an estimated prevalence of 3.8% in the general population.[1] Various factors including age, pregnancy, diabetes mellitus (DM), obesity, overuse of the hand, osteoarthritis, space-occupying lesions, and smoking contribute to the development of CTS.[2-4]

Patients with CTS commonly experience symptoms of pain, numbness, and tingling sensation when using the hand. Clinical evaluation using provocation tests like Phalen's test and Tinel's test helps identify compression signs of the median nerve within the carpal tunnel. Progression of CTS may lead to motor findings like thenar atrophy and impaired grip strength. While CTS can be diagnosed with clinical symptoms and physical examination, the definitive diagnosis is determined by electrophysiological examination. Electrophysiological tests are useful not only in establishing the definitive diagnosis, but also in determining the level of entrapment of the median nerve and revealing the severity of the compression.[1-3]

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Received: March 18, 2023
Revision requested: April 17, 2023
Last revision received: June 17, 2023
Accepted: June 23, 2023
Publication Date: January 31, 2024

Carpal tunnel release (CTR) surgery is more effective than conservative treatment in relieving CTS symptoms. The timing of CTR surgery is an important factor in preventing irreversible damage to the median nerve. Although clinical history and physical examination are often sufficient for diagnosis, there is no diagnostic tool with high sensitivity and specificity for CTS. Electromyography (EMG) is advised to support the diagnosis of CTS or aid in differential diagnosis. It is worth noting that the degree of demyelination caused by median nerve compression may not always correspond with clinical severity, thus surgical intervention is generally advised for patients with severe EMG findings, while conservative treatment is recommended for mild forms of CTS.[2-5] However, some patients with milder EMG findings do not recover despite conservative treatment.

The current study aimed to compare the clinical results of patients who underwent CTR surgery based on their preoperative EMG grading. While EMG grading is commonly used as a diagnostic tool, we recognized that the correlation between EMG findings and clinical symptoms may not always be consistent. As a result, our treatment approach prioritized the severity of symptoms rather than relying solely on EMG results.

METHODS

This retrospective study was approved by Yalova University Ethics Committee (Date: February 10, 2021, Number: 2021/17) and was conducted in accordance with the Declaration of Helsinki.

Study Population

The data of 184 consecutive patients who were diagnosed with CTS and underwent surgery using the conventional open approach between April 2015 and January 2018 were retrospectively reviewed from the electronic records of the hospital and evaluated for the study. Patients classified as grades 4-6 according to the Bland classification as well as patients classified as grades 1-3 who experienced ongoing symptoms despite at least 3 months of conservative treatment were included in the study. The exclusion criteria were incomplete follow-up (n=17), inadequate records (n=22), patients who underwent primary surgery in a different center (n=12), and patients with cervical disc herniation (n=31). Ultimately, a total of 102 patients with CTS were included in the final analysis.

MAIN POINTS

- The CTR surgery is effective in the treatmentof CTS across a spectrum of mild to severe EMG grades.
- Patients with higher preoperative clinical scores and EMG grade benefited more from CTR surgery.
- Any relationship was detected between the duration of symptoms and improvement in clinical scores.

Preoperative Evaluation

In the clinical evaluation, patients with typical symptoms of CTS were evaluated with Phalen's and Tinel's tests. The duration of the symptoms was recorded, and all patients underwent EMG performed by the same neurologist to confirm the initial diagnosis of CTS. The EMG results were classified according to the Bland classification (grades 1-6). Conservative treatment was recommended for patients with grade 1-3 CTS or grade 4-6 patients who refused surgical treatment. The treatment involved changes in daily living activities, using hand splints, and taking vitamin B6. Carpal tunnel release surgery was planned for patients who did not improve despite 3 months of conservative treatment and for those with grade 4-6 CTS. All patients were informed about the CTR surgery before signing the voluntary consent form. The patients were also asked to fill out the Boston Questionnaire.

Surgery

Two different types of surgical techniques are employed for the treatment of CTS: open and endoscopic. In the current study, all patients were operated on using the open technique. Prior to the surgery, all patients received prophylactic intravenous administration of 1 g cephalexin monohydrate. The surgical procedure commenced with a longitudinal incision made on the inter-thenar section, measuring approximately 5 cm in length. The transverse carpal ligament was cut parallel to the skin incision after the skin and subcutaneous tissue were opened. Additionally, a thorough examination of the carpal canal was performed to detect any mass lesions or anatomical abnormalities.

Postoperative Follow-Up

Hand therapy was started on the postoperative first day for all patients. Cephalexin monohydrate was prescribed for a duration of 5 days to prevent infection. Hand splints were not recommended to any patients. Sutures at the wound site were removed on the 15th day if no wound problems existed. The patients were invited for clinical controls at the 3rd, 6th, 12th, and 24th months. At the final follow-up, EMG was repeated, and the patients were asked to fill out the Boston Questionnaire again.

Data Collection

The patients were divided into 2 groups according to the preoperative EMG results: group 1 (n=48) consisting of grades 1-3 patients and group 2 (n=54) consisting of grades 4-6 patients.

The duration of symptoms and patient characteristics such as age, gender, dominant hand, alcoholism, smoking, comorbidities, and distal radius fracture history were noted. The scores from the Boston Questionnaire were calculated to determine the symptom severity scale (SSS) and the functional status scale (FSS).

The changes in Boston Questionnaire scores (ΔSSS and ΔFSS) and the grade of EMG before and after surgery (ΔEMG) were calculated. The groups were statistically compared, and all variables were analyzed to determine their relationship with the magnitude of the changes.

Statistical Analysis

Statistical analysis was performed using the Statistical Package for the Social Sciences Statistics software version 21.0 (IBM Corp., Armonk, NY, USA). The numerical data were expressed as means, SDs, and ranges, whereas the categorical data were given in frequencies and percentages. The comparison of means was performed using the Student's *t*-test or Mann–Whitney *U*-test following the Kolmogorov–Smirnov normality test. The comparison of the frequencies was performed using the Chi-square test. Multiple regression analyses were done to assess the influence of independent variables on the improvement in scores. *P*-values lower than .05 were considered statistically significant.

RESULTS

Of the 102 patients included in this study, 88 (86.3%) were female and 14 (13.7%) were male. The youngest of these patients was 32 years old and the oldest was 85 years old (mean age: 55.5 ± 9.92 years). While 63 patients (61.8%) did not have any comorbidities, 39 (38.2%) patients had at least 1 comorbid disease (Table 1). None of the patients used alcohol, but 11 (10.8%) were smokers. The procedure was performed on the dominant hand in 64 cases (62.7%). Ten patients had previously encountered a distal end fracture of the radius, which was conservatively treated. There were no statistically significant relationships between these variables and ΔSSS, ΔFSS, or ΔEMG.

Table 1. Comorbidities in Carpal Tunnel Syndrome Patients

	Frequency (n = 102)	%
None	63	61.8
HT	12	11.8
DM	6	5.9
COPD	1	1
RA	4	3.9
HT and DM	7	6.9
COPD and HT	1	1
DM and RA	4	3.9
HT and CP	2	2
RA and COPD	2	2

COPD, chronic obstructive pulmonary disease; CP, cardiac problems; DM, diabetes mellitus; HT, hypertension; RA, rheumatoid arthritis.

The mean duration of symptoms before surgery was 19.6 ± 12.1 months for group 1 and 19.8 ± 10.8 months for group 2. The mean postoperative follow-up times were 27.6 ± 2.0 months for group 1 and 26.8 ± 2.0 months for group 2. There were no statistically significant relationships between the duration of symptoms and ΔSSS, ΔFSS, or ΔEMG.

According to the Bland classification, no patients had a normal or grade 1 classification before the surgery. At the 2-year follow-up, no patients were classified as grade 6 (Figures 1 and 2). When evaluating the improvement in the EMG grade (ΔEMG), group 2 showed significantly better improvement compared to group 1 (2.01 ± 0.98 vs. 0.91 ± 1.08, respectively; *P* = .00).

Overall, both the SSS and FSS scores improved after CTR surgery. There was no difference between groups in terms of ΔSSS; however, the FSS scores showed better improvement in group 2 (*P* = .00). Detailed results are presented in Tables 2 and 3.

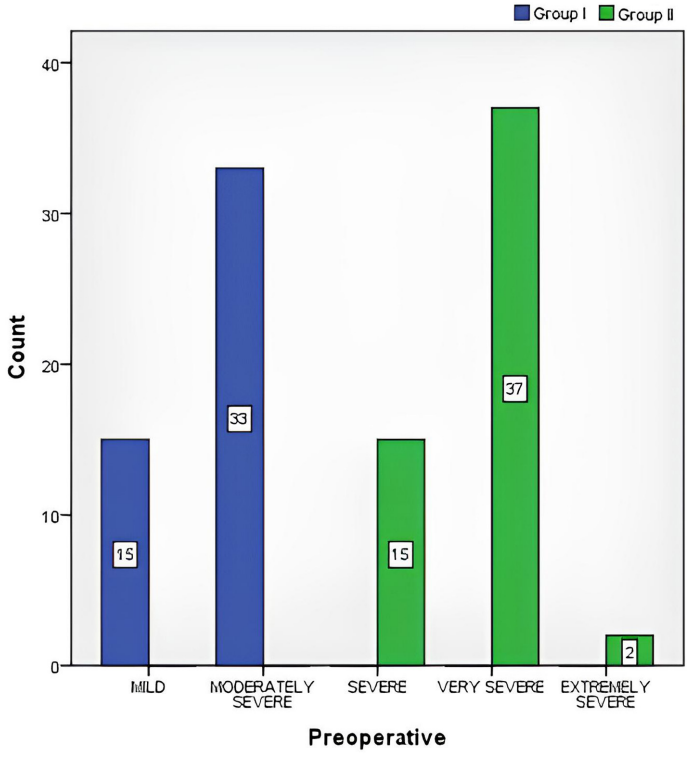

Figure 1. Preoperative electromyography grading by group.

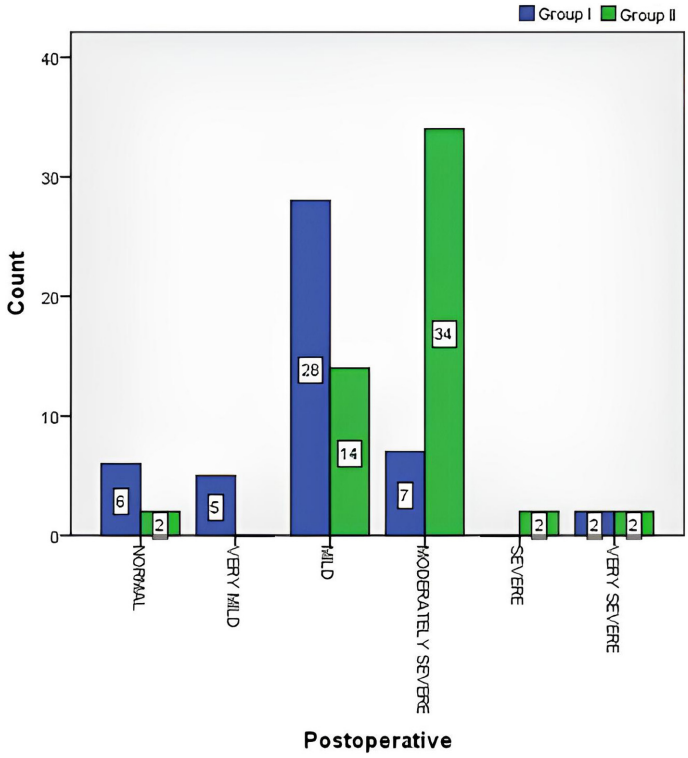

Figure 2. Postoperative electromyography grading by group.

When considering the results of all patients regardless of the groups, a significant relationship was observed between the preoperative SSS scores and ΔSSS scores (P=.004). Similarly, a significant relationship was found between the preoperative FSS scores and ΔFSS scores (P=.005). Patients with higher preoperative scores benefited more from CTR surgery.

No infections were observed in any patient. A delay in wound closure was seen in 5 patients, but there were no problems during the follow-up period.

DISCUSSION

The most important finding of the current study highlights the effectiveness of CTR surgery in the treatment of CTS across a spectrum of mild to severe EMG grades. At the 2-year follow-up, the Boston scores and EMG grades improved in both groups. Notably, patients with higher preoperative clinical scores benefited more from CTR surgery.

Table 2. Change Between the Preoperative and Postoperative Symptom Severity Scale Scores by Group

	Preoperative	Postoperative	ΔSSS
Group 1	2.45 ± 0.72	1.51 ± 0.84	0.94 ± 0.51
Group 2	2.69 ± 0.62	1.54 ± 0.63	1.15 ± 0.53

Table 3. Change Between the Preoperative and Postoperative Functional Status Scale Scores by Group

	Preoperative	Postoperative	ΔFSS
Group 1	3.16 ± 0.67	1.81 ± 0.78	1.35 ± 0.65
Group 2	3.56 ± 0.58	1.84 ± 0.75	1.71 ± 0.52

Carpal tunnel syndrome is more prevalent among individuals with diabetes, particularly those with diabetic polyneuropathy, which is a complication of diabetes.[6,7] Despite all diabetic patients in our study having more severe preoperative EMG grades (no normal or mild forms), we did not detect a statistically significant relationship between diabetes and improvement in scores. Masud et al.[8] showed that the patients who had a duration of symptoms exceeding 12 months benefited less than the patients with shorter durations. However, in the current study, we did not detect any relationship between the duration of symptoms and improvement in scores.

In addition to DM, sex, rheumatoid arthritis, smoking, and distal radius fracture have been defined as risk factors for CTS.[9] According to the results of our study, these variables had no effect on score improvement after CTR surgery.

In a similarly constructed study by Kronlage and Menendez[10], the authors showed an association between preoperative and postoperative CTS scores (pain and numbness scores), with the moderate group consistently demonstrating better scores than the severe group during follow-up.[10] De Kleermaeker et al.[11] reported that CTS patients with more symptoms and more limitations in hand function needed greater improvement in SSS and FSS after surgery for the CTS procedure to be considered successful. In our study, preoperative scores had a significant effect on changes in scores. Although the FSS scores and EMG grades of group 2 improved more, group 1 still exhibited better scores throughout the study.

In CTS, the compression of the median nerve by the transverse carpal ligament leads to demyelination of the nerve, which in turn affects nerve conduction and alters EMG results. Traditionally, CTR is traditionally recommended for those with severe EMG results. However, the degree of demyelination does not always correlate with the EMG outcomes. The treatment choice for patients with persisting symptoms despite having low-grade EMG findings remains unclear.[3,12] Finsen and Russwurm.[13] performed CTR surgery on 106 patients clinically diagnosed with CTS, without prior knowledge of their preoperative electrodiagnostic test results. In the follow-up, the researchers conducted electrodiagnostic tests and compared the results with the preoperative ones, concluding that clinical diagnoses alone are sufficient to determine the need for CTS surgery. Away from discussing diagnostic value, our results indicate that preoperative EMG

has a prognostic value for CTS. In addition, while patients with low-grade EMG results benefited from CTR surgery, patients with severe EMG grades derived greater benefit from the surgery compared to milder CTS patients, while still experiencing more symptoms.

The current study provides a comparison of CTR surgery outcomes between lower and higher grade EMGs and offers prognostic insights 2 years after the surgery. However, it is important to acknowledge that our study had some limitations, including the lack of evaluation of patients' BMIs, occupations, economic status, and educational level.

In conclusion, the current study suggests that patients with higher preoperative Boston Questionnaire scores benefit more from CTR surgery, while patients with low-grade EMG results also require and benefit from surgery.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Yalova University (Date: February 10, 2021, Number: 2021/17).

Informed Consent: Approval was obtained from the hospital management where patient data was collected.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept – H.Y., S.Ö.; Design – H.Y., S.Ö.; Supervision – H.Y., N.K., S.Ö.; Resources – H.Y., S.Ö.; Materials – H.Y., N.K., S.Ö.; Data Collection and/or Processing – H.Y., S.Ö.; Analysis and/or Interpretation – H.Y., N.K., S.Ö.; Literature Review – H.Y.; Writing – H.Y.; Critical Review – N.K., S.Ö.

Declaration of Interests: The authors declare that they have no competing interest.

Funding: The authors declared that this study has received no financial support.

REFERENCES

1. Zamborsky R, Kokavec M, Simko L, Bohac M. Carpal tunnel syndrome: symptoms, causes and treatment options. Literature review. *Ortop Traumatol Rehabil*. 2017;19(1):1-8. [CrossRef]
2. Sen D, Chhaya S, Morris VH. Carpal tunnel syndrome. *Hosp Med*. 2002;63(7):392-395. [CrossRef]
3. Wang L. Guiding treatment for carpal tunnel syndrome. *Phys Med Rehabil Clin N Am*. 2018;29(4):751-760. [CrossRef]
4. Calandruccio JH, Thompson NB. Carpal tunnel syndrome: making evidence-based treatment decisions. *Orthop Clin North Am*. 2018;49(2):223-229. [CrossRef]
5. Lee YH, Kim J, Cho J, Lee MH, Oh S, Bae KJ. Which factors affect the rate of surgery performed in patients with carpal tunnel syndrome? *J Hand Surg Asian Pac Vol*. 2018;23(4):562-565. [CrossRef]
6. Moon HI, Shin J, Kim YW, Chang JS, Yoon S. Diabetic polyneuropathy and the risk of developing carpal tunnel syndrome: a nationwide, population-based study. *Muscle Nerve*. 2020;62(2):208-213. [CrossRef]
7. Ibrahim I, Khan WS, Goddard N, Smitham P. Carpal tunnel syndrome: a review of the recent literature. *Open Orthop J*. 2012;6:69-76. [CrossRef]
8. Masud M, Rashid M, Malik SA, Ibrahim Khan M, Sarwar SU. Does the duration and severity of symptoms have an impact on relief of symptoms after carpal tunnel release? *J Brachial Plex Peripher Nerve Inj*. 2019;14(1):e1-e8. [CrossRef]
9. Padua L, Coraci D, Erra C, et al., Carpal tunnel syndrome: clinical features, diagnosis, and management. *Lancet Neurol*. 2016;15(12):1273-1284.
10. Kronlage SC, Menendez ME. The benefit of carpal tunnel release in patients with electrophysiologically moderate and severe disease. *J Hand Surg Am*. 2015;40(3):438-44.e1. [CrossRef]
11. De Kleermaeker FGCM, Boogaarts HD, Meulstee J, Verhagen WIM. Minimal clinically important difference for the Boston Carpal Tunnel Questionnaire: new insights and review of literature. *J Hand Surg Eur Vol*. 2019;44(3):283-289. [CrossRef]
12. Klokkari D, Mamais I. Effectiveness of surgical versus conservative treatment for carpal tunnel syndrome: a systematic review, meta-analysis and qualitative analysis. *Hong Kong Physiother J*. 2018;38(2):91-114. [CrossRef]
13. Finsen V, Russwurm H. Neurophysiology not required before surgery for typical carpal tunnel syndrome. *J Hand Surg Br*. 2001;26(1):61-64. [CrossRef]