

The outcomes of carpal tunnel decompression based on electro-diagnostic approaches and clinical symptoms in patients suffering from carpal tunnel syndrome (CTS)

Taher Erfanifam¹, Pouria Hashemie Anaraki², Leila Vahedi³,
Jalal Nourmohammadi⁴, Bashir Emami⁵, Amin Khameneh⁶

¹Department of Surgery, Iran University of Medical Science, Tehran, ²Student Research Committee, Golestan University of Medical Sciences, Gorgan, ³Assistant Professor, MD-PhD of Medical Genetics, Road Traffic Injury Research Center, Health Management Research Institute, Tabriz University of Medical Sciences, Tabriz, ⁴Department of Pediatrics, Shahid Hasheminejad Medical Research Center, Mashhad University of Medical Sciences, ⁵Department of Nursing Management, Imam Khomeini Medical Research Center, Kermanshah University of Medical Sciences, ⁶Medical Student, Student Research Committee, Tabriz University of Medical Sciences, Tabriz, Iran

ABSTRACT

Introduction: The main objective of this study was to assess the outcomes of carpal tunnel release surgery based on the electro-diagnostic approaches and its clinical symptoms in patients who suffered from carpal tunnel syndrome (CTS). **Methods:** This was a prospective cross-sectional study that consisted 50 participants of 100 patients of which 22 of them were men, and 78 of them were female. All the participants were examined through their clinical symptoms including pain, by parentheses, and also using the Levine-Katz Questionnaire before and after the open surgical operation. Additionally, patients with electrophysiological (EP) disorders were evaluated using electromyography (EMG) and nerve conduction velocity (NCV) (EMG-NCV) tests. Then, the association of the findings and results of this study was analyzed and then compared together using a particular statistical analysis model before and after the surgical procedure. **Findings:** The data achieved from the present study demonstrated that a significant improvement in both sexes and age groups was observed, and there was no significant difference in the level of improvement based on age and gender. Moreover, there was a significant correlation between the improvement severity of clinical symptoms and the improvement of severity of muscle nerve disease and their functions. **Conclusion:** It was observed that the surgical procedure for the treatment of carpal tunnel syndrome, improves its clinical symptoms in patients tested with electrodiagnostic techniques. Moreover, diversity of age and sexual condition did not affect the results of the study.

Keywords: Carpal tunnel syndrome, clinical symptoms, electrodiagnostic testing (electrography), surgery

Introduction

The carpal tunnel (CT) is a narrow passageway in the wrist, which opens into the hand. It is surrounded by the bones of the wrist

Address for correspondence: Dr. Amin Khameneh,
Medical Student, Student Research Committee, Tabriz
University of Medical Sciences, Tabriz,
Iran.
E-mail: AminKhameneh77@gmail.com

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underneath and the transverse carpal ligament across the top.^[1] The passageway from the wrist to the hand is known as carpal tunnel (CT) that opens into the hand. CT is surrounded by wrist bones and transverse carpal ligament (TCL) at its above from underneath and the top sides.^[1] CT is where the median nerve runs from the forearm to the hand and gives the feeling to all fingers.^[2,3] Moreover, many tendons pass CT too, and when any kind of edema happens, the large median nerve could be easily compressed that would cause median nerve compression which

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is known as Carpal tunnel syndrome (CTS).^[4,5] CTS is a disorder of the hand that is very painful which is created due to extra pressure on the median nerve which passes through the wrist.^[6,7] The major reported symptoms for these syndromes are such as numbness, pins and needles, and pain which particularly would be presented at night time.^[7] CTS could be induced from any type of edema inside the wrist, repetitive movements of arms and hands, obesity, diabetes, arthritis, hypothyroidism, and sometimes pregnancy.^[8,9] When CTS happens, the pain possibly extends up the arms. Suggested treatments include wearing a wrist rest pad and splint, cortisone injection (corticosteroid injection), and finally, if the two mentioned options don't work, clinicians may propose surgery.^[10-12] Two of the most common consequences of this syndrome are weak grip strength, and after a long period, degeneration of the muscles may occur.^[2,3] People with CTS are not able to control their sensory and motor function muscles appropriately.^[6,13] Some researchers have proposed that the symptoms of the median nerve would happen due to any extra pressure on the thoracic outlet or the region where the median nerve passes the muscle of pronator teres that is located mainly in the forearm. Sensing pain or parenthesis, and numbness in the median nerve of the wrist are the main representative neuropathic symptoms (NS) of the CTS.^[14] Moreover, the muscles of the thumb may become weak and emaciated if the syndrome is not treated as the inability of muscles in receiving adequate nerve stimulation.^[15,16] Severe CTS is mainly a common representative symptom of hereditary transthyretin amyloidosis (hATTR) with polyneuropathy. Conducting initial surgery for treatment of CTS is a common treatment option in patients who later suffer from transthyretin amyloid cardiomyopathy (ATTR-CM).^[8,9] The range of pressure on the carpal tunnel that results in deformation from 2 to 10 mm on the wrist skin increases the extension of the wrist to 10-fold.^[17,18,19] When the wrist is extended and bent repetitively, the fluid pressure in the tunnel will increase significantly through the thickening of the synovial tissue.^[20,21] The surgical procedure of treatment of carpal tunnel is conducted through the release of the transverse carpal ligament. Surgical procedure is recommended mainly when there is a static constant pressure on the wrist and the muscle weakness, numbness, and atrophy that cannot not be controlled by other physical treatment options.^[10,11] It should be noted that surgical treatment could be done with regional or local anesthesia, with or without sedation, or generally under general anesthesia. Generally, when the CTS symptoms are milder, they could be controlled during long periods. However, when CTS is presented with severe cases, they would be stricter symptomatically and could be treated by surgical treatments. Anyway, both treatment options of wearing wrist braces and surgical techniques could achieve similar results in the long term of 12–18 months after the treatment.^[22] Recognition of CTS based on clinical symptoms with electrodiagnostic techniques has been proposed by many recent studies. Additionally, the detection of CTS with a combination of ultrasonography and its related clinical symptoms has been suggested by several recent studies. Other clinical trials on recognition of CTS have recommended applying a combination of electrodiagnostic testing techniques and ultrasonography to detect its clinical symptoms.

It has been highly reported that when the patient experiences no more symptoms, the diagnostic process of CTS could be done precisely just after conducting the operation. In this study, which was conducted in () hospital, () city, (The name of country), the diagnostic process of CTS was carried through the combination of an electrodiagnostic testing method and its clinical symptoms. These tests could be done by conducting nerve conduction studies (NCS). When the speed and strength of nerve signals in the NCS test is negative for carpal tunnel syndrome, further ultrasonography tests should be carried out.^[10] Electrodiagnostic testing studies are often compulsory for verification of CTS diagnosis and deprivation of any other possible causes of CTS clinical symptoms including polyneuropathy or cervical radiculopathy. NCS studies could be applied for predicting the development risk of CTS in patients who don't have any symptoms and also for prediction of the consequences of decompression surgery. Various Electrodiagnosis (EDX) examinations are developed for achieving a more precise detection of CTS. These tests provide the opportunity for the practitioners to face various situations in more suitable applications of the tests in clinical practice.^[23] A lot of clinical trials have demonstrated the advantages of detection of CTS using EDX techniques and were evaluated by the American Association of Neuromuscular and Electrodiagnostic Medicine Evidence-based recommendations for EDX studies in CTS. Unfortunately, there is not much information about the effectiveness of treatment of CTS with both surgical and physical treatments, but usually, the results of their EDX test are normal.^[24] The present study aimed to evaluate the consequences of applying surgical techniques for the treatment of CTS based on the clinical symptoms of treated patients and also the findings of EDX tests applied to these patients in Iran.

Material and Methods

In this regard, a prospective cross-sectional study was conducted to examine the outcome of applying surgical techniques for the treatment of CTS using the patient's clinical symptoms and their EDXs test results. Here, in our study, 22 patients were men and the rest of them were women. The orthopedic section of the () hospital admitted all the participants while all were recognized with CTS and then were chosen for the study. The demographic data of all the patients were recorded precisely all were interviewed by a specialized person about their clinical symptoms related to CTS. Patients' clinical symptoms, NCS, and the US outcomes associated with CTS were evaluated based on medical records. Analysis of the achieved outcomes of this study was categorized into three main groups of CTS patients consisting of overall, typical, and atypical cases. The outcomes of clinical examinations of US and NCS studies and their sensitivity on the patients were determined as the primary and secondary outcomes of the study, respectively. Pre-surgery and after that all the symptoms of patients with CTS consisted of pain, parenthesis were recorded and analyzed using the Levine questionnaire. Moreover, the EMG-NCV testing technique was used for the evaluation of patients with EP conditions.

Statistical analysis

Statistical package for social sciences (SPSS) (19) was used for analyzing the data of the present study. The student's t-test was used for comparing the data of all participants that included age and duration of CTS complaints from CTS. Moreover, for comparing variation between the groups, Fisher's exact and Chi-square tests were used. The significance level of 0.001 was considered as a P value.

Ethics issue

The present study was conducted after obtaining approval from the ethics committee of the Tabriz University of Medical Sciences. All patients' information was stored confidentially. At first, informed consent was obtained from patients after explaining the goals of the project.

Result

The demographic data of participants of the present study is shown in Table 1. The patients were aged between 30 and 80 years, and the dispersion of patients by their age was 12, 31, 43, 9, and 5 for the age groups of 30–40, 41–50, 51–60, 61–70, 71–80, respectively. Based on this data, patients in the age groups of 41–50 and 51–60 were more than the other age groups.

The data from the present study revealed that CTS was more common in the left hand of the participants of the present study.

The data from Table 2 represents the distribution pattern of CTS patients based on their disease severity in EDX tests before and after surgery. It could be seen that the severity of CTS symptoms after conducting surgical techniques decreased significantly. Based on the results of EDX tests, applying physical and surgical techniques for the treatment of CTS resulted in a significant decrement in the severity of diseases. As could be seen from the data available in Table 3, the severity of pain and other symptoms in patients with CTS was higher on the day before the surgery.

Patients with a lower duration of disease, represent a higher level of pain severity in comparison with those with a higher duration of involvement in this disease after being treated with surgical operations.

Patients who underwent surgical treatment for their CTS disease faced higher sleep disturbances after surgery in comparison with those who were treated with physical techniques. Based on the data achieved from the questionnaire in this study, it was observed that after conducting surgical treatments on patients with CTS, the severity of symptoms in patients with lower intensity and also their sleep disturbances were higher compared to other patients with a higher level of symptoms intensity. According to the factor of a clinical symptom of CTS patients, the dispersion pattern of patients after conducting the surgical operation decreased significantly due to its effectiveness as well as a considerable decrement in clinical symptoms of patients.

On the other hand, the dispersion pattern of CTS patients based on the function factor of hands after conducting surgical operation showed a significant decrease in comparison with its pattern before the surgery that may be due to the effectiveness of surgery in the treatment of CTS disease.

The data from Table 4 shows that the function of hand muscles improved based on the comparison conducted between surgical muscle nervous tests before and after the surgery. Evaluation of muscle nervous system changes before and after conducting surgical operation showed there was a significant association between them, and the muscle functions had improved considerably.

As could be from the data presented in Table 5, conducting a comparative study between functional and clinical symptoms based on the age and the gender of participants demonstrated a significant association between the severity of clinical symptoms and the severity of the disease based on EMG-NCV test showed a considerable improvement in the function of muscles.

Table 1: Examination of patients by gender

| | Relative abundance | The cumulative frequency percentage |
|--------|--------------------|-------------------------------------|
| Gender | | |
| Male | 78 | 78 |
| Female | 22 | 22 |
| Total | 100 | -- |

Table 2: The rate of patients involved in CTS based on the results of electrodiagnostic tests before and after surgery

| Severity of symptoms intensity | Before | After | P |
|--------------------------------|--------|-------|-------|
| Mild | 4 | 32 | ≤0.01 |
| Medium | 36 | 41 | ≤0.01 |
| Intense | 60 | 27 | ≤0.01 |
| Total | 100 | 100 | ≤0.01 |

Table 3: The rate of patients with CTS disease based on their score of pain at the night before and after surgery

| Severity of symptoms intensity | Before | After | P |
|--------------------------------|--------|-------|-------|
| Painless | 0 | 30 | ≤0.01 |
| Mild | 0 | 37 | ≤0.01 |
| Medium | 23 | 23 | ≤0.01 |
| Intense | 29 | 3 | ≤0.01 |
| Very intense | 48 | 7 | ≤0.01 |
| Total | 100 | 100 | ≤0.01 |

Table 4: Effect of surgery on the neuromuscular system before and after conducting surgery on CTS patients on the function of hands

| Intensity | Before | After | P |
|-----------|--------|-------|-------|
| Mild | -- | 12 | ≤0.01 |
| Medium | 24.5 | 15.3 | ≤0.01 |
| Intense | 25.2 | 19.6 | ≤0.01 |

Table 5: Association of gender and the clinical symptoms of CTS patients based on the main score of symptoms

| Symptoms | Before | After | Association | P |
|--------------------------|--------|-------|-------------|-------|
| Male clinical symptoms | 34.5 | 17.64 | Decreased | ≤0.01 |
| Female clinical symptoms | 41.15 | 18.79 | Decreased | ≤0.01 |

Finally, it was observed that there was not a significant association between clinical symptoms and age and also muscle function and age that their correlations were 0.13 and 0.32, respectively. However, the association of age and muscle function based on surgical operation outcomes was more significant in comparison with the association of age and the clinical sign.

Discussion

Despite the fact that the present study covered the outcomes of surgical options for treatment of CTS, its main objective was to specify patients with outcomes below the optimal level, in order to make the patients and their expectations more familiar with the effectiveness of treatment options more exactly. Nowadays, CTS patients have more accurate knowledge about the risks, advantages, disadvantages, and the main outcomes of surgical options for the treatment of their disease. Having knowledge in this regard involves patients in the process of decision making that simplify their treatment process and improves their satisfaction. The level of satisfaction of patients with carpal tunnel release could be evaluated through assessment of clinical symptoms. Generally, younger patients who do not have any focal neurologic deficits with a shorter duration of CTS symptoms while showing a positive Phalen maneuver diagnostic test are more satisfied with the outcomes of their surgery. The syndrome of median nerve compression could cause clinically evident fatigue or weakness that could be stopped through treatment of CTS by surgery. Younger patients whose outcomes of surgical treatment of CTS are not appropriate immediately after the operation they experienced a shorter duration of disease, the outcomes of surgery may be better over time.

Shannon *et al.*^[25] revealed that a considerable improvement was observed in the rate of complaints. The patients who were treated by surgical procedures represented an improvement of 76% after surgery, whereas 41.7% revealed that they gained full recovery after about 1/2 of a year after surgery. Additionally, the score of symptom severity and Functional status improved significantly in those patients who were treated by surgery. Another study by Osiak *et al.*^[26] revealed that the majority of CTS patients whose EDX test results were normal would benefit from being treated with carpal tunnel release.

In a study by Carlson *et al.*^[27] it was reported that EPs could not have any significant role in determining the consequences of applying surgical treatment for the treatment of CTS. Their study revealed a different result compared to the results of our study which showed an obvious association between electrodiagnostic and clinical recovery tests. The data from the present study revealed

that 34 patients had moderate to severe and severe CTS symptoms. The rate improvement of CTS severity was more than 80% in a period of 6 months after surgery and nearly 90% in a period of 9 months after surgery. It's while the rate of patients who were satisfied or completely satisfied with the treatment was lower than 50%. Anyway, other patients were complaining of serious symptoms with a low rate of improvement based on nerve conduction studies.

In a study by Pattankar *et al.*,^[28] it was reported that conducting carpal tunnel release technique for the treatment of CTS could improve the rate of satisfaction among patients who underwent wide-awake local anesthesia no tourniquet (WALANT) or Marker and Cell (MAC) technique. It should be noted that there were not any considerable differences between the studied groups in comparison with the tested outcome measures. One of the main facilities of that study was that all the patients and surgeons were free to choose between MAC and WALANT techniques based on their complications and outcomes.

In a similar study by Kato *et al.*,^[29] it was revealed that 14 days after surgery, the outcome in patients with both studied groups represented a decrease in their symptoms, and in patients with severe symptoms did not report a complete recovery. However, Alimohammadi *et al.*^[30] reported age and gender are two key factors that could affect the outcomes of surgery and the improvement of symptoms after carpal tunnel release operation.

Another study by Sudlow *et al.*^[31] demonstrated that the outcomes of surgery were acceptable with a rate higher than 90% 1/2 a year after the surgery. Some factors would cause adverse and inappropriate outcomes which include age, negative Phalen's test, negative results of a 2-point discrimination test, weakness of physiopedia description abductor pollicis brevis muscle, and having a longer duration of symptoms. Nocturnal symptoms such as snoring, usually loud and habitual, gender, and retrograde radiation were not associated with the achieved outcome of surgical operation.^[31]

EP studies have reported that the severity of symptoms would improve during 6 months by 85% after conducting surgical therapies. The data from the present study are in line with the previous studies which demonstrated that nearly 90% of patients who undergo surgical treatments are satisfied with the surgery. Multanen *et al.*^[32] reported nearly all the participants who undergo surgical treatment for their CTS syndrome were satisfied with the outcomes of their surgery, and their symptoms improved significantly after about 1 year of surgery.

Tahririan *et al.*^[33] reported that after about 1 year of surgery distal motor latencies (DML), and distal sensory latencies (DSL) as the most important parameters in the electrodiagnosis of CTS syndrome improved. Anyway, in some cases even after 1 year complete improvement of symptoms was not seen. Another study by Jørgsholm *et al.*^[23] revealed that after conducting surgical treatment, sensory nerve conduction velocities (SCV) and DML

improved significantly. Anyway, they reported that after a period of 6 months, all the mentioned parameters had significantly improved.

The results achieved from the present study showed that the factors which could cause CTS symptoms may not be the same as those that slow down electrical impulse moves measured by the nerve conduction velocity (NCV) test. Consequently, improvement of symptoms was not associated with the grades of EP tests that are mainly based on nerve conduction.

Conclusion

Based on the data from the present study, it was concluded that if the patients were selected precisely for appropriate therapies. For instance, conducting surgical therapy for the treatment of CTS yields the most satisfactory outcomes for the patients. However, for a specific group of patients, a high level of satisfaction could not be achieved during the same period of time after the surgery. When CTS lasts longer, controlling the symptoms of patients may be more difficult. In this regard, conducting conservative management for controlling the symptoms of patients with CTS through prolonged times is not advised at all. A satisfactory level of improvement in symptoms of patients with CTS could be achieved through conducting surgery for affected patients, especially for those with severe levels of disease. Anyway, the treatment of CTS patients by these techniques could be done easily at any age and gender. Here, we showed that conducting surgical treatment for the management of CTS improves and decreases the symptoms of this disease in patients of any age and gender. Treatment of patients with the mentioned surgical techniques improves the life quality of patients and also are more satisfied in comparison with other treatment options.

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Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patients have given their consent for their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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