# Proximal palmar mini-incision carpal tunnel release technique

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ABSTRACT

**Background:** Carpal tunnel syndrome is the most common entrapment neuropathy in humans today. For patients in whom conservative treatment fails, surgical decompression is indicated. Various surgical techniques are becoming increasingly popular. Due to the rapid postoperative recovery shown after endoscopic operations, proximal palmar mini-incision for carpal tunnel release is a comparative alternative.

**Methods:** Ninety four patients [113 hands] with a carpal tunnel syndrome underwent carpal tunnel release through a 1-cm longitudinal incision made just over the distal flexor crease. The self- administered Boston Questionnaire was used to assess the severity of patients' symptoms and their functional status, both before and after the surgical intervention and at their final follow-up. Patients were also asked, during the final follow-up, about the pain level of their scar tissue and functional outcome.

**Results:** There was a significant decrease in the Boston Carpal Tunnel Questionnaire scores for the symptom severity scale and the functional status of patients in this group, post- operatively at one month and at final follow - up. The mean operative time was significantly shorter than open or endoscopic CTR. After 1 month, only 4 hands[3.5%] stated they had scar tissue pain, no recurrence, short period return to work &cost effective.

**Conclusions:** proximal mini-incision is as effective as ECTR. Furthermore, it is also a safe and simple procedure with shorter operative time& reduced surgical cost. The absence of relapse and good clinical results make this technique suitable.

**Key words:** carpal tunnel syndrome; microsurgery; surgical procedures, minimally invasive.

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The word "carpus" is derived from the Greek word karpos, which means "wrist."The carpal tunnel is a passageway in the wrist through which the median nerve and tendons of the hand travel. Carpal tunnel syndrome was described by Sir James Paget in 1853. The carpal tunnel is a narrow, confined space: the floor of the tunnel is made up by the carpal bones of the wrist, and the roof is created by the transverse carpal ligament

Carpal tunnel syndrome (CTS) is the most common peripheral neuropathy in the body[1].It is one of the most frequent conditions that lead to work disability in the USA with a Prevalence of 3.7% [2]and over 500,000patients undergo carpal tunnel release (CTR) each year [3-6].The estimated economic cost of carpal tunnel release is up to$2.8 billion annually [7, 8].

A number of conservative and surgical treatments have been advocated, with surgical treatment performed on symptomatic patients who are unresponsive to conservative management [9-11]

The aim of surgical intervention is to decompress the median nerve by sectioning the transverse carpal ligament. Damage of the palmar cutaneous branch of the median nerve, reflex sympathetic dystrophy, hypertrophic scar formation, scar sensitivity, palmar hematoma, bowstringing of the flexor tendons, double crush, and adherence of the flexor tendons had been reported as the causes of persistent symptoms after median nerve release. [12-15].

Among the surgical treatment options, standard open surgery, endoscopic surgery and mini-incision open surgical technique and ultrasound- guided procedures all have advantages and disadvantages when compared to one other [9,10,11,16,17,18,19]The most commonly performed surgical procedure in the treatment of CTS, open carpal tunnel release (OCTR) produces reliable symptom relief. OCTR requires an incision on the palm about 1 or 2 in. in length. Through this incision, the skin and subcutaneous tissue are divided, followed by the palmar fascia, and ultimately, the transverse carpal ligament (TCL). However, the subcutaneous tissue, superficial palmar fascia, and in some cases, the Palmaris brevis have to be incised to expose the TCL. Consequently, scar tenderness, pillar pain, weakness, and a delay in return to work are known to occasionally occur [20, 21].

The limitations of OCTR resulted in the development of endoscopic carpal tunnel release (ECTR) in the late 1980s. [20,22,23]ECTR involves one or two smaller incisions (less than 0.5 in each) through which instrumentation is introduced including a synovial elevator, probes, knives, and an endoscope used to visualize the underside of the TCL. Although ECTR results in a rapid return of strength and function, concerns remain about the risks of median nerve injury and incomplete release by the endoscopic probe, a steep learning curve, the high device cost, and the significant setuptime and effort required, other drawbacks of ECTR include a narrow view of the surgical field provided [24,25] The average return-to-work time is 54 days for OCTR and 28 days for ECTR [26].

In recent years, the development of ultrasound-guided procedures has provided a new approach for CTR. Ultrasound allows the exploration of carpal tunnel anatomywith a wide field of view at high resolution. Its flexibility, widespread availability, low cost, and short learning curve make it an effective tool in the diagnosis and treatment ofCTS [27,28]Ultrasound-guided CTR was first reported in 1997 [29,30,31].Since then, many researchers have focused on percutaneous procedures using different dividing elements to transectthe TCL because ultrasound provides satisfactory surgical visualization.

The selected dividing elements include hook knife [32] angle knife [33], saw blade [27,28] and needle tip[34,35].& lastly the use of a thread [36] One weakness of the

percutaneous approaches isthat these mini-tools require repetitive cutting motions to divide the TCL, which increases the risk of technical errors including iatrogenic injuries or incomplete release, especially for patients with a narrow gap between the median nerve and the ulnar artery[36].
Since more effective treatment options that have a reduced overall cost and enable earlier rehabilitation are preferred, mini-incision surgical techniques are increasingly being used in order to meet these criteria [10,11] Investigating the superiority of one surgical technique over another can help to identify the most effective technique[9,10,11]

**Methods.** For this prospective, randomized clinical study, between June 2003 and September 2014 322 patients were Diagnosed as a case of CTS 304 Female (94%), 18 Male (6%) patients, ,all of them had received conservative treatments, such as anti- inflammatory drugs, wrist splints, and local steroid injections.
In all patients, the diagnosis was based on a clinical presentation involving median nerve compression and on electrophysiological evidence of median nerve compression below the elbow. Surgical treatment performed on symptomatic patients who are unresponsive to conservative management. Of those operated on and followed 94 patient(113 hands) underwent proximal palmar mini-incision CTR.

All patients were operated on in an outpatient setting under general mask anesthesia and tourniquet. Skin preparation and sterilization was performed as usual (before surgery the forearm, wrist and hand were cleaned with povidone iodine solution)

The incision was located at the superior region of the palm. There is a triangle on this area. Distal flexion crease is the base of this triangle. The thenar crease created lateral edge of this triangle, the hypo-thenar crease is the medial border of this triangle. The tip of this triangle continues with the inter-thenar crease. The incision was started from just proximal and ulnar to the mid-point of the base of the triangle crossing the crease with mild inclination on midline of the triangle and extended for 1 cm toward the tip of the triangle {Figure 1}. A mini skin retractor was used to retract the incisioned skin on the ulnar side of the palmaris longus tendon (PLT), {Figure 2}. The subcutaneous fat tissue was dissected laterally

When the proximal site of the transverse carpal ligament (TCL) was identified, the PLT was retracted radially and the palmar cutaneous branch of the median nerve preserved.

**Figure 1:** Site of incision for CTS release(sutured).

Using a No.15 scalpel with the point directed upward, the Proximal end of TCL was cut in a proximal to distal direction. A dissector was used to release any adhesion between the TCL & the underling structures, release of the TCL from the tissue above it was done by the use of the dissector by repeated movement of the dissector.

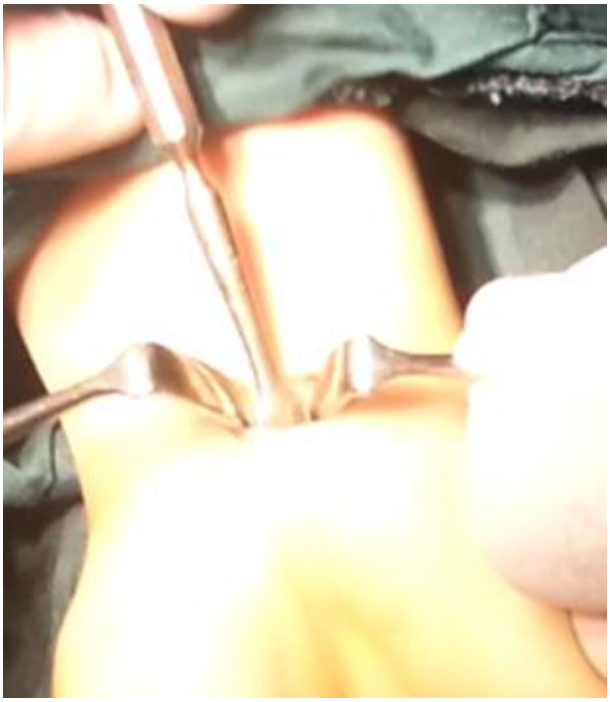

**Figure 2:** Mini retractor& dissector used in dissection.

then by using blunt end scissor division of the rest of The TCL was then completed(figure 3). The terminal cut was ended before reaching the junction of the transverse line drawn from the proximal edge of the first web space (transverse broken line) and the middle/ring finger axis(longitudinal broken line),(figure). The antebrachial fascia was cut vertically, staying on the ulnar side of the PLT.

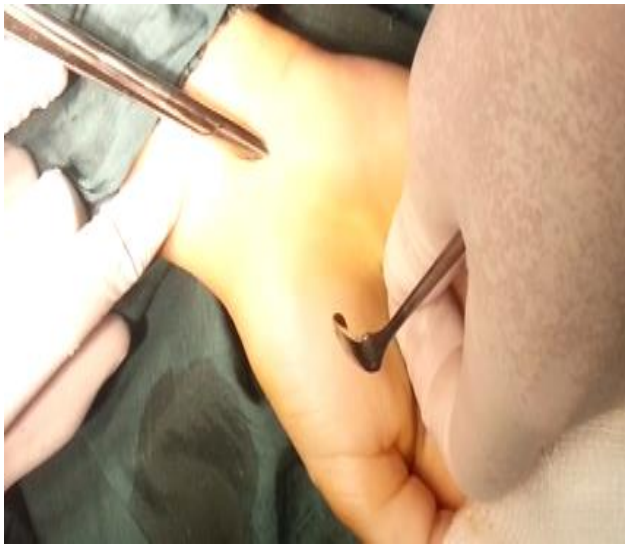

**Figure 3:** Scissor used to complete CTL release.

The surgical area was then irrigated with sterile saline solution. The sectioning of the ligament was checked along the carpal tunnel, and the median nerve was inspected from any adhesion & confirmation by the aid of the dissector in the deep site of the operation.

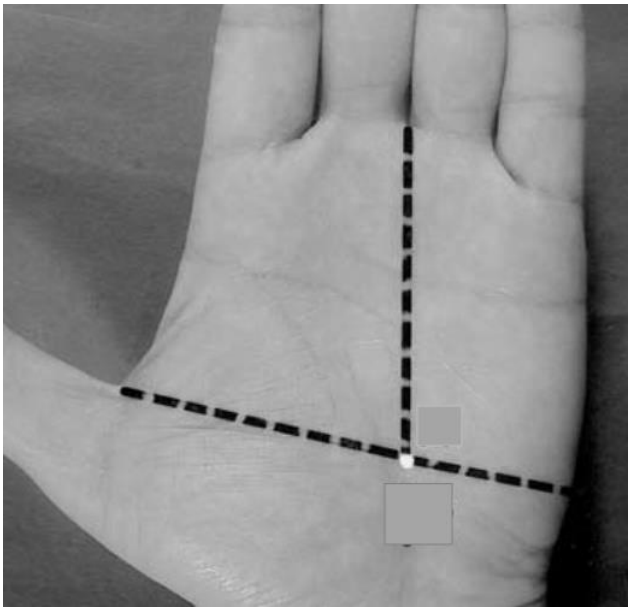

Figure 4: image show the site of distal end of scissor cut.

Figure 5: Bilat proximal mini-incision CTR.

Finally, the surgical site was cleaned with normal saline and the skin closed with 2/0 Silk or prolene. The wound was then dressed and bandaged. The tourniquet pressure was released, and the wrist and proximal palm were compressed for few minutes to achieve hemostasis. No splint was used. Single injectable antibiotics dose was given. Non-steroidal anti-inflammatory drugs were given to control pain The patients were instructed to move their fingers after the operation. The skin sutures were removed 10 days after the operation.

**Results.** One hundred thirteen procedures in 94 patients were carried out, 19 patients (20%) underwent bilateral operations 16 of them in one session. The patients included 92 women and 2 men aged 20 to 66 years (average, 34.7 years). 38 was Lt hand (34%) and 75 was the Rt hand (66%). We analyzed the outcome of 113 hands. The average follow-up period was 7.34 years (range 0.4-11.7 years). The mean duration of symptoms was 12 months.

Table 1: Scores of Levine-Katz questionnaire by 3 months and comparison.

| Study | Technique | No of patients | Mean age | Symptom severity | Function Status |
|---|---|---|---|---|---|
| Current | MPCTR | 30 | 34.7 | 1.52 | 1.43 |
| Danqing Guo et al. [34] | TCTR | 16 | 52 | 1.4 ± 0.5 | 1.2 ± 0.3 |
| Trumble et al. [25] | OCTR | 72 | 56 | 1.9 ± 0.9 | 1.9 ± 0.9 |
| Atroshi et al. [37] | ECTR | 63 | 44 | 1.5 ± 0.5 | 1.3 ± 0.5 |

MPCTR mini-proximal CTR ,TCTR thread ultrasound CTR, OCTR open CTR, ECTR endoscopic CTR

We interviewed some patients by telephone using a standardized questionnaire for this assessment. The Boston questionnaire is self-applied and evaluates the severity of symptoms and the functional status of patients with carpal tunnel syndrome. The symptoms severity scale (SSS) evaluates symptoms regarding severity, frequency, time and kind. The functional status scale (FSS) evaluates how the syndrome affects daily life. Questions concerning symptoms severity scale are composed of 11questions addressing: pain intensity during daytime and nighttime, time of pain during the day, dormancy, weakness, tingling sensation at night, frequency of that night tingling sensation, and skill. Each question has five answers numbered from 1 to 5, arranged in an increasing order of symptoms severity.

Therefore, 1 means no symptoms, 2 mild symptoms, 3 moderate symptoms,4 intense symptoms, and 5 severe symptoms.Questions concerning functional status are composed of 8 questions, where each one corresponds to a functional activity (writing, buttoning clothes, holding a book while readings, holding a telephone hang, housekeeping, opening a glass vial cap, carrying market bags, bathing and dressing). Each activity has five difficulty degrees, where degree 1 corresponds to no difficulty, degree 2 little difficulty, degree 3 moderate difficulty, degree 4 intense difficulty, and degree 5 cannot perform the activity at all due to hands and wrists symptoms.

Table-2-Patients' results of Boston carpal tunnel questionnaire scores& comparison preoperative &1 month postoperatively.

| | Preoperative | | | Postoperative After 1 month | | |
|---|---|---|---|---|---|---|
| | Current | Ucar G1 | Ucar G2 | Current | Ucar G1 | Ucar G2 |
| Results of symptomatic severity score (SSS) | 3.51 | 3.27 | 3.38 | 1.52 | 2.41 | 2.65 |
| Results of functional status scale (FSS) | 3.23 | 3.10 | 3.13 | 1.43 | 2.14 | 2.19 |

Ucar et al[54] G1 incision distal to flexor crease G2 incision proximal to flexor crease.

All answers should be concerned to the symptoms within a typical period of 24 hours, for the last two weeks. The patients should answer to the 11 first questions choosing only one alternative. Regarding the last eight questions, they should select the degree of difficulty felt in each activity described, according to the label on the questionnaire itself.

In case a patient had both hands operated, two questionnaires should be applied, one for each hand. From answers, two scores were calculated. The symptoms severity score (SSS) refers to the first 11 questions.
The functional status score (FSS) refers to the last 8 questions. The calculation is the sum of answers divided by the number of questions. Unanswered questions were excluded from calculation. An average of the answers for each question was calculated; aiming a careful analysis of results for each question The postoperative evaluations were performedvia subjective assessment with a standardized telephone interview The scores of self-administrated symptom severity and functional status (Levine-Katz questionnaire) from 30 validated questionnaires SSS 1.52& FSS 1.43 in the first month.

Also the patients inquired about the degree of relief of preoperative numbness and pain of the operated hand, any postoperative pillar and/or scar pain, recovery in terms of their daily activities and return to their previous work. The average duration of the procedure was 5 min, excluding the time of preparation.

A total of 101 hands (89.4%) had excellent relief of symptoms (90%-to-complete improvement),8 (7.1%) had good relief of symptoms (70%- or-greater improvement), 4 (3.5%) had fair relief of symptoms (50%-or-greater improvement). In the first month postoperatively pain of the operated hand was noted in 4 hands (3.5%) suffered pain at site of surgery resolved completely after 3 months. A subjective decrease of grip strength was noted in 1 hand (0.88%). Poorer performance in lifting heavy objects, as compared with the preoperative state, was noted in 4 hands (3.5%). Towel squeezing was worse in 3 hands (2.6%), and buttoning ability was worse in 3 hands (2.6%). The return-to-work period was 1 to 4 weeks (mean, 2 weeks).One hand suffered tourniquet palsy for 5days .All of them improved after 1 month.

Three hands suffered temporary nerve irritation (numbness) 1 to ring finger 1 to index finger &the third case suffered neuralgia to thumb and index fingers sustained for 3 weeks for which resurgery by open exploration of the median nerve and all its branches in the hand, no insult was found probably the injury results from penetration of the median nerve during puncture of the CTL, the condition resolved completely after 5 months. No major neurovascular injuries occurred. No recurrence was noted. A significant improvement in subjective sensibility was reported within 24 hour, and sleep quality improved for all cases.

**Discussion.** The goal of surgical treatment for CTS is to decompress the median nerve by transecting the TCL. To reach this goal, various surgical techniques are currently used; most of these have equal rates of success. In carpal tunnel surgery, procedures performed with standard open techniques require a large incision .This can lead to complications such as tethering of the flexor tendons, excessive scar tissue formation and increased sensitivity. [14, 35,36]Forth is reason, mini open and endoscopic surgical techniques performed through a smaller incision have been recommended. Mini-incision procedures were performed using a small longitudinal palmar incision or a transverse wrist incision. Few, or no, complications were observed with these techniques [9-12,16,17,19,38-43]. Minimally invasive techniques allow early motion and minimize scar tissue pain, thus meeting the post-operative expectations of the patient.

When mini-incision and endoscopic surgical techniques were compared, no significant difference was found between the outcomes in the short or long term1[40,44-46] The disadvantages of endoscopic techniques include (1) high cost, (2) possible damage to the neighboring soft tissues (3) inability to perform a complete sectioning of the transverse carpal ligament.[19,47,26]

Return to work in our study was 14 days. Agee et al[48] reported 25 days in ECTR and 46 days in OCTR. Benedetti et al [49] 24 days ECTR 42 days OCTR, Brown et al[50] report 14 ECTR and 28 OCTR, while Erdmann et al [51]reported 14 days ECTR, 39 days OCTR.

Aydin Keramettin et al.[52] compared mini uni-skin incision and standard incision. There was no reoperation, skin infection, and palmar cutaneous branch injury in all groups. The scores of grip, pinch and cosmetic results were better in the patients who were operated on with mini uni-skin incision technique from those of standard incision in the ratio of 26%, 17%, and 54% respectively. Palmar tenderness was lower in patients operated on with mini uni-skin from those of standard incision.

Broomley et al [11] in their investigation, used a mini-incision technique and reported less scar tissue formation, shorter operative time, less post-operative pain and the possibility for local anesthesia. Avci and Sayli[10] reported good results and fewer complications for the knife-light

technique that involves a short longitudinal palmar incision. Paolo et al [53] compared the standard mini-incision technique to the knife-light technique on 185 patients. A tourniquet was applied to all patients. Axillary block was performed in some cases, while local anesthesia was administered for the others. The study found that the operative time was shorter than 20 minutes in patients who received the knife-light technique through a transverse incision at the flexor crease. Short term outcomes were found to be better among these patients than for patients undergoing standard mini-incision.

In our study the mean duration of the operation was five minutes excluding the time of preparation. The shorter operative time in the proximal mini incision in comparison to distal palmar incision resulted from the absence of dense soft tissue mass that needs to be excluded. The median nerve was reached easily and the proximal edge of the transverse carpal ligament could be seen. However, for distal approach in the palm the need to pass through the subcutaneous dense fat tissue to reach the transverse carpal ligament resulted in a loss of time [54].

A bloodless surgical field is important in hand surgery; using a tourniquet produces a bloodless surgical field help in ease of dissection. No tourniquet was used in Ucar et al [54] and claimed no surgical difficulty was observed in their study. Tzarnas and Darby [55] reported good results, with no complications, in surgeries performed under local anesthetic containing adrenaline without a tourniquet.

After testing the reliability of the surgical procedure on cadavers, Dayican et al [56] performed carpal tunnel surgery on 96 patients, through a vertical incision proximal to the flexor crease of the wrist. No neurological complications were reported. The procedure was performed under local anesthesia, without a tourniquet. The mean operative time was found to be nine minutes, with no bleeding noted. Significant clinical results were observed at post-operative follow-up.

In our study general mask anesthesia has been used in the majority of patients. No intraoperative discomfort or any other anesthetic complications occurred. No intraoperative endotracheal intubation during the operation became necessary. The overall operation time, including anesthetic preparation, was greatly reduced. Almost all of the patients receiving the general mask anesthesia were satisfied with this alternate anesthetic procedure.

Early in this study 3 hands got temporary nerve irritation .Agee et al[40]of 82 hands reported 2ulnar neurapraxia in ECTR and injury to deep motor branch of ulnar nerve (1 patient). Benedetti et al [49] of 33 patients reported 1 transient neurapraxia after ECTR. Brown et al [50] of 84hands reported 1 partial transection of the superficial palmar arch 1 digital nerve contusion and 1 ulnar nerve neurapraxia. Dumontier et al[57] reported transient reflex sympathetic dystrophy in 2 patient ECTR from 60 patients and 2 patient OCTR from 43 patients. Jacobsen et al [58] reported 3 transient numbness on the radial side of ring finger after ECTR on 16 hands.

Radial retraction of the Palmaris longus tendon and incision of the transverse carpal ligament on the ulnar side& using a No.15 scalpel with the point directed upward during first penetration of TCL reduce the risk of neurological damage Patients had shorter operative time and less hypertrophic scar tissue pain at final follow-up.

Although in large series, cosmetic problems originated from excessive scar formation seems relatively uncommon problem after carpal tunnel surgery. But it is clear that palmar skin surface lost their biomechanical movements and elasticity after surgery even in normal wound healing process. The limited skin incision occupies small area on the palmar surface of the hand. This provides more movement capability, elasticity and better appearance to the skin surface. Klein et al[59] reported successful results with open surgical techniques performed through a 1 cm incision.

In regards to the efficacy of symptom relief, the Mini proximal incision release of CTS in the present study had results (96.5%) complete relief comparable with those of other reported techniques.

Some researchers have claimed that the endoscopic carpal tunnel release (ECTR) decreased the postoperative morbidity of standard open carpal tunnel release[50] In previous studies, patients who underwent ECTR had less pillar pain, faster recovery of grip and pinch strength, and earlier return to daily activities and work than those who underwent non endoscopic treatments. In the present study, our patients had postoperative incidence of scar and pillar pain of 3.5%, which was close to that of the endoscopic techniques and other minimal palmar incision techniques. The reduction in the destruction of skin, subcutaneous tissue, and palmar fascia and the preservation of the important fascia convergence between the thenar and hypothenar muscles is believed to have contributed to the lower morbidity observed with endoscopic and minimal palmar incision techniques. In recent years, the development of ultrasound-guided procedures has provided a new approach for CTR. Ultrasound instrument is needed in the operation and learning curve reported to master the operation. One weakness of the percutaneous approaches is that these mini-tools require repetitive cutting motions to divide the TCL, which increases the risk of technical errors including iatrogenic injuries or incomplete release, especially for patients with a narrow gap between the median nerve and the ulnar artery.

ECTR is not without risk, and incomplete decompression is possible. The complications of injury to the superficial palmar arch or median or ulnar nerve and of incomplete release of the carpal tunnel have been well documented[60]. ECTR is a demanding procedure that is prone to technical errors and complication rate reach 5.6% [61] and more costly [62].

The mini proximal-incision technique presented here is intended to decrease the size of not only the skin and palmar fascia opening but also tissue destruction.

In addition, to avoid injury to the superficial palmar vascular arch and the third common digital nerve arch the end of the last cut of the blunt scissor should be 0.5 to 1.0 cm proximal to the intersection of the axis of the middle finger/ring finger and the transverse line drawn from the proximal edge of the first web space, as depicted in the report by Atik et al. [63]With accurate location of the skin incision and stoppage point of incision, the risks of major neurovascular or tendon injuries in the proximal palmar-incision technique can be further minimized. The palmar cutaneous branch of the median nerve, which is always radial to the axis of the middle finger/ring finger, can also be preserved in this skin incision. CTS secondary to ancillary pathology needs surgical treatment around 5% (this can be excluded by careful clinical examination) ultrasonography and/or MRI may be included to the preoperative diagnostic tests [64]

In conclusion, The surgical procedures performed in this study are low-cost techniques that require no hospitalization & no sophisticated instrument and yield successful clinical results. . Its postoperative morbidity is less than that of other surgical techniques and similar to that of ECTR. Because of its safety and simplicity, is believed to be a good alternative to ECTR & superior to standard open surgical technique.

We consider that the selection of the mini-surgical technique used should depend on the experience and skill of the surgeon.

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