Endoscopic Carpal Tunnel Release

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Introduction

Carpal tunnel syndrome (CTS) is the most common nerve neuropathy in the upper extremity, affecting approximately 5% of the general population [1]. Characterized by compression of the median nerve by the transverse carpal ligament (TCL) at the wrist, CTS can be a fairly debilitating condition causing discomfort and/or numbness in the thumb, index, long, and ring finger and motor weakness in the hand.

The treatment of CTS has evolved significantly over the last century. Patients who fail conservative treatment with splinting, therapy, and corticosteroid injections often require surgical management. The first carpal tunnel release (CTR) was performed by Herbert Galloway in 1924 [2]. Since then, a variety of surgical techniques have been developed to release the TCL and decompress the underlying median nerve. Although the open CTR (OCTR) approach remains the most commonly utilized technique, over the last three decades, several endoscopic techniques, such as the two-portal endoscopic technique by Chow in 1989 [3], single proximal portal approach by Agee in 1992 [4], and single distal portal approach by Mirza in 1995 [5], have been developed and refined. In this chapter, we will discuss these three commonly utilized endoscopic CTR (ECTR) techniques and describe in detail the single proximal portal technique. Furthermore, we will discuss indications/contraindications, complications, and surgical outcomes of ECTR.

Indications/Contraindications

Indications for ECTR are generally similar to those for conventional OCTR (Table 13.1). Most idiopathic CTS can be treated using endoscopic techniques. However, ECTR is relatively contraindicated in several circumstances. While many argue that recurrent CTS is a relative contraindication to ECTR [6], Trumble and colleagues reported excellent results with endoscopic revision carpal tunnel release and emphasize potential benefits of this technique in appropriately selected patients [7]. Since incomplete division of the transverse carpal ligament is a primary cause of persistent CTS and may contribute to recurrence, one must be cognizant that the cause of failure of the previous surgery might be due to

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Table 13.1 Indications/relative contraindications for endoscopic CTR

Indications	Contraindications
Idiopathic CTS	Recurrent CTS
	Anticoagulation
	Inflammatory conditions (i.e., rheumatoid arthritis, amyloidosis)
	Severe CTS[a]
	CTS secondary to fracture/trauma

CTS carpal tunnel syndrome, *CTR* carpal tunnel release
[a]Based on Sucher criteria [34]: unobtainable median sensory response, low-amplitude median mixed nerve response, and low-amplitude median compound muscle action potential with prolonged distal latency

anatomic abnormalities (e.g., compressive lesions) that cannot be visualized using an endoscopic approach. Therefore, most surgeons advocate for the conventional open technique in the setting of recurrent CTS.

Additionally, many surgeons believe that ECTR should be avoided in patients with certain preexisting conditions, including anticoagulation and inflammatory conditions such as rheumatoid arthritis or amyloidosis. Since hemostasis is a concern in the setting of anticoagulation, the conventional open approach is the preferred technique in order to avoid bleeding complications that may be better avoided by open surgical visualization. ECTR in patients with inflammatory conditions should also be approached with caution. Patients with rheumatoid arthritis or other inflammatory conditions have a higher risk of synovial lesions or other pathology which can interfere with visualization of the carpal tunnel, or occasionally even the introduction of endoscopic device at the wrist. Endoscopic technique also precludes synovectomy, which may be necessary in some of these patients. That said, ECTR can be performed reliably in inflammatory arthritis patients whose disease is quiescent [8]. ECTR should also be carefully considered in patients with a history of trauma or hand/wrist fractures, since these events can perturb the bony anatomy of the carpal tunnel. Lastly, some argue that patients with severe median nerve compression necessitating extensive neurolysis or tenosynovectomy should instead undergo conventional open CTR, as these adjunctive procedures cannot be performed via an endoscopic approach [9, 10].

Surgical Techniques

Positioning

In general, with any ECTR technique, the patient is placed supine with the arm abducted on an operating arm table. The surgeon is positioned on the medial side of the abducted arm (if right hand is the dominant hand) in order to facilitate the use of the dominant hand for maneuvering the endoscope, while the assistant is positioned on the opposite side. Some surgeons prefer to use their dominant hand for all cases (requiring them to sit on the head side of the hand table to release the nondominant hand), while others prefer to maintain their position on the axillary side of the hand table (and use their nondominant hand to release the nondominant hand of the patient).

Anesthesia

ECTR can be performed using general, regional, and local anesthesia. More commonly, regional and local anesthesia is used, with general anesthesia reserved for those unable to tolerate local or regional blocks. Several studies have examined the efficacy and the postoperative outcomes with local versus regional anesthesia. While some studies have suggested less cost and equally effective intraoperative analgesia with local-only techniques, our experience is that injection of local anesthetic into the skin over the transverse carpal ligament creates fogging of the endoscope and poor visualization, requiring an unacceptably high rate of conversion to open procedure in these circumstances [11].

In our practice, we generally use local anesthesia with IV sedation, and it is well tolerated. The distal wrist crease and proximal forearm fascia are infiltrated with a 1:1 solution of 1% lidocaine with epinephrine with 0.5% plain bupivacaine. A tourniquet is utilized, and it is inflated to 250 mmHg after local anesthesia infiltration to reduce bleeding.

Endoscopic Approaches

Currently, there are three main distinct types of ECTR techniques performed (Table 13.2). The most commonly performed technique is the single proximal portal technique, first described by Agee in 1992 [4]. This technique utilizes a proprietary device (MicroAire, Charlottesville, VA) which is composed of a 2.7-mm 30-degree-angle arthroscope, a fiber-optic light source and camera, and a handpiece with attached disposable blade cartridge into which the endoscope is inserted (Fig. 13.1A, B). The Chow dual-portal technique was introduced by James C. Y. Chow in 1989 [3]. Unlike the Agee technique, the Chow technique uses a two-port approach which creates a fixed space in which to operate. A cannula is fixed at the proximal and distal portals, and a 4-mm 30-degree endoscope with an incorporated knife is inserted at the proximal portal, which is then used to incise the TCL (Fig. 13.2a, b). Lastly, in 1995, M. Ather Mirza described a single distal portal approach which utilizes a 1.5-cm longitudinal palmar incision along the thenar crease, a standard 4-mm 30-degree endoscope, and a knife/sleeve device which is used to divide the TCL and decompress the carpal canal [5]. The

Table 13.2 Three endoscopic CTR approaches

Technique	Year of development	Description
Agee	1992	Single proximal portal approach
Chow	1989	Two-port approach
Mirza	1995	Single-distal port approach

CTR carpal tunnel release

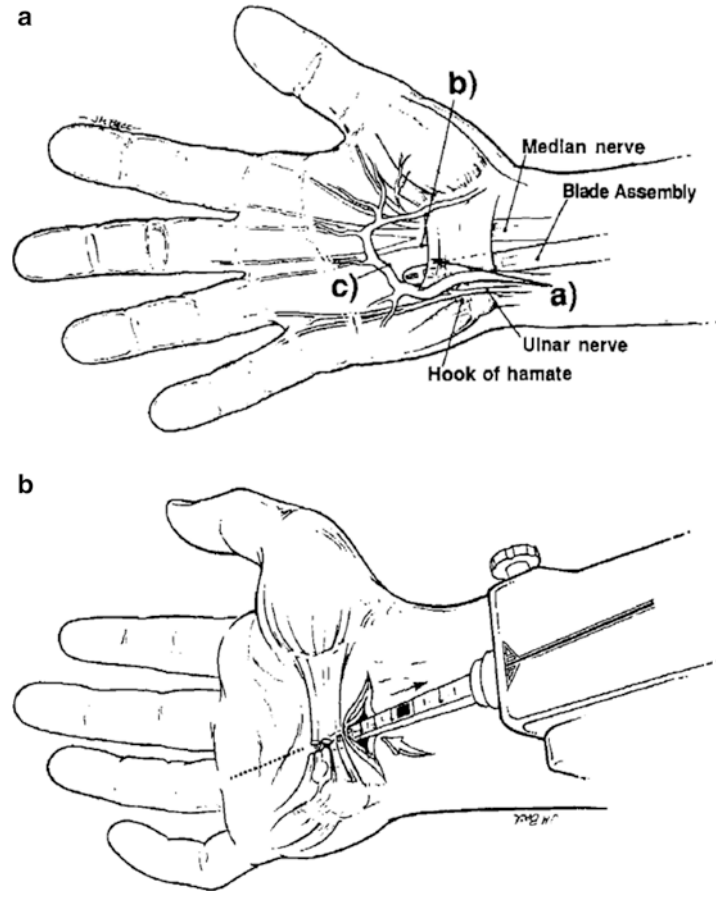

Fig. 13.1 The original description of the single proximal portal technique by Agee. (**A**) Schematic of the relative position of the endoscopic device relative to the distal edge of the TCL (**a**), ulnar limit of the median nerve (**b**), and proximal limit of the superficial palmar arch (**c**). (**B**) The device is inserted parallel to the plane of the palm and forearm

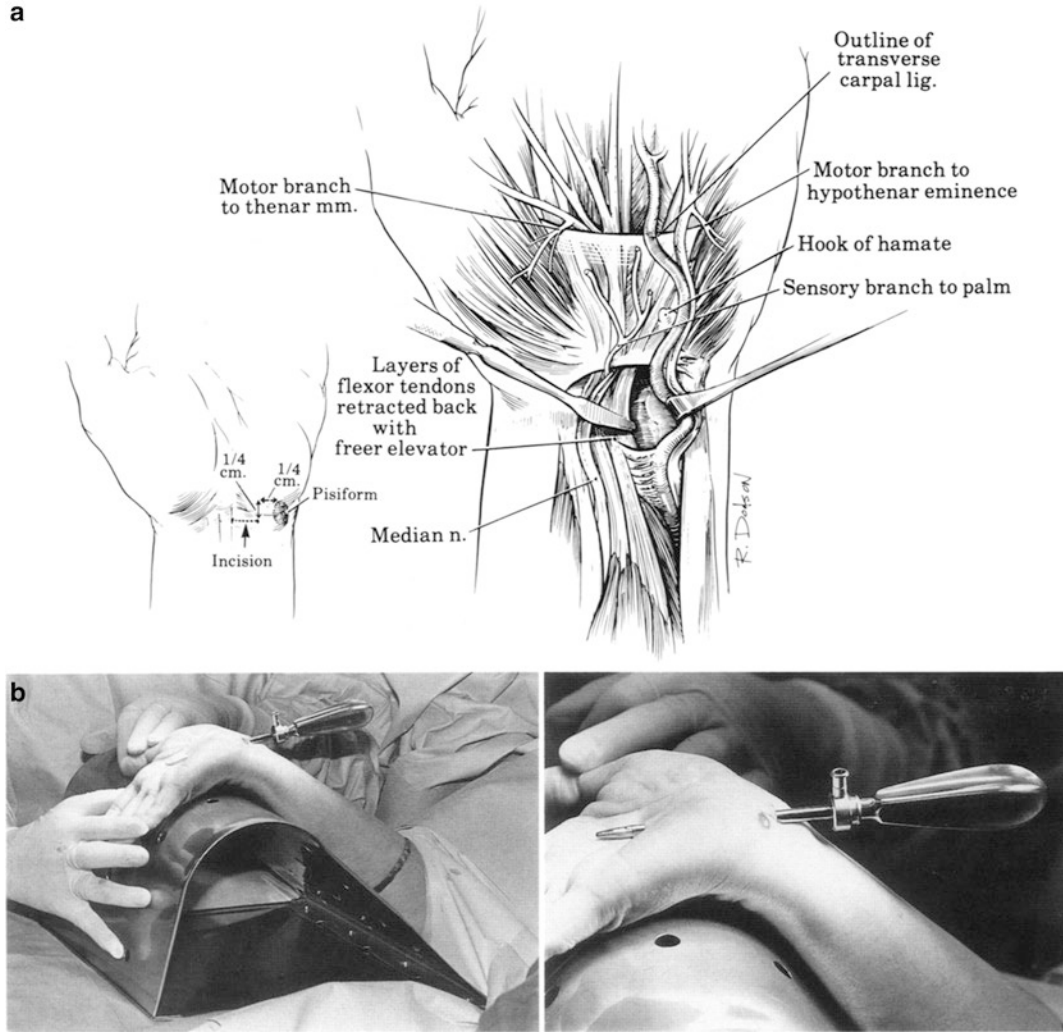

Fig. 13.2 The Chow two-portal technique. (**a**) Schematic of the cannula position relative to the volar wrist structures. (**b**) The hand positioned on the wrist extension platform with the cannula inserted

single distal portal approach can also be done using the MicroAire device (Fig. 13.3a–c) [12].

The Single Proximal Portal Technique

The senior author has extensive experience with the single proximal portal technique so a brief description of the operative technique is provided below:

1. *Incision, Exposure, Insertion*

   A 1–2-cm transverse incision is made at the proximal flexor wrist crease ulnar to the palmaris longus. Careful dissection is performed down to the antebrachial fascia using skin hooks for exposure (Fig. 13.4). The fascia is incised by creating a distal ulnarly based L-shaped flap. The distal antebrachial fascia proximal to the incision just made is divided under direct vision with scissors. Means and colleagues demonstrated that pressure on the median nerve can remain elevated even after release of the TCL if the antebrachial fascia is intact [13]. For this reason, we always include division of the distal antebrachial fascia as part of ECTR. The maneuver takes less than a minute to perform and does not add additional cost to the procedure.

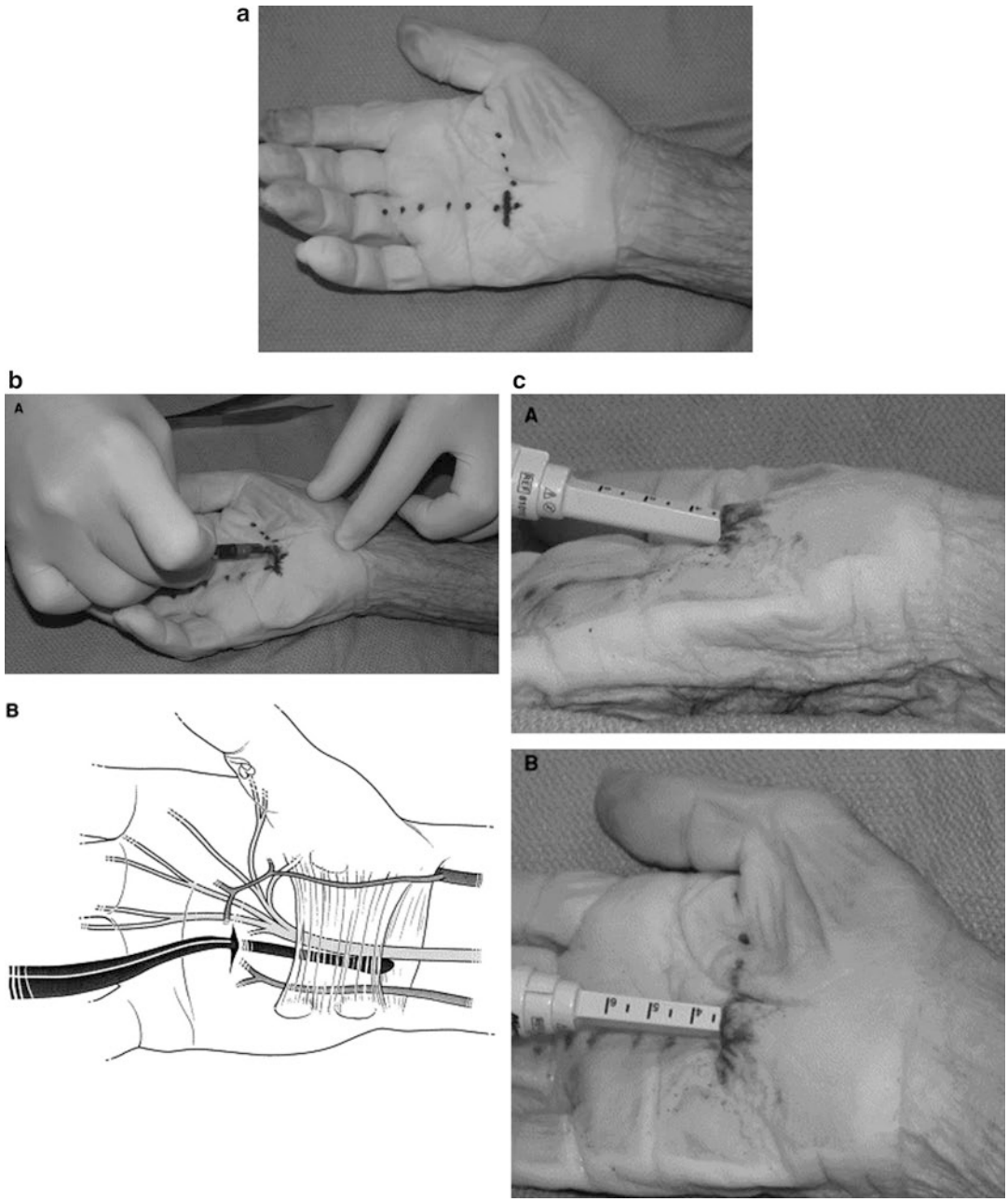

Fig. 13.3 The single distal portal technique. (**a**) The incision is placed at the intersection of Kaplan's cardinal line and the fourth ray. (**b**) Schematic of the location of the endoscope passage relative to the superficial palmar arch and the ulnar limit of the median nerve. (**c**) The endoscope is inserted into the carpal tunnel

2. *Retinaculum Incision*

A synovial elevator is passed distally several times along the axis of the fourth ray to elevate the synovium off of the transverse carpal ligament (TCL) deep surface (Fig. 13.5a, b). The endoscopic device is then inserted into the carpal canal (Fig. 13.6). With the TCL distal edge in full view on the endoscope monitor (Fig. 13.7), the TCL is divided from the distal to proximal edge using the device blade. If

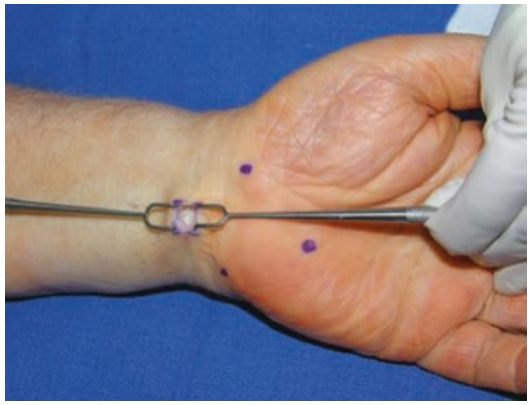

Fig. 13.4 The distal antebrachial fascia is exposed via a transverse incision of a volar crease immediately proximal to the volar wrist crease

there are any issues with visibility of the TCL, the surgical approach is then converted to an open procedure.

3. *Assessment of Release*

   Next, to ensure adequate release of the TCL, the device is reinserted and the TCL is visualized from its most distal edge to its most proximal edge for any fibers that may be tethered to the cut edges of the retinaculum. The presence of these fibers indicates that an incomplete division should be suspected. Using the device blade, the undivided TCL fibers are divided to ensure complete release, with careful attention to the location of the median nerve to avoid transection/injury (Fig. 13.8).

4. *Closure*

   The skin is closed with interrupted nylon sutures or a resorbable subcuticular suture. Prior evidence suggests that there is no difference in pain reduction or long-term cosmetic outcome with either skin closure technique [14].

Postoperative Care

Traditionally, carpal tunnel release patients were managed postoperatively with immobilization for 1–3 weeks. However, several lower-level evidence studies have demonstrated that splinting may actually slow the postoperative recovery process [15]. Therefore, most surgeons now place the hand in a large bulky hand dressing for only 1–3 days postoperatively to avoid bleeding in the carpal tunnel. ECTR patients are also encouraged to begin using the hand immediately after surgery. While some studies have found better surgical outcomes in terms of grip and pinch strength, subjective symptom measures, and functional status with immediate hand therapy [16, 17], other studies have identified this same benefit by simply allowing the patient to begin moving and light use of the hand immediately after surgery [18].

Complications

Overall, ECTR is a safe procedure. A limited number of high-level studies have explored complications following ECTR. Most reported complication rates range from 0 to 5% [19, 20]. During the early development stages of the endoscopic technique, the experience was plagued with several complications [21]. However, blade redesign, modifications to insertion techniques, and increasing surgeon experience have dramatically decreased the frequency of complications.

The most feared complication is transection or trauma to the median nerve. Although transection of the median nerve is very rare [22], some research has found higher rates of transient (non-permanent) median nerve injury after endoscopic surgery compared to open [23]. In order to minimize the risk of nerve transection or neuropraxia, surgeons must be aware of the various anatomical variations arising from the ulnar aspect of the median nerve which place the nerve at risk for iatrogenic injury.

Another feared complication after ECTR is bleeding. As with any surgical procedure, postoperative bleeding can occur due to inadequate hemostasis, resulting in swelling of the hand and an increased risk of infection. To minimize this risk, we use a bulky, soft compressive bandage for the first 24–48 h postoperatively which helps tamponade any bleeding from the wound.

To minimize any complications following ECTR, surgeons must have a low threshold for

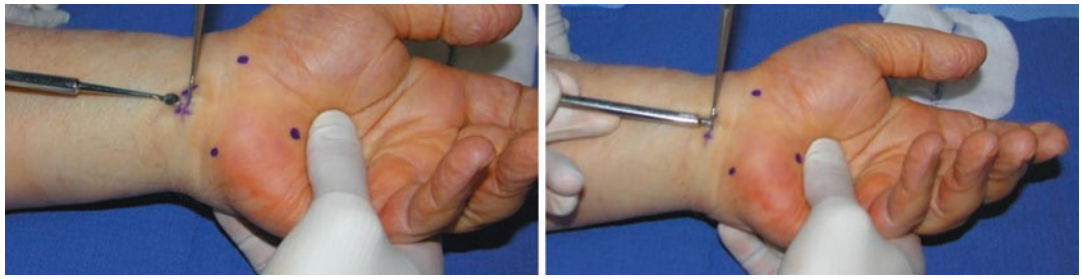

Fig. 13.5 A synovial elevator is used to free the synovium within the carpal tunnel from the deep surface of the TCL

Fig. 13.6 The endoscopic device is inserted into the carpal tunnel parallel to the plane of the TCL

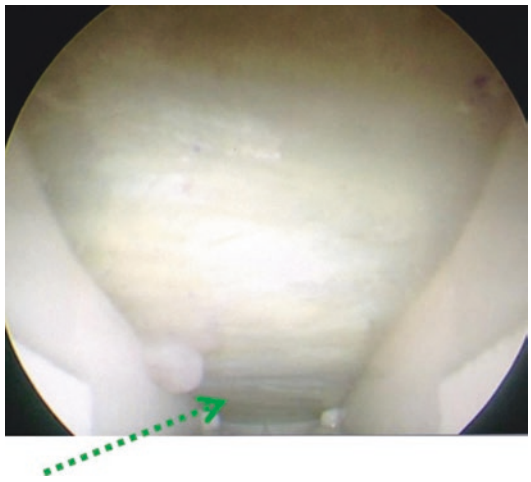

Fig. 13.7 The distal end of the TCL is identified on the monitor as the junction of the white transverse fibers of the TCL and the more yellow fat of the palm just distal to it

Fig. 13.8 The radial-sided cut edge of the TCL is visualized, confirming adequate release. Gentle supination of the endoscope (with the blade retracted) allows visualization of the median nerve to confirm it has not been injured

converting to an OCTR. Visibility is extremely important in ECTR, and if visibility is compromised, risk for nerve injury is increased. Thus, if bleeding minimizes visualization of the nerve, or if the surgeons experience significant resistance during the introduction of the endoscope (likely secondary to anatomical variations or synovial adhesions) [24], conversion to an OCTR is highly recommended.

In summary, ECTR is a generally safe procedure. Chow et al. published their 13-year experience with their technique and reported a 1.1% overall complication rate [25]. In another series with 14,722 patients, Hankins et al. reported only one nerve injury and a low conversion rate to OCTR (0.07%) [26]. Overall, when comparing open and endoscopic CTR, complication rates seem to be very low and similar for both procedures [27].

Outcomes

Over the last two decades, numerous studies have explored surgical outcomes after ECTR. Several of these studies have compared open versus endoscopic CTR on postoperative recovery. Multiple studies have shown that endoscopic and conventional open techniques have equivalent *long-term* functional outcomes [28, 29]. Trumble et al. performed a randomized, double-blinded multicenter trial comparing open versus single proximal portal ECTR and showed statistically significant improvement in pain and hand strength in the ECTR group when compared to the open group at 6 weeks and 3 months. However, long-term hand pain and strength at 1 year were found to be equivalent [30]. Similarly, Macdermid et al. found significantly better grip strength and pain control at 1 and 6 weeks, but these differences dissipated by 12 weeks [31]. Conversely, several studies have found similar short-term and long-term postoperative outcomes after ECTR and OCTR. A recent Cochrane Review summarized the current literature on surgical outcomes after ECTR and concluded that ECTR may "enable patients to return to work or daily activities sooner" but may not "offer better relief from symptoms in the short- and long-term compared to OCTR" [32]. Overall, the current evidence suggests that long-term relief of neuropathic symptoms, improvement in functional status, and subjective patient satisfaction are similar between ECTR and OCTR.

Conclusion

ECTR is becoming increasingly prevalent in the surgical treatment of CTS. Although initial reports described higher complications rates, the endoscopic techniques have been refined and have yielded improved surgical outcomes. Unlike other areas in hand surgery, several high-level studies have been published assessing the efficacy of ECTR. These studies, although still limited due to unstandardized outcome metrics, provide evidence that ECTR is a safe technique with excellent results, including that patients may recover faster and/or with less pain from this technique. Furthermore, studies have gone on to demonstrate that ECTR is a cost-effective procedure [33]. With increasing experience, we anticipate that ECTR will continue to increase in prevalence in the surgical treatment of CTS.

References

1. Atroshi I, Gummesson C, Johnsson R, Ornstein E, Ranstam J, Rosén I. Prevalence of carpal tunnel syndrome in a general population. JAMA. 1999;282(2):153–8. doi:10.1001/jama.282.2.153.
2. Amadio PC. The first carpal tunnel release? J Hand Surg. 1995;20B:40–1.
3. Chow JC. Endoscopic release of the carpal ligament: a new technique for carpal tunnel syndrome. Arthroscopy. 1989;5(1):19–24.
4. Agee JM, Mccarroll HR, Tortosa RD, Berry DA, Szabo RM, Peimer CA. Endoscopic release of the carpal tunnel: a randomized prospective multicenter study. J Hand Surg Am. 1992;17(6):987–95.
5. Mirza MA, King ET, Tanveer S. *Palmar* uniportal extrabursal endoscopic carpal tunnel release. Arthroscopy. 1995;11(1):82–90.
6. Jones NF, Ahn HC, Eo S. Revision surgery for persistent and recurrent carpal tunnel syndrome and for failed carpal tunnel release. Plast Reconstr Surg. 2012;129(3):683–92.
7. Lura S, Waitayawinyu T, Trumble TE. Endoscopic revision of carpal tunnel release. J Hand Surg Am. 2008;121:2029–34.
8. Belcher HJ, Varma S, Schonauer F. Endoscopic carpal tunnel release in selected rheumatoid patients. J Hand Surg Br. 2000;25:451–2.
9. Jebson PJ, Agee JM. Carpal Tunnel syndrome: unusual contraindications to endoscopic release. Arthroscopy. 1996;12(6):749–51.
10. McClelland WB, Means KR. Palmaris profundus tendon prohibiting endoscopic carpal tunnel release: case report. J Hand Surg Am. 2012;37(4):695–8.
11. Nabhan A, Steudel WI, Dedeman L, et al. Subcutaneous local anesthesia versus intravenous regional anesthesia for endoscopic carpal tunnel release: a randomized controlled trial. J Neurosurg. 2011;114(1):240–4.
12. Lifchez SD, Murphy SM. Endoscopic carpal tunnel release through a single distal portal. Tech Orthop. 2006;21:30–4.
13. Means Jr KR, Parks BG, Lee SK, Segalman KA. Release of the transverse carpal ligament alone is associated with elevated pressure beneath the distal volar forearm fascia in a cadaver model of carpal tunnel syndrome. J Hand Surg Am. 2007;32:1533–7.
14. Hansen TB, Kirkeby L, Fisker H, et al. Randomised controlled study of two different techniques of skin

suture in endoscopic release of carpal tunnel. Scand J Plast Reconstr Surg Hand Surg. 2009;43(6):335–8.
15. Cook AC, Szabo RM, Birkholz SW, King EF. Early mobilization following carpal tunnel release. A prospective randomized study. J Hand Surg Br. 1995;20(2):228–30.
16. Janssen RG, Schwartz DA, Velleman PF. A randomized control study of contrast baths on patients with carpal tunnel syndrome. J Hand Ther. 2009;22(3):200–7.
17. Peters S, Page MJ, Coppieters MW, Ross M, Johnston V. Rehabilitation following carpal tunnel release. Cochrane Database Syst Rev. 2013;6:CD004158.
18. Pomerance J, Fine I. Outcomes of carpal tunnel surgery with and without supervised postoperative therapy. J Hand Surg Am. 2007;32:1164–5.
19. Chow JCY, Hantes ME. Endoscopic carpal tunnel release: thirteen years' experience with the Chow technique. J Hand Surg. 2002;27A:1011–8.
20. Okutsu I, Hamanaka I, Yoshida A. Retrospective analysis of five-year and longer clinical and electrophysiological results of the world's first endoscopic management for carpal tunnel syndrome. Hand Surg. 2013;18(3):317–23.
21. Brown RA, Gelberman RH, Seiler 3rd JG, Abrahamsson SO, Weiland AJ, Urbaniak JR, Schoenfeld DA, Furcolo D. Carpal Tunnel Release: a prospective, randomized assessment of open and endoscopic methods. J Bone Joint Surg. 1993;75(9):1265–75.
22. Pajardi G, Pegoli L, Pivato G, et al. Endoscopic carpal tunnel release: our experience with 12,702 cases. Hand Surg. 2008;13(1):21–6.
23. Boeckstyns ME, Sørensen AI. Does endoscopic carpal tunnel release have a higher rate of complications than open carpal tunnel release? An analysis of published series. J Hand Surg Br. 1999;24:9–15.
24. Uchiyama S, Nakamura K, Itsubo T, et al. Technical difficulties and their prediction in 2-portal endoscopic carpal tunnel release for idiopathic carpal tunnel syndrome. Arthroscopy. 2013;29(5):860–9.
25. Chow JC, Hantes ME. Endoscopic carpal tunnel release: thirteen years' experience with the Chow technique. J Hand Surg Am. 2002;27(6):1011–8.
26. Hankins CL, Brown MG, Lopez RA, et al. A 12-year experience using the Brown two-portal endoscopic procedure of transverse carpal ligament release in 14,722 patients: defining a new paradigm in the treatment of carpal tunnel syndrome. Plast Reconstr Surg. 2007;120(7):1911–21.
27. Benson LS, Bare AA, Nagle DJ, Harder VS, Williams CS, Visotsky JL. Complications of endoscopic and open carpal tunnel release. Arthroscopy. 2006;22(9):919-24–924.e1-2.
28. Macdermid JC, Richards RS, Roth JH, Ross DC, King GJ. Endoscopic versus open carpal tunnel release: a randomized trial. J Hand Surg Am. 2003; 28(3):475–80.
29. Larsen MB, Sørensen AI, Crone KL, Weis T, Boeckstyns ME. Carpal tunnel release: a randomized comparison of three surgical methods. J Hand Surg Eur Vol. 2013;38(6):646–50.
30. Trumble TE, Diao E, Abrams RA, et al. Single-portal endoscopic carpal tunnel release compared with open release: a prospective, randomized trial. J Bone Joint Surg Am. 2002;84A:1107–15.
31. MacDermid JC, Richard RS, Roth JH, King GJK. Endoscopic versus open carpal tunnel release: a randomized trial. J Hand Surg. 2003;28A:475–80.
32. Vasiliadis HS, Georgoulas P, Shrier I, Salanti G, Scholten RJ. Endoscopic release for carpal tunnel syndrome. Cochrane Database Syst Review. 2014;1: CD008265.
33. Chung KC, Walters MR, Greenfield ML, Chernew ME. Endoscopic versus open carpal tunnel release: a cost-effectiveness analysis. Plast Reconstr Surg. 1998;102(4):1089–99.
34. Sucher BM. Grading severity of carpal tunnel syndrome in electrodiagnostic reports: why grading is recommended. Muscle Nerve. 2013;48:331–3.