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Original Research

A Novel Supraretinacular Endoscopic Carpal Tunnel Release: Instrumentation and Technique (Cadaveric Study)

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A R T I C L E I N F O

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Purpose: Endoscopic carpal tunnel release has been shown to be associated with a shorter return to work compared with open carpal tunnel release in the treatment of carpal tunnel syndrome. Unfortunately, it may be associated with a higher risk for median nerve injury when the carpal tunnel is used as a portal for instrumentation. The purpose of this study was to assess safety in using a newly designed retractor through a supraretinacular approach.

Methods: We used 8 wrists (4 left and 4 right wrists) from 4 fresh-frozen cadavers for this study. Supraretinacular endoscopic carpal tunnel release using the supraretinacular retractor was performed by a single investigator, followed by exploration of the carpal tunnel and the structures surrounding it. Surgeries were performed using a new surgical instrument consisting of an arch-shaped blade and handle. It includes a retainer adapted to receive a 2.4- or 2.7-mm endoscope and to retain it at the apex of the arch, which can be moved in and out to visualize the entire transverse carpal ligament. The space below the blade is also used as a portal to insert scissors and instrumentation to cut the transverse carpal ligament.

Results: All 8 carpal tunnels were completely released with no injury to the median nerve, superficial palmar arch, flexor tendon, or violation into Guyon canal. Mean distance of the flexor retinaculum division to the recurrent motor branch, palmar cutaneous branch, and superficial palmar arch was 6.87 ± 2.80, 7.13 ± 5.33, and 9.13 ± 4.42 mm, respectively. All specimens had an extraligamentous recurrent motor branch.

Conclusions: The retractor and described technique were safe and effective in this cadaveric study. Further clinical trials are necessary before it can be adopted as a safe and reliable technique.

Type of study/level of evidence: Therapeutic IV.

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Carpal tunnel syndrome can be treated operatively by conventional open carpal tunnel release (OCTR) or endoscopic carpal tunnel release (ECTR). Although the ECTR technique has proven superior in terms of recovery time, return of hand strength, functional outcome, patient satisfaction, and shorter absenteeism from work,[1–5] it is also associated with a higher risk for transient median nerve dysfunction, which is attributed to surgical manipulation when inserting instruments into the stenosed carpal tunnel.[6–9] Most endoscopic techniques employ an infra-retinacular or trans-carpal tunnel approach. The most common infraretinacular ECTR methods include the techniques of Chow[10] and Agee et al.[11] Both require the insertion of endoscopic instruments into the carpal tunnel.

Ip et al[12] and Ecker et al[13] presented a supraretinacular ECTR (SRECTR) technique in which the endoscope is inserted superficially into the flexor retinaculum. This technique improved visualization of carpal tunnel structures and avoided disturbing the

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Figure 1. Supraretinacular retractor with L bar for scope placement.

Figure 2. Dome-shaped beaver space for entry of the endoscope or Metzenbaum or tenotomy scissors.

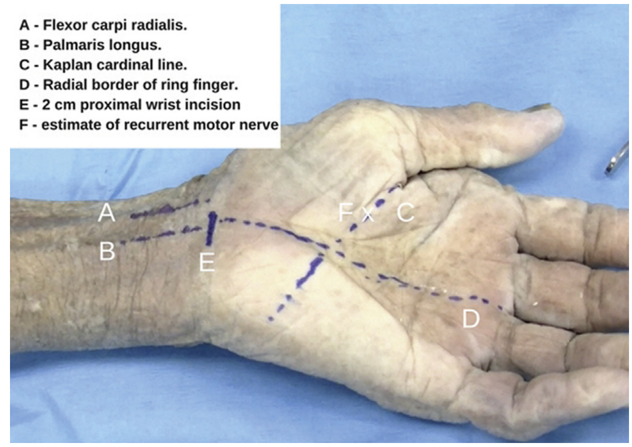

Figure 3. Surface anatomy markings of safe zone.

Figure 4. Two-centimeter incision made over proximal wrist crease.

median nerve before retinaculum dissection, because the carpal tunnel is not violated. However, Ip et al reported a high incidence of pillar pain and hypertrophied scars after surgery among patients. We believe this is caused by the bulky instrumentation, which was originally designed for cubital tunnel release by Hoffman. In their technique, a 4.0-mm endoscope was used, compared with our technique with a 2.4- or 2.7-mm endoscope. Our novel instrument and surgical technique were designed to address these problems.

Our technique and instrument were subjected to cadaveric testing to assess the margin of safety with respect to key anatomical structures and technical efficacy using a smaller customized retractor with a smaller endoscope (2.4 or 2.7 mm) employing a supraretinacular approach.

Materials and Methods

We obtained approval from the Medical Ethics Committee, University Malaya Medical Centre (Ethics Committee No. 1182.36). Eight wrists from 4 fresh-frozen cadavers were used. A single investigator performed SRECTR using the supraretinacular retractor employing the technique described subsequently. This was followed by exploration of the carpal tunnel and its surrounding structures.

The surgeries were performed using a new surgical instrument (Fig. 1), a retractor made of an arch-shaped blade (Figs. 1, 2) with a handle extending upward from the proximal end of the blade. The handle is adapted to receive a removable L-shaped endoscope retainer, the L-bar. This retainer can receive either a 2.4- or 2.7-mm

Figure 5. Tunnel made between superficial subcutaneous tissue and flexor retinaculum using Metzenbaum scissors for supraretinacular retractor insertion.

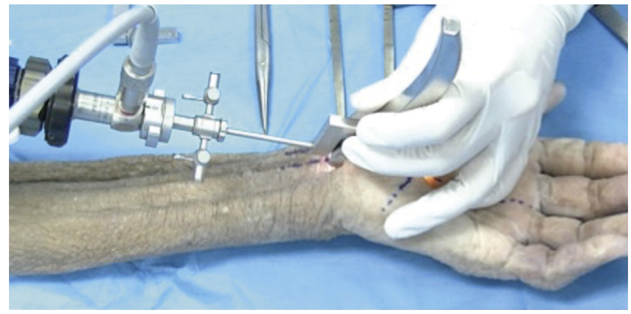

Figure 6. Insertion of supraretinacular retractor with L bar for endoscope. Endoscope is advanced through L bar.

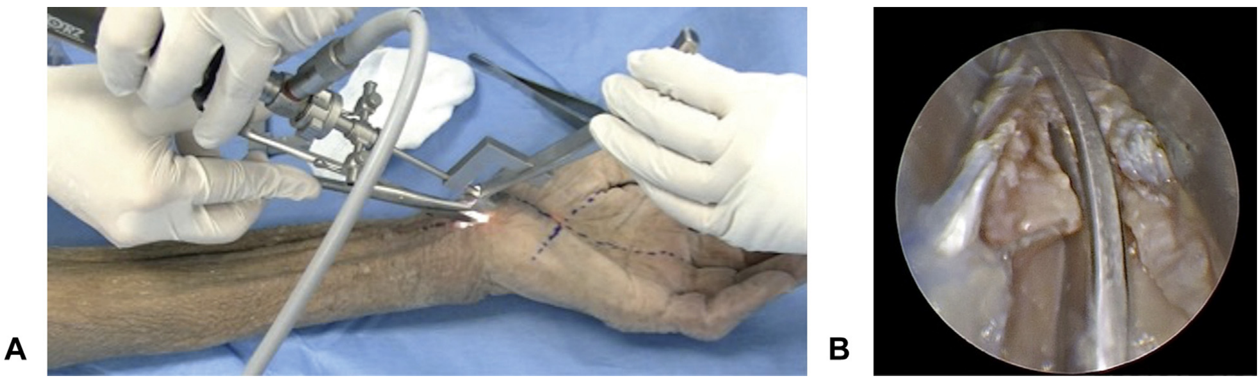

Figure 7. **A** Flexor retinaculum identified under endoscope and dissected with Metzenbaum scissors with sequential cuts. **B** Endoscopic view placed on top of flexor retinaculum showing partially cut flexor retinaculum with median nerve underneath.

endoscope and retain it at the apex of the arch, which can be moved in and out to visualize the entire transverse carpal ligament. The space below the blade is also used as a portal for insertion of scissors and instrumentation to cut the transverse carpal ligament.

Surgical technique

Surface anatomy landmarks of vital structures were labeled as illustrated in Figure 3,[14–16]: the flexor carpi radialis, palmaris longus, Kaplan's cardinal line, and the radial border of the ring finger. A transverse incision about 2 cm wide was made over the radiocarpal wrist flexion crease between the palmaris longus tendon and the ulnar border of the ring finger (Fig. 4).[16] A supraretinacular space was created using Metzenbaum scissors by blunt dissection along the axial line between the middle and ring finger and ending at Kaplan's cardinal line (Fig. 5). The width of the tunnel made was about 2 to 3 cm wide to allow insertion of the supraretinacular retractor, which, together with a 2.4-mm endoscope (Karl Storz GmbH & Co. KG, Tuttlingen, Germany), was inserted into the space (Fig. 6). The endoscope was held in place using the L-bar, which enabled it to be perched at the top of the supraretinacular retractor's dome. This allowed visualization of the entire transverse carpal ligament. Metzenbaum scissors were then used to dissect the proximal part of the transverse carpal ligament and visualize the median nerve underneath. The transverse carpal ligament was then divided along the longitudinal axis of the radial border of the ring finger (Fig. 3) using the Metzenbaum scissors under endoscopic vision (Fig. 7B). This was done in a series of small sequential cuts, dissecting tissues underneath the transverse carpal ligament to ensure that all structures, especially the median nerve, were not adherent to it before a cut was made (Fig. 7A, B). This process was repeated until the entire transverse carpal ligament was released. This was determined through clear visualization of the distal edge of the transverse carpal ligament or of the fat pad that covers the median nerve at the end of the transverse carpal ligament. The antebrachial fascia was then dissected proximally and fully released under direct visualization.

After each release, wrists were explored for potential injury to surrounding structures including the superficial palmar arch, palmar cutaneous branch of the median nerve, recurrent motor branch of the median nerve, flexor tendons, and median nerve trunk. We also assessed for potential violation of Guyon canal, completeness of release of the carpal tunnel, and where the release was performed in relation to the median nerve trunk. The proximity of the release to the surrounding structures was also measured using a caliper and a Codman surgical ruler (Codman & Shurtleff, Ryanham, MA).

Results

A total of 8 wrists (4 left and 4 right wrists) on 4 cadavers were tested. All 8 carpal tunnels were completely released with no injury to the median nerve, superficial palmar arch, or flexor tendon or violation into Guyon canal. Mean distance of the flexor retinaculum division to the recurrent motor branch, palmar cutaneous branch, and superficial palmar arch was 6.87 ± 2.80, 7.13 ± 5.33, and 9.13 ± 4.42 mm, respectively. All specimens had an extra-ligamentous recurrent motor branch.

Discussion

The evolution of modern surgery has been edging toward minimalism. Various mini OCTRs with or without customized instruments or ECTRs have been described.[4,10,11,16–19]

The mini OCTR has limitations in terms of its safety profile, because it is performed without direct visualization. Related studies focused on marking the boundary of dissection, when the flexor retinaculum is released, without visualizing the structure.[16–19] Although it has a remarkable safety profile equivalent to a standard OCTR, the risk for neurovascular injury is unpredictable, especially from aberrant nerves or muscles.

Per Nagle[20],ECTR was first introduced in the 1980s by Okutsu, and was further developed by Chow[10] and Agee et al.[11] These techniques allowed direct visualization of the flexor retinaculum during release. All 3 techniques introduced an endoscope and instrumentation into the carpal tunnel. Although this is a potential point of entry, it can be a tight and nonexpansile fibro-osseous space. Therefore, insertion of instruments into this space may increase intracarpal pressure and potentially injure structures in the carpal tunnel including the median nerve. These techniques visualize the flexor retinaculum from inside the carpal tunnel before release, which is not a familiar view to surgeons who have been trained to perform open carpal tunnel release. Thus, ECTR requires a certain level of training because of its steep learning curve.[21] One study found that the 2-portal ECTR technique was associated with an inverse relation between the number of procedures performed and the rate of complications.[22] The alternative supraretinacular approach proposed by Ip et al[12] and Ecker et al[13] has the benefit of minimal invasive surgery and provides a better plane of sight for aberrant nerves or muscles over the palmar surface of the flexor retinaculum. The endoscopic view using the supraretinacular approach is similar to that of the open release technique and may be easier to adopt for surgeons who were trained to perform open releases. In addition, the SRECTR technique avoids inserting surgical instruments into the tight carpal tunnel, which may lower the risk for injuring the median nerve. Results from both authors showed equivalent efficacy and safety compared with conventional ECTR, but it had a high incidence of pillar pain and scar hypertrophy.

The new supraretinacular retractor that we designed allowed the use of a smaller 2.4-mm (Karl Storz GmbH & Co. KG) or 2.7-mm (Smith & Nephew, Memphis, TN) endoscope. By mapping the safe zone before surgery, the endoscopic instrument's insertion projection and depth can be determined (Fig. 3). When coupled with clear visualization through the endoscope, this would reduce the risk for injuring vital structures in and around the carpal tunnel. The endoscope may also assist the surgeon in recognizing anatomical anomalies or rare causes of carpal tunnel syndrome such as lipoma, ganglion, and neurofibromatosis,[23] compared with mini incision carpal tunnel release.

This study showed that the novel retractor is safe for use in SRECTR. We believe that this new technique has 2 main advantages compared with ECTR using the transcarpal tunnel approach. First, by avoiding the need to insert an instrument into the tight and stenotic carpal tunnel, the risk for iatrogenic injury to the median nerve is reduced. Second, the endoscopic view in this technique is similar to that of the open technique and may make the technique easier to learn. This study was done mainly to establish the safety profile of the new instrument and technique. We are currently performing a follow-up study to compare actual pressure within the carpal tunnel between SRECTR and ECTR techniques, as well as a clinical study to assess whether these benefits translate into better surgical outcomes for the patient.

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