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Mini-Open Versus Extended Open Release for Severe Carpal Tunnel Syndrome

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Abstract

Background: Carpal Tunnel Syndrome (CTS) represents the most prevalent peripheral neuropathy in clinical settings, comprising approximately 90% of all entrapment neuropathies. This study aimed to evaluate the effectiveness of the extended open release compared to the mini-open technique in managing CTS.

Material and methods: This retrospective case series reviewed sixty patients diagnosed with severe CTS via electrodiagnostic tests and grip strength analysis. These patients were evenly divided into two groups: Group A (GA) underwent an extended open carpal tunnel release with an incision extending proximal to the wrist flexion crease, and Group B (GB) underwent a mini-open carpal tunnel release (2-3 cm). Follow-up periods were set at six months and one year, with evaluations focusing on return to work, cosmetic outcomes using the Vancouver Scar Scale (VSS), responses to the Boston Carpal Tunnel Questionnaire (BCTQ), and overall patient satisfaction.

Results: At the six-month follow-up, GA's mean symptom severity score (SSS) was 14.766±3.147, compared to 12±3.102 for GB. After one year, these scores changed to 12.666±8.921 for GA and 11.5±5.339 for GB, with the differences proving statistically significant ($P \leq 0.001$) at both intervals. Functional severity scores (FSS) also showed significant differences at the six-month checkpoint, with scores of 10.866±8.951 for GA and 9.733±4.668 for GB ($P \leq 0.03$).

Conclusions: The use of the mini-open approach was found to be better in terms of symptoms and functional improvement, patients' satisfaction, and cosmesis as compared to the extended open approach. However, grip strength measurements after one year showed comparable results between the two groups.

Keywords:

CTS, mini-open CTR technique, extended CTR technique, Boston Carpal Tunnel Questionnaire (BCTQ) score

Introduction

Carpal tunnel syndrome (CTS) represents the most prevalent form of peripheral entrapment neuropathy, with a lifetime incidence estimated at up to 10% (1). It occurs when the median

nerve, which consists of nerve fibers from the C5 to T1 spinal nerves, becomes compressed inside the carpal tunnel (2).

The etiology of CTS is predominantly idiopathic; however, a thorough evaluation often reveals specific causes (3). It most frequently affects individuals aged 40 to 50 years (4). The development of the syndrome is facilitated by factors such as increased thickness of the tendon sheath or decreased size of the carpal canal (5). Moreover, repetitive wrist flexion and extension movements can exacerbate median nerve compression by raising internal canal pressure, which is known to fluctuate with changes in wrist positioning (6, 7).

The causes of CTS include; structural discrepancies, physiological predispositions, and mechanical loads to the wrist (8). A detailed patient history is crucial for diagnosis, as symptoms typically manifest in the distribution of the median nerve in the hand (9). Patients often experience nocturnal episodes of burning pain, tingling, and numbness, which may be alleviated by dangling the arm off the bed or shaking it (10). In more severe cases, individuals may exhibit clumsiness and weakness, particularly during tasks requiring fine motor skills, such as buttoning clothes (11).

The condition is more common in female than in male (12). While it predominantly occurs in the 40-50-year-old age group, younger individuals may also develop the condition due to factors like pregnancy, rheumatoid arthritis, chronic renal failure, or gout. Advanced stages of CTS can lead to atrophy of the thenar muscles and weakened thumb abduction (13). Additionally, radicular symptoms from cervical spondylosis can complicate the diagnosis and may coexist with CTS (14).

In terms of treatment, traditional methods such as open carpal tunnel release (OCTR) often result in significant scarring (15), while endoscopy-assisted carpal tunnel release (ECTR) carries a risk of nerve damage (16). Consequently, the mini-incision carpal tunnel release (MCTR), which involves a smaller incision of approximately 1.5 cm compared to 3.5 cm in OCTR, has emerged as a superior alternative offering better outcomes in a shorter timeframe (17, 18).

Due to the few studies in the country, this study is aimed at comparing the outcome of extended open versus mini-open technique for the treatment of CT.

Patients and Methods

A comparative, case series study design was employed to fulfill the objectives of this investigation. The research was conducted at the Erbil Teaching Hospital, located in Erbil City, northern Iraq. Data were collected over six months from April 1 to September 30.

The study included patients aged 25-55 years, of both sexes, diagnosed with severe CTS, as confirmed by nerve conduction studies. Exclusion criteria encompassed individuals who had previously undergone carpal tunnel release, had multiple surgeries on the same hand, cervical neuropathies, or associated conditions such as De Quervain syndrome or Trigger finger.

Data Collection

A questionnaire, the Boston Carpal Tunnel Questionnaire (BCTQ), was developed to collect data which was initially recorded in each patient's file. Additional missing information was obtained via telephone. The data collection forms included: results from the initial electrodiagnostic tests, grip strength analyses, and findings from specific physical examination maneuvers, all of which were recorded prospectively at the patient's initial visit. Sixty patients were selected and divided into two groups of thirty each. Group A (GA) underwent extended open-release surgery, where the incision was extended proximally beyond the wrist flexion crease, while Group B (GB) underwent mini-incision surgery, with the incision measuring between 2-3 centimeters.

The Vancouver Scar Scale (VSS) was employed to assess patient satisfaction regarding the appearance of their surgical scars (19).

In terms of symptom severity score (SSS) and functional severity score (FSS), the BSTQ was self-administered to all patients at the six-month and twelve-month follow-up intervals (20).

Extended Open carpal tunnel release

For the standard open carpal tunnel release, various anesthesia options were utilized, including intravenous regional anesthesia (Bier block), general anesthesia, axillary blocks, and local anesthesia. However, patients generally experienced greater relaxation and better tolerance of the tourniquet under intravenous regional anesthesia. An upper arm tourniquet was used, and for obese individuals, a forearm tourniquet was utilized. The surgical cut was performed about 6 mm towards the ulnar side of the thenar crease in order to prevent damage to the palmar cutaneous branch of the median nerve. A curved cut that runs along to the crease of the palm, extending upwards in a zigzag pattern over the wrist towards the ulnar side. During the procedure, careful release of the carpal ligament along the ulnar side was performed, followed by visualization of the median nerve. The flexor tendons were retracted to inspect the floor of the carpal canal for any abnormalities. During initial carpal tunnel release, common operations like synovectomy or neurolysis of the median nerve were not recommended. After the incision was closed with interrupted 3-0 nylon sutures, the wrist was placed in a neutral posture, and a heavy dressing was put on. Deflating the tourniquet was done only after the dressing was applied. There were occasions when a sling was used in the first postoperative phase (18).

Post operative care

Post-surgery, the dressings were inspected before patient discharge, and adjusted or replaced as necessary to prevent constriction, a frequent source of postoperative discomfort. Patients received pain medication prescriptions but were encouraged to manage discomfort with over-the-counter options like paracetamol or ibuprofen. Surgical sutures were typically removed 10-14 days following surgery. Prophylactic antibiotics, either systemic or local, were not recommended for patients undergoing clean, elective carpal tunnel release (21).

Mini-open technique

The surgical site was delineated with a skin pen before applying a tourniquet. The longitudinal incision commenced just distal to the wrist's distal flexion crease, slightly ulnar to the midline,

extending 2-3 cm towards the third web space. Following exposure of the flexor retinaculum, the ligament was incised. Post-release of the median nerve pressure, an examination of the carpal tunnel was conducted to identify any pathologies. After that, the skin was stitched with 3-0 nylon, and the wound was covered with a sterile pad and wrapped with soft gauze, applying minimum pressure. The tourniquet was loosened after the administration of the dressing (22).

Post operative care

Postoperatively, the dressing was inspected before patient discharge and adjusted or replaced as needed to prevent excessive compression, which could lead to postoperative pain. Rather than relying solely on pain medication, patients were encouraged to engage in physiotherapy. Surgical sutures were removed approximately 10-14 days after the procedure (23).

Ethical consideration:

The study received approval from the Scientific Council of Orthopedic Surgery of the Iraqi Board for Medical Specializations, and authorization was granted by the Directorate of Health of Erbil. Verbal and written consent were obtained from each participant before enrollment..

Statistical analysis

Data were processed using the Statistical Package for the Social Sciences (SPSS) software, Version 27. Statistical evaluations were conducted using the chi-square test and t-test, with results presented as mean ± standard deviation and percentages. A P-value of less than 0.05 was considered statistically significant.

Result

This study included a total of 60 patients diagnosed with severe CTS confirmed by NCS. These patients were equally divided into two groups of 30 each. In GB, 25 patients (83.3%) were female and 5 (16.7%) were male, with ages ranging from 25 to 55 years. The mean ages were 42.466±4.259 for GA and 41.933±3.221 for GB. Regarding the patients' occupations, 25 (83.3%) in each group were manual laborers. GA included two patients with diabetes mellitus (DM), compared to none in GB, and one patient with hypothyroidism (Table 1).

Table 1. Demographic data in two groups participating in the study

Characteristics		Group A	Group B
Age		42.466±4.259*	41.933±3.221
Sex	Male	5 (16.7%) **	5 (16.7%)
	Female	25 (83.3%)	25 (83.3%)
Occupation	Handworker	25 (83.3%)	25 (83.3%)
	Non handworker	5 (16.7%)	5 (16.7%)
Comorbidity	Diabetes mellitus	2 (6.7%)	3 (10%)
	RH-arthritis	-	1 (3.3%)
	Other	1 (3.3%)	-

*Mean±SD, **frequency (%)

The mean duration of the surgical procedure was notably shorter in GB, at 10.4±1.547 minutes, compared to 15.933±2.369 minutes in GA. Furthermore, the mean time for returning to work was approximately half in GB (10-20 days, mean 12.966±8.361 days) compared to GA (20-30 days, mean 25.166±7.145 days). The differences in both surgical duration and return-to-work time were statistically significant (P≤0.001) (Table 2).

Table 2. Mean time of operation and back to work between both groups

Characteristics	Group A	Group B	P-value*
Operation time (minute)			
Mean	15.933±2.369	10.4±1.547	0.001
Range	15-20	10-15	-
Back to work			
Mean	25.166±7.145	12.966±8.361	0.001
Range	20-30	10-20	-

* P-value t-test, **Mean±SD

Postoperative complications varied between the groups. In GA, the most common complication was scar formation, affecting 14 (46.7%) patients, followed by 6 (20%) experiencing pillar pain. In contrast, GB had only 5 (16.7%) patients with scars and 3 (10%) with pillar pain. The incidence of complications, including infection, pain, scar formation, sympathetic dystrophy, and pillar pain, showed a statistically significant difference (P≤0.001). However, the recurrence of symptoms was similar between the groups, indicating no significant statistical difference (Table 3).

Table 3. Frequency of post-operative complication in both groups

Complication		Group A	Group B	P-value*
Infection	Yes	3 (10%)	1 (3.3%)	0.001
	No	27 (90%)	29 (96.7%)	
Pain	Yes	5 (16.7%)	3 (10%)	0.001
	No	25 (83.3%)	27 (90%)	
Scare	Yes	14 (46.7%)	5 (16.7%)	0.001
	No	16 (53.3%)	25 (83.3%)	
Sympathetic dystrophy	Yes	2 (6.7%)	-	0.001
	No	28 (93.3%)	-	
Pillar pain	Yes	6 (20%)	1 (3.3%)	0.001
	No	14 (80%)	29 (96.7%)	
Recurrence	Yes	2 (6.7%)	3 (10%)	0.09
	No	28 (93.3%)	27 (90%)	

*P-value Chi-square and fisher exact test

According to the VSS, 15 (50%) patients in GB had outcomes classified as Scale 1 (very good), whereas 12 (40%) in GA were merely satisfied with their scar outcomes. This difference was statistically significant (P≤0.005) (Table 4).

Table 4: Cosmetic outcome according to VSS

Vancouver scar scale	**Group A**	**Group B**	**P-value***
Very good	1 (3.3%)	15 (50%)	0.005
Good	10 (33.3%)	10 (33.3%)	
Satisfied	12 (40%)	4 (3.3%)	
Unsatisfied	7 (23.3%)	1 (3.3%)	

*P-value Chi-square

The mean SSS in GA was 14.766±3.147 at six months and 12.666±8.921 at one year, while in GB, it was 12±3.102 at six months and 11.5±5.339 at one year. The differences were statistically significant at both intervals (P≤0.001). The FSS also differed significantly at the six-month interval (10.866±8.951 for GA vs. 9.733±4.668 for GB; P≤0.03), but not at the one-year follow-up (P≤0.184) (Table 5).

Table 5: Comparison between two procedures by BCTQ symptoms and function (grip strength)

symptoms severity score	**Group A**	**Group B**	**P-value***
Symptoms			
BCTQ 6 month	14.766±3.147	12±3.102	0.001
BCTQ 1 year	12.666±8.921	11.5±5.339	0.001
functional			
BCTQ 6 month	10.866±8.951	9.733±4.668	0.03
BCTQ 1 year	8.4±8.223	8.3±6.224	0.184

* P-value t-test

Discussion

The American Academy of Orthopedic Surgeons recommends both nonoperative and operative interventions for the initial treatment of early CTS. Initially, a non-operative course is advised (24). Carpal tunnel release, involving the division of the flexor retinaculum, has proven to be a highly effective surgical technique for managing CTS (25). There are several methods for carpal tunnel release, including the extended open technique, the mini-open, and the endoscopic approach (26). Each technique has been successful in alleviating symptoms of CTS, though they each present distinct advantages and disadvantages. Historically, the extended-release technique has been preferred by many surgeons for over 50 years (27, 28), due to the advantage of providing direct visualization of all structures within the tunnel (29). However, this technique is not without complications, which has led to the development of newer techniques such as the mini-open and endoscopic methods over the past two decades (30, 31).

Several researchers, including Lee, Strickland, and Shapiro, have reported favorable outcomes using the mini-incision technique. This method involves a limited palmar incision that preserves a fascial convergence between the thenar and hypothenar muscles and avoids crossing the wrist crease with the skin incision. Such anatomical considerations are crucial for facilitating rapid postoperative recovery (17).

The conventional method for carpal tunnel release often entails surgically cutting the transverse carpal ligament (TCL) by making a lengthy incision commencing at Kaplan's cardinal line and continuing beyond the distal wrist crease. A longer surgical cut may lead to extended recovery periods and, in some instances, heightened sensitivity of the resulting scar (32). In recent times, both restricted incision and mini-open procedures for carpal tunnel release have been introduced and have prompted many comparative outcome studies to assess their clinical effectiveness (33). The results of surveys done in 1987 and 2012 among members of the American Society for Surgery of the Hand indicate a change in surgical preferences. The majority of surgeons now prefer the mini-open technique, which involves a shorter incision, over the conventional larger incision (32). According to a poll conducted in 2012 among AAHS members, the mini-open strategy was found to be the most often used, with 45.5% of respondents preferring it, compared to 33.3% who favored the extensile approach.

Surprisingly, in situations where electrodiagnostic tests showed significant CTS, there was a comparable preference for using the mini-open procedure compared to a more extensive approach (42.3% vs 43.9%, respectively). Surgeons may choose to make a bigger incision when treating severe CTS (34, 35, 36).

Jugovacet et al. demonstrated in their study that intervals between surgery and return to daily activities were significantly shorter for patients with a limited palmar incision compared to those with a traditional open technique (TOT) (median 5 days vs. 10 days; $p<0.001$), with less scar tenderness observed in the limited incision group. The present study findings align with these results, showing a quicker return to work for GB (10-20 days, mean 12.9%) compared to GA (20-30 days, mean 25.1%) (35).

Aslani et al. compared patient satisfaction between those who underwent mini-incision and endoscopic release versus those who underwent the TOT, finding higher early patient satisfaction with the mini-incision, similar to our study results (37).

Cirpar et al. found the mini-incision (3cm) for carpal tunnel release to be as safe and effective as the TOT, corroborating our data (38).

According to the current study findings, Suppaphol et al. demonstrated that limited open carpal tunnel release is as effective as the standard open technique but offers better cosmetic outcomes and improvement in grip strength (39).

Liawrungrueang et al. noted that the endoscopic method did not provide any advantages over the short incision approach (28). These findings underscore the importance of considering potential severe neurovascular complications that may follow endoscopic carpal tunnel release. The current study suggests that the mini-incision technique incorporates the benefits of the endoscopic approach without its drawbacks, yielding better overall results.

Conclusions

The mini-open incision technique is effective and offers significantly better outcomes in terms of symptoms, function, and cosmetic satisfaction compared to the extended open incision technique, with the exception of grip strength, which was comparable between the groups after one year.

Recommendations

1. Further study that includes a larger number of patients.

2. Longer duration of follow up.

3. Mini-open technique became standard operation.

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Consent for publications: The authors conducted a thorough examination and gave their endorsement to the final article.

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