RESEARCH ARTICLE

Carpal Tunnel Syndrome: Open or Endoscopic Release Surgery Method?

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Received: 03 July 2021 *Accepted: 31 January 2021*

Abstract

Background: Carpal tunnel syndrome (CTS) or median nerve neuropathy is among the causes of numbness, paresthesia, and sensory and motor dysfunction in the affected hand. The objective of this study was to compare open and endoscopic carpal tunnel release (ECTR) methods.

Methods: A multicenter, historical cohort study was performed on 47 hands in 46 patients with a clinical diagnosis of CTS and a failed trial of conservative treatment. Samples were divided into two groups consisting of 23 patients receiving open carpal tunnel release (OCTR) and ECTR. Outcome measurements had been carried out six weeks after the operation and included handgrip strength, post-op pain, and missing job days.

Results: Patients in both groups were comparable regarding baseline characteristics such as age, gender, and handgrip strength. Both methods significantly improved handgrip strength. No significant difference was detected between the two groups concerning handgrip strength improvement (*P=0.700*) and sick leave days (*P=0.564*). Open carpal tunnel release resulted in more significant post-op pain (mean 5.91±1.24 compared to 2.43±0.73 after endoscopic release), which was significant (*P=0.000*). No complications were reported with any technique.

Conclusion: This study revealed that apart from post-op pain, other investigated endpoints were similar in both groups. Although the small sample size has limited our ability to draw a conclusive statement, these data suggest that there is no need to utilize the endoscopic technique for the optimum result, especially when this method requires more advanced equipment and could increase surgery costs. Therefore, both approaches can result in good clinical outcomes.

Level of evidence: III

Keywords: Carpal tunnel syndrome, Endoscopy, Endoscopic carpal tunnel release, Hand strength, Open carpal tunnel release

Introduction

Carpal tunnel syndrome (CTS) or median nerve neuropathy results in sensory and motor dysfunction in the affected hand. The symptoms comprise numbness, paresthesia, pain, and weakness in the area where the median nerve innervates (1). This condition has an incidence of 2.3% per 100 people/year in the working population and accounts for about 600,000 surgeries in the USA annually. In addition to its substantial impact on individual lives, this problem increases sick leaves and imposes a great burden on health care systems and communities (2-4). Therefore, it is crucial to utilize the optimal treatment method to alleviate this immense damage to an individual's quality of life and to the whole society (5, 6).

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Conservative treatments, including immobilization by applying a wrist splint, prescription of oral non-steroidal anti-inflammatory drugs, and injection of steroidal medicines, could relieve pain and help patients with mild to moderate symptoms (7, 8). However, surgery and nerve decompression are the treatments of choice in severe cases and those who do not respond to these conventional non-surgical methods (9). For many years, open carpal tunnel release (OCTR) was the only option for surgery; until the 90s, when endoscopic carpal tunnel release (ECTR) was presented as an alternative technique that was presumed to be a safe and effective method with an acceptable amount of complications (10). Since each approach has some advantages and disadvantages, determining the optimal treatment is controversial. Conventionally, ECTR leaves fewer scars; therefore, patients usually prefer this method. However, this procedure needs an expert endoscopist and more equipment, resulting in extra costs. Furthermore, compared to OCTR, the latter method's superiority is disputable in terms of clinical outcomes (11, 12). Based on previous studies, both methods seem to have comparable symptom relief (13).

This historical cohort study aims to identify the potential difference between these two methods and determine which is more beneficial concerning handgrip recovery and rehabilitation time. We hypothesized that there is no significant difference between ECTR and OCTR regarding handgrip strength improvement (primary outcome), the severity of postoperative pain, and the number of sick leave days (secondary outcomes).

Materials and Methods

Study design and participants

In this retrospective cohort study, samples were selected from patient records of two hospitals between 2018 and 2020 to compare surgery outcomes between ECTR and OCTR methods. The inclusion criteria were all patients with a clinical diagnosis of CTS verified by an experienced hand surgeon, failed trials of conservative and non-operative treatments such as splints and corticosteroid injections who had undergone ECTR or OCTR surgery (14). Patients with acute CTS or those who were pregnant were excluded. Accordingly, 46 eligible patients were selected, and their data was extracted. Considering that one hospital's patients routinely underwent ECTR procedures while in the other hospital, OCTR was the preferred operation method, 23 patients were randomly selected from each hospital for a total of 46 patients.

Primary assessment

Demographic information was collected from patient's medical records, including age, gender, hand dominance, symptom duration, chronic medical conditions, history of trauma, and exposure to a vibratory tool. The presence of signs and symptoms such as nocturnal tingling, numbness, and thenar atrophy and results of Tinel's and Phalen's tests was also retrieved from patient's files (15). Moreover, measurements of handgrip strength, the impairment of which is one of the most important median nerve entrapment symptoms, was recovered, too. To have a similar unit of measurement and minimize human judgment and subjective error, the assessments had been done by a device called a handgrip dynamometer which can determine handgrip strength in Kilogram units. Six weeks after the surgery, postoperative data was also collected from records that included measurement of handgrip strength, sick leave days, and postoperative pain. A 10-grade numerical scale was implemented to measure the latter variable.

Operative methods

Experienced surgeons performed the operations, and surgeries were generally done under regional anesthesia. Two different surgical teams, one team in a hospital for OCTRs and another in the other hospital for ECTRs, conducted the operations. Open carpal tunnel release begins with 2mm ulnar to thenar crease incision, which is then extended 3 to 4 cm proximally. Next, the superficial palmar fascia is released to expose the transverse carpal ligament (TCL), then the TCL is cut longitudinally, and the wound is closed. In ECTR, a 1 cm incision is made at the distal wrist crease level in the center of the wrist; the Palmaris longus tendon is retracted radially if present; the carpal tunnel then is dilated with dilators, aligned with the base of the ring finger. After placement of a slotted cannula into the carpal tunnel, the TCL is cut from the distal with the blade under the endoscope's direct vision; the wound is closed subsequently (16).

Outcomes

Before any analysis, the ECTR and OCTR groups were compared regarding the demographic variables and the prevalence of chronic medical conditions to ensure a baseline resemblance. The primary outcome of this study was handgrip strength improvement, assessed before and after surgery in both groups. The values were compared with the preoperative measurements and then analyzed to detect any significant difference between these operation methods. The secondary outcomes were the severity of postoperative pain and the number of sick leave days. A comparison concerning these secondary outcomes was also made to identify any superiority or significant differences between the groups.

Sample size and statistical analysis

The sample size was determined by the following formula: . Where $Z\alpha/2$ was 1.96, $Z\beta$ was 0.842 for a $\beta = 0.8$, d was considered 2kg of handgrip strength difference, and since most of our CTS cases were female, SD was considered 3.6 according to previous studies (17). The data were described with mean and standard deviation in numerical variables and frequency and percentage in categorical variables. Additionally, median and interquartile range (IQR) were used to describe symptoms as a non-normal variable. The normality was assessed with Shapiro–Wilk tests and graphical approaches (e.g., histograms and Q-Q plots). The association of categorical variables, such as gender with the study group, was assessed with Chi-square exams or Fisher exact tests. The mean differences of numerical

variables in the two groups were assessed with independent t-tests. In addition, the Mann-Whitney U test was utilized for the numerical variable with non-normal distribution (symptoms duration). The *P-value<0.05* was considered statistically significant. The SPSS software program (version 18) was used for the analysis of data.

Results

Participants

Forty-six patients with CTS enrolled in the study, 23 in each group [Table 1]. The first group underwent OCTR for treatment, and ECTR was performed for patients in the second group. All of these patients attended their postoperative visits and completed their follow-ups and, therefore, were included in the final statistical analysis.

We found no significant difference between open and ECTR groups regarding the baseline demographic variables, occupation type, exposure to a vibratory tool, and traumatic injury. Similarly, the prevalence of various medical comorbidities in OCTR and ECTR groups were examined, revealing no significant difference. Medical conditions that were compared are as follows: hypothyroidism, diabetes mellitus, renal dysfunction, and arthropathy.

In addition, a comparison of signs and symptoms prevalence and duration was made. The symptom prevalence revealed no significant difference. The signs and symptoms compared between OCTR and ECTR groups included nocturnal tingling, numbness, thenar muscle atrophy, Tinel's test, Phalen's test, and two-point discrimination. The most prevalent symptoms were nocturnal tingling, numbness, and positive Tinel's test. The median (IQR) symptom duration in the open release group was 12.0 (6.0-84.0) months compared to 12.0 (8-24.0) months in the endoscopic release group with no significant difference (*P=0.626*).

Table 1. Baseline characteristics and demographic data of the two study groups

Variable	Open (n=23)	Endoscopic (n=23)	*P-value*
	Mean±SD/ median (IQR) or frequency (%)		
Age, year	56.34±8.39	52.95±10.52	0.234
Gender			
Male	2 (8.7)	4 (17.4)	0.665
Female	21 (91.3)	19 (82.6)	
Operation side			
Right	10 (43.5)	10 (43.5)	1.0
Left	13 (56.5)	12 (52.2)	
Bilateral	0 (0.0)	1 (4.3)	
Hand dominance			
Right	22 (95.7)	19 (82.6)	0.346
Left	1 (4.3)	4 (17.4)	
Occupation type			
Manual	23 (100)	22 (95.7)	1.0
Non-manual	0 (0.0)	1 (4.3)	
Symptoms duration, months	12.0 (84.0-6.0)	12.0 (24.0-8.0)	0.626*
Exposure to vibratory tool	0 (0%)	1 (4.3%)	1.0
Arthropathy	2 (8.7%)	1 (4.3%)	1.0
Nocturnal Tingling	23 (100%)	23 (100%)	1.0
Numbness	22 (95.7)	23 (100)	1.0
Thenar Muscle Atrophy	13 (56.5)	12 (52.2)	1.0
Positive Tinnel's Test	21 (91.3)	22 (95.7)	1.0
Positive Phalen's Test	19 (82.6)	20 (87)	1.0
Two Point Discrimination	1 (4.3)	0 (0.0)	1.0
History of Trauma	0 (0.0)	1 (4.3)	1.0
Hypothyroidism	2 (8.7)	5 (21.7)	0.414
Diabetes	6 (26.1)	8 (34.8)	0.749
Renal Dysfunction	2 (8.7)	0 (0.0)	0.489

SD: Standard deviation, IQR: Interquartile range (quartile 3-quartile 1).
.*Based on the Mann-Whitney U test

Table 2. Assessed outcomes of the two study groups

Variable	Open	Endoscopic	*P-value*
	Mean (SD)		
Preoperative Hand Grip	13.21 (4.8)	14.91 (7.2)	0.357
Postoperative Hand Grip	14.3 (5.3)	16.6 (3.8)	0.107
Hand Grip Improvement	2.17 (3.85)	2.43 (2.17)	0.700
Return to Work (days)	10.82 (5.32)	11.26 (4.80)	0.564
Postoperative Pain Score	5.91 (1.24)	2.43 (0.73)	0.000

SD: standard deviation

Outcomes

The preoperative and postoperative handgrip strength measurements showed similar baseline and outcome values between open and endoscopic release groups with no significant mean difference. As shown in [Table 2], there was a statistically significant difference in handgrip strength improvement after the procedure in both surgical methods: from a mean of about 13 Kg to 14 Kg for the OCTR group (*P=0.013*) and 15 Kg to 16.5 for ECTR group (*P<0.001*); respectively before and after surgery. Independent-sample t-test showed no significant difference between the two methods regarding hand grip improvement (P=*0.700*).

The mean (SD) number of days for the patients to return to work was 10.82 (5.32) in the open release group compared to 11.26 (4.80) in the endoscopic release group. This comparison revealed no significant difference between these groups (0.564).

On the contrary, one of the secondary endpoints in this study showed a significant difference between these two approaches. Analysis of pain after surgery showed a mean of 5.91 ± 1.24 points in the open release method compared to 2.43 ± 0.73 points in the endoscopic release method, which was a significant difference highlighting ECTR's superiority regarding this matter (P<*0.001*).

Discussion

Carpal tunnel syndrome is known to be the result of any phenomenon that can elevate carpal tunnel pressure. Accordingly, trauma, considered a factor that increases pressure in the tunnel by inflammatory processes, requires special attention. Timely treatment can acutely restrict these inflammatory processes and chronically prevent post-healing fibrosis occurrence, which sometimes is resistant to surgical treatment options. Therefore, early diagnosis and detection of these types of trauma are essential, especially in complicated traumatic patients where altered conciseness or other life-threatening conditions in the emergency ward admission and physician's concentration on life-saving measures can lead to permanent loss of patient's occupation due to CTS. A patient who has survived a severe accident but is unable to return to his previous profession is practically lost in the profession section. Therefore, with emergency medicine, physicians' special attention to the importance of this syndrome and its diagnosis, the patient's professional future can be protected.

In this cohort study, the potential difference between OCTR and ECTR was investigated with respect to their outcome. The preceding results confirmed our hypothesis that there is no significant difference between these two methods, and they could improve handgrip strength equally. Furthermore, except for the pain scores after surgery, other investigated endpoints were similar in both groups. The difference in the pain scores after surgery could be because of the smaller incision size in the endoscopic approach, which might decrease in the long term and could be considered negligible.

These data suggest no need to utilize an endoscopic approach to reach an optimum outcome, especially when this method requires more advanced equipment and could increase surgery costs. Therefore, based on these results, we should not impose any of these methods on the patient, and the final decision should be up to the patient after explicating the similarity of outcomes.

The latter statement also reaffirms the systematic review by Vasiliadis *et al.*, which demonstrated that the efficacy of both methods was comparable (18). In the mentioned study, the endoscopic approach was preferred to open for handgrip strength improvement and return to work. In addition, they confirmed that these statements could be inaccurate due to the high risk of bias and ambiguity of the analysis. Zho *et al.* also showed that there is no significant difference between these two methods regarding hand function, operation time, and overall complication; even though in their study, pain after surgery was similarly lower in the endoscopic approach, they demonstrated that ECTR has an increased rate of reversible nerve injury (19). On the contrary, the study published by Li *et al.* favored ECTR rather than OCTR. This study showed a higher satisfaction rate, shorter return to work time, and more key pinch strength recovery in the endoscopic approach (20).

The present study encountered some limitations, including the possibility of some remaining confounders that were overlooked, possible human errors, a small sample size, and a short follow-up duration, which restricted us from drawing a solid conclusion. A multivariate analysis was applied to reduce possible confounder effects, and we tried to minimize the human error by rechecking the data. A major obstacle in the current study was persuading the patients to complete their follow-ups. To reach this goal, these follow-ups were made free of charge to overcome this problem.

Subsequently, all patients completed their follow-up sessions. Another drawback in our study that might affect its generalizability was the fact that OCTR and ECTR surgeries were performed in different hospitals and were performed by two different surgical teams. Therefore, different environments and staff for the study groups might have affected our results.

The present study was performed in two hospitals with a small number of patients with limited demographic backgrounds, which might not adequately represent the general population. However, we suggest that more multicenter studies should be carried out in different situations with larger sample sizes to reach a more comprehensive result considering ethnicity and other probable relevant variables that were not considered in this study.

The ECTR and OCTR were comparable regarding handgrip strength and return to work time. However, the endoscopic approach group may have lower pain scores because of its smaller incision size. Although a specific conclusion cannot be drawn due to the small sample size, our data suggests that neither of these approaches should be preferred over the other, and patients must choose one of these two methods after elucidating the costs and benefits of each.

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