Microsurgical Mini-Open Carpal Tunnel Release: Surgical Technique and Narrative Review of Literature

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Abstract

The authors describe their technique of mini-open carpal tunnel release performed with a surgical microscope. The authors also compare the surgical approaches for the management of carpal tunnel syndrome and review the pertinent literature.

Keywords
- carpal tunnel
- carpal tunnel release
- endoscopic
- microscopic
- mini-open
- review
- surgery

Introduction

Carpal tunnel syndrome (CTS) is the most common entrapment neuropathy affecting humans, with an incidence of around 4% in the human population.[1] Typically, CTS is more commonly seen in association with obesity, diabetes mellitus, hypothyroidism, pregnancy, and rheumatoid arthritis. Work requiring the use of vibrating tools and repetitive and forceful use of hands is also a well-known risk factor for CTS.[2] Typically, women are three times more commonly affected than men. Symptoms typically include pain and paresthesias in the median nerve distribution of the hand involving the palmar aspect of the thumb, index finger, middle finger, and lateral half of the ring finger. Pain typically wakes the patient from sleep, and patients usually get relief with repetitive shaking of the hand (Flick's sign).[3] Severe cases are associated with thenar atrophy and weakness of the median innervated muscles of the hand. Phalen's maneuver, Tinel's sign, and other provocative maneuvers have varying sensitivity (36–68%) and specificity (58–77%).[3] An electrophysiology study (EDX) includes a nerve conduction study and electromyography, mainly of the abductor pollicis brevis. The sensitivity of EDX is 56 to 85% and the specificity is 94–99%.[4] The EDX also helps in ruling out other radiculopathies or polyneuropathies.

Ultrasound median nerve cross-sectional area greater than 9 mm^2 at the carpal tunnel inlet has a sensitivity of 87.3% and specificity of 83.3% for the diagnosis of CTS.[5] Magnetic resonance imaging (MRI) is usually reserved for other space-occupying lesions in the carpal tunnel

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mimicking CTS.[6] Some other lesions that may mimic an entrapment CTS are neurofibroma, ganglion cyst, lipomatosis of nerve, Dejerine–Sottas syndrome, etc.[6]

The aim of this study is for the authors to describe their method of performing a mini-open carpal tunnel release (mCTR) in entrapment CTS and perform a narrative review of the pertinent literature about surgical management of CTS.

Technique of mCTR

The diagnosis of CTS is usually made clinically with confirmation from an EDX study (►**Figs. 1** and **2**). Imaging is typically restricted to cases with atypical presentation or a suspected mass lesion. The authors perform CTR with local anesthesia and sedation. The patient is placed comfortably supine on the operating table, and the affected arm is placed on an arm board in a 90-degree abducted position with the supinated hand. No tourniquets are used.

The surgeon and assistant are seated on a surgical chair on either side of the arm board.

The standard landmarks for the mCTR are the Kaplan cardinal line and another line in the web of the ring and middle fingers. A 2- to 2.5-cm skin incision is marked starting distally at the intersection of the above two lines and proximally short of the wrist crease. The skin and subcutaneous tissue are infiltrated with lignocaine. The skin incision is deepened up to the superficial fascia and then opened in the same line as the incision. After that, the operating microscope is brought into the field. The transverse carpal ligament (TCL) is identified by its transverse arrangement of fibers and whitish color. The TCL is cut layer by layer carefully under magnification. Usually, the TCL is cut more along the ulnar side to avoid injury to the recurrent branch of the median nerve. Once the deepest layer is cut, the glistening median nerve is noted underneath. A Penfield no. 4 dissector is passed between the deepest layer of the TCL and the median nerve, and the overlying TCL is cut sharply with a blade with the Penfield no. 4 dissector acting as a guard. The Penfield no. 4 dissector has a very thin profile and it is always lifted up toward the TCL rather than pushing the compressed nerve inferiorly. The skin edges are pulled up gently with a handheld hook to work under the skin incision. Once the TCL is completely cut, fine curved mosquito forceps are introduced and glided over the nerve proximally to ensure no resistance is felt and the tip of the forceps is felt in the distal forearm. Similarly, the fine-curved mosquito forceps are again introduced and glided over the nerve distally to reach the palmar space without any resistance. This step is done under visualization by tilting the operating microscope and lifting the skin edges. Usually, the fat in the palmar space protrudes under the distal part of the skin incision after a complete TCL section. Overzealous use of the bipolar cautery is avoided around the median nerve to prevent nerve damage and delayed scarring. Once hemostasis is achieved, only the subcutaneous tissue and skin are closed. Skin is closed with absorbable subcuticular sutures and a thick dressing is applied over the wound.

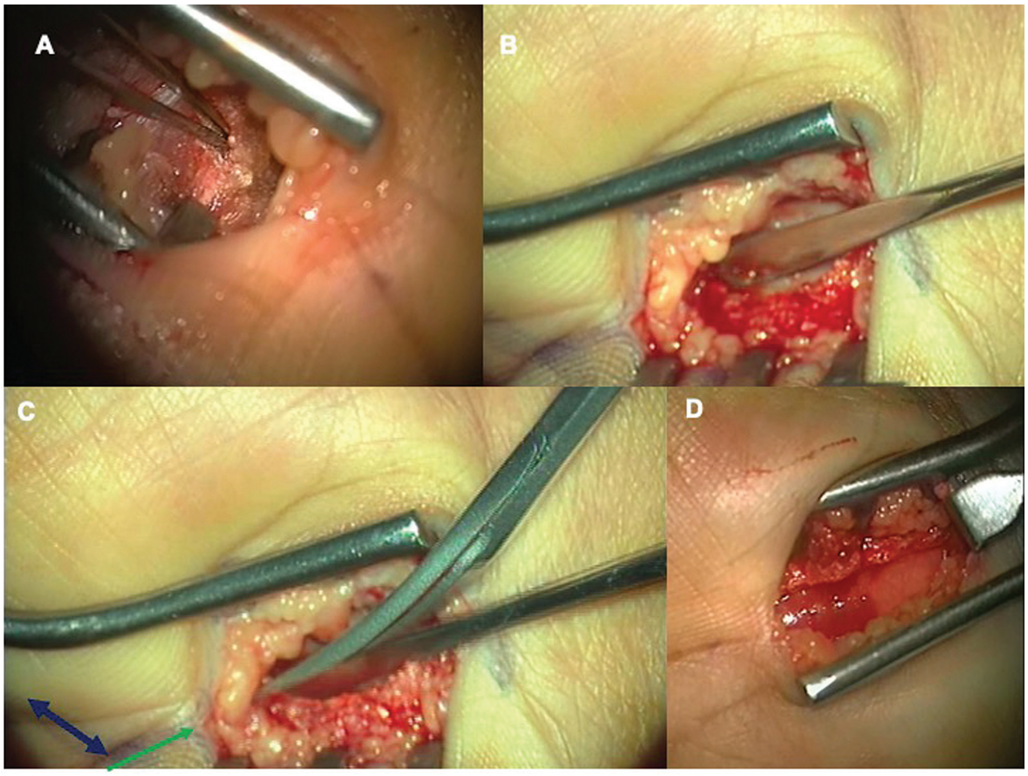

Fig. 1 (**A**) Transverse carpal ligament (TCL) identified by its whitish color with transverse fibers. (**B**) Penfield 4 placed between the TCL and the median nerve. (**C**) The TCL is being cut with scissors. The *green arrow* shows the line drawn from the web of the middle and ring fingers and the *blue arrow* shows the Kaplan cardinal line. (**D**) Median nerve seen after cutting the TCL.

Fig. 2 (**A**) Mosquito forceps passed over the median nerve distally to ensure no residual distal compression. The asterisk symbol (*) shows the tip of the forceps in the mid-palmar space. (**B**) Mosquito forceps passed over the median nerve distally to ensure no residual proximal compression. The gloved finger palpates the tip of the forceps in the deep forearm space. (**C**) Completely decompressed median nerve (#).

Normal hand usage is allowed in the postoperative period and gradual hand-strengthening exercises are allowed.

Discussion

Surgical Management of CTS

Sir James Paget described the clinical features of CTS in 1854.[7] Galloway performed the first-described CTR in 1924.[7] Surgery is the treatment of choice for the management of severe CTS. Mild to moderate CTS are generally treated with nocturnal wrist splinting. Local corticosteroid injection with or without ultrasound guidance is also useful for symptomatic relief and decreases the need for surgery in some cases.[8] Long-term favorable outcome from surgery range from 75 to 90%.[9] A recent systematic review of more than 2,500 patients reports complete resolution of paresthesias in 55 to 98% of cases, resolution of numbness in 39 to 94% cases, pain resolution in 64 to 100% cases, and weakness resolution in 60 to 75% cases.[10] The important predictors of favorable surgical outcomes were duration of symptoms, electrophysiological severity, preoperative grip strength, and age.[11]

The usual surgical techniques include a standard open CTR (OCTR), mCTR with multiple variations, and endoscopic CTR (eCTR).[12,13] The OCTR usually involves a 5-cm skin incision along the radial border of the hypothenar muscle up to the distal crease, which can be extended further if necessary.[12] Some authors have also described a larger **S**-shaped skin incision crossing the wrist crease into the forearm.[14] OCTR has good overall safety since the entire median nerve is decompressed completely under vision. However, wound complications and postoperative pain is higher with OCTR.[14]

mOCTR has an equivalent neurological outcome to OCTR with lesser postoperative pain and lower incidence of wound complications.[14,15] This allows patients a potentially early return to work. mOCTR also has a shorter operating time.[14,15] The authors' technique uses the operating microscope, which is readily available in a neurosurgical setup. The use of a microscope provides excellent illumination and magnification. The microscope also allows visualization of the recurrent median nerve and palmar cutaneous nerve and its anomalous variants. The assistant can also assist more efficiently using the other eyepiece of the microscope. This technique of mOCTR is best described as "microsurgical mini-open carpal tunnel release."[16,17] A recent systematic review and meta-analysis of more than 2,300 cases again reiterated the excellent results of mOCTR.[18] Currently, it is the most common type of CTR performed in the United States.[18] mCTR has multiple variations described in the literature, including single incision, double incision, and use of nasal speculum.[18,19] Usually, the length of the incision described in the literature ranges from 0.5 to 3.5 cm.[18] The main differentiating feature of mCTR compared with OCTR is the need to achieve complete TCL transection by minimizing the skin incision. This is typically achieved by passing a "guide" beneath the TCL, protecting the underlying median nerve and thus safely cutting the TCL above the guide through the smaller incision. The complication rate reported in mCTR is approximately 8.9%, which commonly includes scar tenderness, pillar pain, and superficial wound infection.[18] Nerve injury is rare with this technique. The reoperation rate with this technique is 0.6%.[18] The Skin closUre in carPal tunnEl Release (SUPER) trial is currently underway, which compares the advantages of absorbable versus nonabsorbable suture for wound closure.[20]

The first eCTR was performed in 1987 by Okutsu et al.[21] Similar to other techniques, there again exist multiple variations in the eCTR as well. Some of them are using a single-port endoscope (one port contains the channel for the endoscope and the instrument) and dual-port eCTR (one port contains the channel and the other port placed through a separate incision for the passage of instruments) or endoscope with an integrated retractor.[12,22] Simplistically the intraoperative advantages of the endoscope are better visualization and smaller size of the incision. However, eCTR usually involves placing the endoscope under the TCL, and the TCL is cut in an "inside-out" manner compared with a "outside-in" manner of TCL transection in mOCTR and OCTR.[12,23] However, a few trans-TCL endoscopic approaches have also been recently described.[24] A comparison of the single- and dual-port eCTR showed similar outcomes, patient satisfaction rates, and complications.[25]

eCTR has a better patient satisfaction rate, lesser scar pain and pillar pain, and a faster return to work compared with OCTR; however, eCTR has a higher incidence of temporary nerve injury.[26] The higher incidence of transient nerve injury may be secondary to introducing the scope in the carpal tunnel under the TCL in an already compromised space for the median nerve.[27] Unfortunately, the risk of transient nerve deficits continued even if the surgeon was well versed with the eCTR technique and beyond the learning curve, indicating the transient nerve injury is inherent with the technique rather than the experience of the surgeon.[27] The incidence of permanent nerve injury in eCTR and OCTR is the same. The reported reoperation rate for eCTR is 2.08%.[28] Thus, the reoperation rate with eCTR is approximately 2.96 more than OCTR.[28] Male sex, concurrent cubital tunnel syndrome, diabetes, and tobacco use are independent risk factors of requiring revision CTS.[28] Interestingly certain contraindications of eCTR also exist, namely, stiff wrists, malunited radial fractures, synovitis associated with rheumatoid arthritis, etc.[13,24]

Limitations of Published Studies

True comparative studies of OCTR, mCTR, and eCTR are difficult to design, and reviews comparing these techniques with each other are often too difficult to interpret since multiple different variations of each exist. Thus, a true comparison of the three techniques and their numerous variants is extremely challenging.

In addition, the outcome parameters used to study surgery outcomes are numerous and varying. Some commonly used outcome measures are Carpal Tunnel Questionnaire, Michigan Hand Questionnaire, Visual Analog Scale score, Disabilities of the Arm, Shoulder, and Hand score, Boston Carpal Tunnel Questionnaire, Upper Extremity Functional Scale, etc.[13,29] This heterogeneity of outcome scales again makes comparison of published literature difficult.

Thus, it is clear from this discussion that OCTR is the oldest technique of CTR, but mCTR is the most widely used technique of CTR due to its improved pain control and low incidence of complications. In spite of growing popularity of eCTR, due to better scar pain and pillar pain control, it is hampered by the cost, learning curve, higher incidence of temporary nerve injuries, and higher reoperation rates. Thus, in our opinion, mCTR is the technique of choice for surgical management of CTS.

Conclusion

CTR is an effective technique for the management of CTS. mCTR is the most popular technique and is the current gold standard in the surgical management of CTS in view of improved postoperative pain control, lower incidence of resurgery, and nerve injury.

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Conflict of Interest
None declared.

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