

Indications, Surgical Techniques and Safety of Open Versus Endoscopic Carpal Tunnel Release

Mala Thakur^{1*}, Alessia Genova¹, Olivia Dix¹, Asem Saefan¹, Abdalwahab Kawaiah¹ and Abbas Hassan²

¹Xavier University School of Medicine, Aruba

²Department of Surgery, Division of Plastic and Reconstructive Surgery, Northwestern University Feinberg School of Medicine, Chicago, Illinois, USA

*Corresponding Author: Mala Thakur, Xavier University School of Medicine, Aruba.

Received: September 17, 2020; Published: October 29, 2020

Abstract

Carpal tunnel syndrome (CTS) is the most prevalent focal neuropathy affecting the median nerve. The disorder arises when the median nerve in the wrist is compressed and this condition is more common in females than in males. The syndrome is characterized by pain in the hand, numbness and tingling in the distribution of the median nerve. These sensations may be felt in the thumb, index finger, middle finger and the radial side of the ring finger. The treatment of carpal tunnel syndrome (CTS) should be selected considering the stage of the disease, the severity of the symptoms, or patient's preference.

Non-surgical treatments include wrist splinting, change of working position, medications and use of alternative non-vibrating equipment at work. On the other hand, surgical methods include open release and endoscopic surgeries.

Surgery is a treatment for patients that have severe median nerve damage that includes permanent sensory and motor loss under electro-diagnostic studies.

The open carpal release is the most used form of curative therapy when decompressing the median nerve. ECTR is expected to have better outcomes in terms of pain, speed of healing and return to normal activities. Although injuries are rare during and after surgery, several complications related to the branches attached to the median nerve and ulnar artery could arise. Therefore, sufficient surgical techniques, as well as a comprehension of the wrist anatomy, are essential to ensure the carpal tunnel release surgery is safe.

Keywords: Carpal Tunnel Syndrome; CTS Syndrome; Diagnostic Tools; Clinical Features; Management; Carpal Tunnel Release

Introduction

Carpal tunnel syndrome (CTS) is the most prevalent focal neuropathy affecting about three percent of all Americans, with an estimated one million adults from the United States (annually) have CTS requiring medical treatment [1].

Depending on the diagnostic criteria used, the prevalence and incidence vary, ranging from 5 - 16% and 0.125% - 1%, respectively [2].

The disorder arises when the median nerve in the wrist is compressed and this condition is more common in females than in males [3].

For instance, the UK General Practice Research Database in 2000 evaluated that CTS prevalence was 88 per 100,000 in males, while in women, the incidence was 193 per 100,000 [4].

The symptoms for CTS may vary across patients. As such, they are classified into five different stages based on severity [5].

The syndrome is characterized by pain in the hand, numbness and tingling in the distribution of the median nerve. These sensations may be felt in the thumb, index finger, middle finger and the radial side of the ring finger [6].

Different reports suggest that carpal tunnel syndrome is more prevalent in individuals who engage in activities involving frequent wrist motions; however, the relevance of this correlation remains unclear in many aspects. Although a significant number of regular computer users experience hand paresthesia, only a small section of them meet the medical criteria for the diagnosis of carpal tunnel syndrome [7].

While most doctors recommend non-surgical therapy initially, surgical treatment is the most significant of the two methods in relieving paresthesia and pain in patients. However, surgical treatment should be the last option after a documented failure of the non-surgical treatments. Surgical approaches include endoscopic and open carpal tunnel release surgery, while non-surgical therapy involves medications, wrist splinting and physical exercise. Open carpal tunnel surgery is the most commonly recommended surgical treatment of carpal tunnel syndrome. Although this procedure is successful in several instances, different complications arise mostly after the operation. Therefore, proper surgical techniques and understanding of wrist anatomy are crucial for a safe carpal tunnel release surgery.

This review article discusses the indications of surgical intervention, the different surgical techniques and the complication that might arise postoperatively.

Indications for surgery

The indication for surgery for CTS patients may be related to how severe the patient’s symptoms are. Clinical assessment may be the crucial way of detecting whether a patient should go into surgery or use other treatments to help with their symptoms.

In a study, CTS was validated into five different stages based on severity [5]. CTS severity is based on the type of paresthesia within the previous two weeks, any sensory deficits, strength of opposition and abduction of the thumb and status of the thenar eminence muscles [5]. The stages are as followed I, paresthesia only at night or upon waking in any part of the hand innervated by median nerve; II, paresthesia during the day with repetitive movements or prolonged postures; III, any sensory deficits near median nerve; IV, hypotrophy and/or motor weakness of median nerve that supplies the thenar muscles; V, atrophy and/or plegia of same muscles [5]. Stages I/II are borderline acute severity of carpal tunnel syndrome, which could be managed by conservative treatment.

If a patient comes in with higher stages of the syndrome, then surgical decompression would be considered. Surgery is a treatment for patients that have severe median nerve damage that includes permanent sensory and motor loss under electro-diagnostic studies [8]. Patients may present with different symptoms that could lead to a patient being in-between stages that can make it difficult to decide whether surgery or conservative treatment should be provided. However, based on the symptoms and comfort of patient surgery is used for severe damage to the median nerve.

Carpal Tunnel decompression surgery may be overall helpful for patients with severe median nerve damage. In a study by Jennifer Wiperman, it was stated that 70% to 90% of the cases have a good outcome for CTS by surgery [8].

There are currently three different types of surgical treatment for carpal tunnel syndrome, which include open, limited-open and endoscopic surgery [9].

Each surgery has its limitations (Table 1) to whether it is beneficial for the treatment of carpal tunnel symptoms. Patients who do not respond to conservative treatment after three months are offered surgical procedures to relieve the patient’s symptoms of CTS [10].

	OCTS	ECTR
Pain	+++	+
Mobility	Later mobility	Earlier mobility
Return to work	15 days	30 days
Injury rate	More	Less
Skin scaring	Deep	shallow
Operation duration	Long	Short
Limitation(s)	Invasive	Impaired Vision High Cost Higher skill and training requirement

Table 1: A table summarizing the difference between OCTS and ECTR.

The indication for surgery is high in patients with severe median nerve damage because patients have worsening symptoms of paralysis and atrophy of thenar muscles. Open surgery, like an incision of the transverse carpal ligament (TCL) is shown to have low risk and effective treatment methods for CTS [11]. Surgery in open methods is shown to have less nerve injury-related complications compared to endoscopic methods [11]. This makes open surgical methods safer and has better outcomes in CTS patients. Patients with 1 cm skin incisions or even smaller are shown to have better outcomes because less scar tissue is formed compared to 2 cm incisions [11]. Patients are more likely to have a positive outlook on treatment in limited-open-method surgery than endoscopic methods [11].

Incidence of surgery in CTS patients is increasing because there is increasing evidence that this treatment is effective and the durability of the surgery is improving as well [12]. A study done recently was explaining that patients who underwent surgical decompression of the median nerve had better outcomes than patients who did not after five years [13].

Carpal Tunnel decompression surgery also is effective in treatment because it does not take much time to perform the surgery. Patients who are offered surgery have an average time of 18.2 minutes for double tunnel CTS treatment [11]. Patients who undergo surgery are likely to be in the surgical procedure for seven minutes with only using a local anesthetic, which allows for less recovery time [11]. Surgery may also be increasing in CTS because there is more access to day-time surgery [12]. The fact that the surgery takes only a short amount of time and it can be performed during the day it makes patients with these severe symptoms more open to receiving the surgery without further surgical prep. Open carpal tunnel release causes less residual pain, faster return to work and have less wound complications after surgery compared to other surgeries [10].

With good outcomes and a small surgery that does not take much time to heal is more appealing to patients with these severe symptoms of median nerve compression.

Carpal Tunnel Syndrome has many symptoms stated before that can be debilitating. Surgery is a way to relieve these symptoms and potentially lead them to the overall treatment of CTS. A study of open carpal tunnel release performed in the mid-1990s showed that post-operatively patients improve immediately [13]. Patients gained both strength and function postoperatively. CTS symptoms can be relieved by just a simple surgery and patients are able to gain function of their wrist and hand as well as their strength. With only conservative treatment, patients are not able to fully gain their function back nor strength that could help CTS patients return to their daily lives. Carpal tunnel release surgery has shown excellent outcomes by relieving pre-operative pain and increasing patient satisfaction after surgery [14]. With surgery being more satisfying, patients coming in with these symptoms can be relieved by simple surgery, then try something else that potentially may not work long-term.

Surgery for patients diagnosed with Carpal Tunnel Syndrome may do more harm than good. Patients may not get any symptoms relieved by surgery intervention due to surgical failure. One surgical method stated earlier is the incision of the transverse carpal ligament that decompresses the median nerve. However, failure could lead to increased scar tissue forming after surgery, which restricts the patient's movement, causes pain and recurring compression of the nerve is a result [11]. Carpal tunnel syndrome surgery remains uncertain on the durability of the treatment if it will genuinely relieve all symptoms of CTS due to surgical failure [13]. Patients undergoing surgery stated in a study that they had more daytime weakness, pain and difficulty opening jars after surgery [13]. It was reported that after surgery, patients still were feeling pillar pain [10]. This could also lead to why patients decide not to go through with surgery to relieve symptoms.

Patients may develop more complications undergoing surgery. A study reported that there was increased nerve injury in patients who underwent carpal tunnel decompression [10]. This includes injury to the muscles innervated by the nerves that can cause increased pain and atrophy as well. Some of the complications include flexor tendons, median ulnar and digital nerves and superficial palmar arterial arch have been damaged in endoscopic decompression surgery in CTS patients [10]. Damage to these features in the wrist may result in another surgery decompression, which can take longer for a patient to recover. Some patients with severe CTS take up a full year to re-

cover [8]. Multiple surgeries can become costly, which is another contradiction to surgical decompression in CTS. Patients may also have to receive more treatment after surgery just to relieve the symptoms of the nerve damage, such as conservative treatments [10].

Overall, surgery may be beneficial or harmful to some carpal tunnel syndrome patients depending on whether the surgical method was performed correctly. Patient's symptoms are difficult to treat with CTS and choosing the right treatment needs to be thoroughly researched to find the relief patients need.

Surgical techniques

The treatment of carpal tunnel syndrome (CTS) should be selected considering the stage of the disease, the severity of the symptoms, or patient's preference [15]. Treatments of CTS are generally successful, but early diagnosis is essential. The late treatment causes lesions and prolonged effects that seriously affect work and activities of daily living [16]. CTS treatment includes non-operative procedures and surgical intervention.

Nonsurgical methods, such as rest, splinting, physical therapy and corticosteroid injections, are assigned at the early stages of CTS. Although such interventions reduce CTS symptoms for a short time but do not alleviate them sufficiently [17]. The nonsurgical methods have proven to be effective in some cases. Corticosteroid treatment is effective in reducing inflammation and edema of synovium and tendons; it also has a harmful effect on tenocyte function by reducing collagen and proteoglycan synthesis [15]. According to Kim, *et al.* subsequent research has suggested that the therapeutic effect of wrist splinting arises from minimizing carpal tunnel pressure, but further research is required to clarify the appropriate injection method and the optimum preparation because corticosteroids have shown a bad effect on the peripheral nerve fibers [15].

Surgical treatment has been reported to be more effective than nonsurgical ones. The Surgical treatment for CTS involves cutting the transverse carpal tunnel ligament (TCL) to release pressure on the median nerve [18]. Open carpal tunnel releases (OCTR) have been performed successfully for many years, it is considered the gold standard for carpal tunnel decompression since Phalen first reported this technique in the 1950s [17,19]. In traditional open surgery, a wide incision is made in the wrist to fully visualize the ligament and surrounding structures, guaranteeing a complete transverse carpal ligament sectioning [18]; however, associated with 60 - 80 mm scars, lengthy recovery periods (25 days) and a complication rate of 1% [17]. Endoscopic carpal tunnel release (ECTR) has gained popularity since its introduction in 1989 by Chow and Okutsu, for which two techniques are commonly used: the single-portal technique and the two-portal technique [15,18,19].

They developed their procedure with a unique tube-like instrument to visualize whole TCL and it was transected under endoscopic assistance [15]. Although endoscopic procedures reduce scarring to 10 mm, this technique can be challenging because the initial placement of the trocar is blind and during the procedure, vision is limited by the narrow range of the endoscope [17]. This entails two main risks, these being failure to identify the distal edge of the TCL, resulting in incomplete release with subsequent recurrence and reoperation and damage to other structures, particularly to anatomical variants of the median nerve and branches [18].

ECTR is expected to have better outcomes in terms of pain, speed of healing and return to normal activities because it is considered a less invasive alternative for OCTR as well as it leaves structures overlying the TCL intact [18].

That is not always the case; many studies stated that the long-term outcomes of both techniques are similar. A study done by Jugovac, *et al.* on 72 patients to compare between the two techniques showed that after three months of the surgery, patients from both groups derived the identical symptomatic relief outcome and there was no significant difference in postoperative electrophysiological findings between both groups. Furthermore, there were no signs of iatrogenic injuries of the palmar cutaneous branch, superficial palmar communication between the median and the ulnar nerve, or motor thenar branch in both groups [20].

According to another study done in 2015 by Hu., *et al.* on 142 patients to compare OCTR and ECTR in patients with bilateral CTS. All patients underwent OCTR on the one hand and ECTR on the opposite hand and the long term follow up results established equal achievement in handgrip strength recovery at least 24 weeks after undergoing either surgery [19].

On the other hand, the positive short-term outcomes of ECTR are more significant than the OCTR. The rate of major nerve, vessel or tendon injury was shown to be lower in the ECTR group, at 0.19% compared with 0.49% for the OCTR group [15].

ECTR was found to provide significant improvements in functional hand recovery, which might allow patients to achieve more significant gains in daily living and self-care activities within a shorter postoperative time interval and could return to work sooner [19].

Jugovac., *et al.* stated after their experiment that the postoperative scars in the patients operated by OCTR were significantly longer than the scars in the patients operated by ECTR and patients after OCTR were seen with more infection, hypertrophic scar and scar tenderness. Furthermore, the operation time was on average, 1.6 min shorter in the ECTR group [20].

Postoperative complications

Several complications could arise following a carpal tunnel release surgery. There are two kinds of persisting difficulties, namely new and pre-operative symptoms [21]. Pre-operative symptoms usually occur when the body fails to release flexor retinaculum completely. On the other hand, further post-surgery complications are often iatrogenic related to damage caused by the median nerve branches. The palmar cutaneous branch is the most commonly injured and that leads to painful scars, painful neuroma, or altered sensibility. Damage on the ulnar nerve is a rare complication after the decompression of the median nerve. The ulnar nerve's anatomy is well outlined.

The palmar cutaneous branch protrudes from the forearm below the flexor carpi ulnaris. It emerges close to the wrist and supplies the mid-palm with skin.

Next, a dorsal sensory nerve emerges from the palmar cutaneous' border close to the pisiform. The ulna nerve extends further across the Guyon's canal between the hook of hamate and the pisiform. At this juncture, a bifurcation forms into the deep motor neuron and a superficial sensory nerve.

The deep motor branch emanates from the ulnar end of the nerve and passes below the central trunk and gets enjoined into the deep end of the ulnar artery. Then it enters into the deeper edge of the palm distal and adjacent to the hook of the hamate where it supplies much of the small hand muscles [6].

Ulnar nerve palsy is not a common complication related to open carpal tunnel surgery. This injury usually requires microsurgery repairs followed by subsequent enhancement of hand and wrist functions. Over the years, there have been several types of incisions described to lower the risk of injuries to the palmar cutaneous branches linked to the median nerve or nerves attached to the ulnar nerve.

Physicians associate these two entities with several post-surgery complications.

The classical cutting applied during open carpal tunnel release surgery is similar to the ring finger's radial border. Some medics propose that making an incision on the ulnar end of the fourth ray reduces the risk of post-operative injuries to the branches of the median nerve.

Others oppose this idea and argue that such an incision increases the possibility of damaging the nerves branched to the ulnar nerve since these nerves have a more variable distribution [22].

The branches linked to the median nerve extend radially proximal to the axis of the fourth ray, but they do not cross it.

On the other hand, branches associated with the ulnar nerve pass the incision made on the carpal tunnel along the fourth ray in small sections of cadaveric palms [23]. Different studies indicate that there is no real inter-venous plane close to the carpal canal.

Therefore, although making an incision on the carpal canal reduces both the danger of damaging the branches protruding from the median nerve and injuring the median nerve, it increases the possibility of injuring the ulnar nerve branches. Nevertheless, the number of cases of injuries to the ulnar nerve branches during carpal tunnel release surgery is rare. In cases where these damages occur, conditions like high blood pressure or weak inflation of the tourniquet lead to excessive bleeding and, consequently, poor surgery conditions.

In such a scenario, the surgeon should stop the process or apply basic operation principles to end the problems [21]. Many people regard carpal tunnel release surgery as the most straightforward operation. However, sophisticated surgical techniques and careful supervision are prerequisites to preventing complications that occur once in a while.

Conclusion

Carpal tunnel syndrome is a common nerve disorder that affects the wrist region of the hand. Several factors, such as using vibrating tools, infections and regular use of computers, contribute to the development of this condition. Doctors use both non-surgical and surgical treatments when addressing carpal tunnel syndrome. Non-surgical treatments include wrist splinting, change of working position, medications and use of alternative non-vibrating equipment at work.

On the other hand, surgical methods include open release and endoscopic surgeries. Surgery is a treatment for patients that have severe median nerve damage that includes permanent sensory and motor loss under electro-diagnostic studies. The open carpal release is the most used form of curative therapy when decompressing the median nerve. ECTR is expected to have better outcomes in terms of pain, speed of healing and return to normal activities. Although injuries are rare during and after surgery, several complications related to the branches attached to the median nerve and ulnar artery could arise. Therefore, sufficient surgical techniques, as well as a comprehension of the wrist anatomy, are essential to ensure the carpal tunnel release surgery is safe.

Conflict of Interest

None declared.

Bibliography

1. Tanaka S., *et al.* "The US prevalence of self-reported carpal tunnel syndrome: 1988 National Health Interview Survey data". *American Journal of Public Health* 84.11 (1994): 1846-1848.
2. Atroshi I., *et al.* "Prevalence of carpal tunnel syndrome in a general population". *The Journal of the American Medical Association* 282.2 (1999):153-158.
3. Phalen GSJJ. "The Carpal-Tunnel Syndrome: Seventeen Years' experience In Diagnosis And Treatment Of Six Hundred Fifty-Four Hands 48.2 (1966): 211-228.
4. Burton C., *et al.* "Diagnosing and managing carpal tunnel syndrome in primary care". *British Journal of General Practice* 64.622 (2014): 262-263.
5. Mondelli M., *et al.* "Severity of carpal tunnel syndrome and diagnostic accuracy of hand and body anthropometric measures". *Plos one* 11.10 (2016): e0164715.
6. Ashworth N. "Carpal tunnel". *BMJ Clinical Evidence* (2014).

7. Hunter A, *et al.* "Surgery for carpal tunnel syndrome" (2015).
8. Wipperman J and Goerl KJAfp. "Carpal tunnel syndrome: diagnosis and management 94.12 (2016): 993-999.
9. Smith KS. "Post Surgical Outcomes Following Limited-Open Carpal Tunnel Release or Endoscopic Carpal Tunnel Release". *Eastern Kentucky University* (2019).
10. Gurpinar T, *et al.* "Comparison of open and endoscopic carpal tunnel surgery regarding clinical outcomes, complication and return to daily life: A prospective comparative study". *Pakistan Journal of Medical Sciences* 35.6 (2019): 1532-1537.
11. Yüce İ, *et al.* "Minimally Invasive Open Surgical Approach and Outcomes for Carpal Tunnel Syndrome". *Sisli Etfal Hastanesi Tip Bülteni/ The Medical Bulletin* 53.3 (2019): 247-251.
12. Tadjerbashi K, *et al.* "Incidence of referred carpal tunnel syndrome and carpal tunnel release surgery in the general population: increase over time and regional variations 27.1 (2019): 2309499019825572.
13. Louie DL, *et al.* "Outcomes of open carpal tunnel release at a minimum of ten years". *Journal of Bone and Joint Surgery American* 95.12 (2013): 1067.
14. Ghani R, *et al.* "Minimising Tourniquet Time and Post-operative Pain During Carpal Tunnel Decompression 11.7 (2019).
15. Kim P-T, *et al.* "Current approaches for carpal tunnel syndrome". *Clinics in Orthopedic Surgery* 6.3 (2014): 253-257.
16. Trung DT, *et al.* "Endoscopic carpal tunnel release surgery: a case study in Vietnam". *Journal of Orthopaedic Surgery and Research* 14.1 (2019): 149.
17. Petrover D, *et al.* "Percutaneous ultrasound-guided carpal tunnel release: study upon clinical efficacy and safety". *CardioVascular and Interventional Radiology* 40.4 (2017): 568-575.
18. Vasiliadis HS, *et al.* "Endoscopic and open release similarly safe for the treatment of carpal tunnel syndrome. A systematic review and meta-analysis". *PLoS One* 10.12 (2015): e0143683.
19. Hu K, *et al.* "Intra-individual comparison between open and endoscopic release in bilateral carpal tunnel syndrome: a meta-analysis of randomized controlled trials". *Brain and Behavior* 6.3 (2016): e00439.
20. Jugovac I, *et al.* "Carpal tunnel release by limited palmar incision vs traditional open technique: randomized controlled trial 43.1 (2002): 33-36.
21. Kır MÇ, *et al.* "Comparison of Wide Awake Local Anaesthesia No Tourniquet Technique with Tourniquet Application under General Anesthesia in Carpal Tunnel Syndrome: A Retrospective Study (2019).
22. Yoo HM, *et al.* "Surgical treatment of carpal tunnel syndrome through a minimal incision on the distal wrist crease: an anatomical and clinical study 42.3 (2015): 327.
23. Williamson ER, *et al.* "Multistate Comparison of Cost, Trends, and Complications in Open Versus Endoscopic Carpal Tunnel Release". *Hand (N Y)* (2019): 1558944719837020.

Volume 11 Issue 11 November 2020

© All rights reserved by Mala Thakur, et al.