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ΙΑΤΡΙΚΗ ΣΧΟΛΗ

ΔΙΠΛΩΜΑΤΙΚΗΕΡΓΑΣΙΑ

ΘΕΜΑ

“Minimal Invasive Surgery for tendinopathies and neuropathies of hand: A Review”

ΜΕΤΑΠΤΥΧΙΑΚΟΣΦΟΙΤΗΤΗΣ
ΠΑΘΙΑΚΗΣ ΙΩΑΝΝΗΣ
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ΠΡΑΚΤΙΚΟ ΚΡΙΣΕΩΣ
ΤΗΣ ΣΥΝΕΔΡΙΑΣΗΣ ΤΗΣ ΤΡΙΜΕΛΟΥΣ ΕΞΕΤΑΣΤΙΚΗΣ ΕΠΙΤΡΟΠΗΣ
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Του Μεταπτυχιακού Φοιτητή Παθιάκη Ιωάννη

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Η Τριμελής Εξεταστική Επιτροπή η οποία ορίσθηκε από την ΓΣΕΣ της Ιατρικής Σχολής του Πανεπιστημίου Αθηνών Συνεδρίαση της ....ης ..... 20.... για την αξιολόγηση και εξέταση του υποψηφίου κου Παθιάκη Ιωάννη, συνεδρίασε σήμερα .../.../....

Η Επιτροπή διαπίστωσε ότι η Διπλωματική Εργασία του Κου Παθιάκη Ιωάννη με τίτλο: "Minimal Invasive Surgery for tendinopathies and neuropathies of hand: A Review",
είναι πρωτότυπη, επιστημονικά και τεχνικά άρτια και η βιβλιογραφική πληροφορία ολοκληρωμένη και εμπεριστατωμένη.

Η εξεταστική επιτροπή αφού έλαβε υπ' όψιν το περιεχόμενο της εργασίας και τη συμβολή της στην επιστήμη, με ψήφους ..... προτείνει την απονομή του Μεταπτυχιακού Διπλώματος Ειδίκευσης (Master's Degree), στον παραπάνω Μεταπτυχιακό Φοιτητή.

Στην ψηφοφορία για την βαθμολογία ο υποψήφιος έλαβε για τον βαθμό «ΑΡΙΣΤΑ» ψήφους ....., για τον βαθμό «ΛΙΑΝ ΚΑΛΩΣ» ψήφους ....., και για τον βαθμό «ΚΑΛΩΣ» ψήφους ..... Κατά συνέπεια, απονέμεται ο βαθμός «.....».

Τα Μέλη της Εξεταστικής Επιτροπής

- Ιωάννης Γκρινιάτσος, (**Επιβλέπων)** (Υπογραφή) _____
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στον προστάτη μου

Άγιο Λουκά τον Ιατρό, Αρχιεπίσκοπο Συμφερουπόλεως και Κριμαίας

στους γονείς μου

για την αμέριστη συμπαράσταση τους

στην Ιωάννα

για την ατέλειωτη υπομονή της

θερμές Ευχαριστίες στους Καθηγητές

για τη γνώση που απλόχερα μου χάρισαν

" ...οι δυσκολότερες τέχνες στη ζωή, είναι να μορφώνεις τους ανθρώπους,

να τους θεραπεύεις και να τους δικάζεις..."

Σωκράτης

1. Introduction

Anatomic structures in the hand and wrist lie in close proximity to each other and are critical for precise functioning of the upper extremity. Therefore, minimally invasive surgery (MIS) in this region of the body is of particular interest because of the desire to restore hand function as quickly as possible after a surgical procedure. Oftentimes, the pain, discomfort, and other morbidity associated with surgery are due to the surgical dissection to access the area of interest rather than from the procedure itself. As such, decreased surgical trauma and tissue disruption will lead to decreased postoperative pain and swelling, shorter recovery period, and a faster return to activities of daily living. These advantages not only benefit patients, but also the health care system because most procedures can be done on an outpatient basis; and when required, hospital stays are usually shorter than those for traditional open procedures.

Disadvantages to MIS are the steep learning curve for the surgeon and staff, and higher costs (1). In the early part of the learning curve, MIS is considered more technically demanding than traditional open surgical methods. Surgeons are working in smaller areas through smaller incisions, and need to employ a three-dimensional mental picture of the anatomy. Using instruments like trocars, endoscopes, and cameras requires some degree of "hand–eye" coordination and technological knowhow by the surgeon and his or her assistants. Arthroscopic instruments can be more difficult to maneuver and manipulate because the working end is further away from the surgeon's hands. Often, the surgeon is not looking directly at the three dimensional operative field but at a two-dimensional video screen, which may add to the difficulty of the procedure. Because of this, there is a possibility of causing iatrogenic trauma to surrounding tissue that is not in view of the camera or fluoroscopic image. However, these problems can usually be mastered with training, experience, and precise knowledge of the anatomy.

1.1 Advances in Hand MIS

There have been several factors that have led to advances in wrist and hand MIS. First, improvements in fiber-optic technology(and its use in the arthroscope and endoscope) have enhanced visualization of intra- and periarticular anatomy that previously could not be seen on standard open exposures.

Arthroscopy is generally agreed to be the gold standard for diagnosis of intra-articular wrist pathology(2). In conjunction with improved visualization of the joint, dedicated and appropriately sized arthroscopic instruments have been developed for the surgeon to treat pathologies in the hand and wrist (3). For example, triangular fibrocartilag complex tears can be derided or repaired through the scope(4). Similar to the larger joints, small joint arthroscopic surgery has gained a place in the upper extremity and continues to push the field of MIS forward.

The mini C-arm image intensifier has also been a major contribution to MIS of the upper extremity, combining superior image quality, ease of use, and relatively low doses of emitted radiation (5–7). A typical mini C-arm has a focus X-ray tube that uses 0.02 to 0.10 mA of current with a tube potential of 40 to75 kV and a narrow field, resulting in less ionizing radiation than the bigger C-arms. The patient's arm can be placed close to the image intensifier to generate high-quality digital images, yet there is enough room to perform the surgery (Fig. 1). This capacity to perform an operation under dynamic, real-time fluoroscopy allows for percutaneous reduction and fixation of a fracture, thereby lessening the invasiveness of the procedure.

Another area of MIS advancement in the hand and wrist is the development of implants and surgical devices specific to minimally invasive techniques. For example, the MICRONAIL(Wright Medical Technology, Arlington, Tennessee, U.S.A.) was designed to be inserted by percutaneous means through the "bare spot" between the first and second dorsal compartment tendons; it is a rigid fixation device for distal radius fractures and malunions (8,9). For metacarpal and proximal phalangeal shaft fractures, flexible prebent intramedullary nails can be inserted through a small incision at the base of the bone with the aid of a prefabricated awl (Small Bone Fixation System, Hand Innovations, LLC, Miami, Florida, U.S.A.) (10).

Minimally invasive carpal tunnel release can be performed with one of several systems (11) that were designed specifically for the purpose of dividing the transverse carpal ligament without violating the overlying skin and subcutaneous tissue, as is done with the traditional open method. Another example of a specially designed instrument is the HAKI knife (BK Meditech Inc., Seoul, South Korea), which was developed for percutaneous trigger finger release (12).

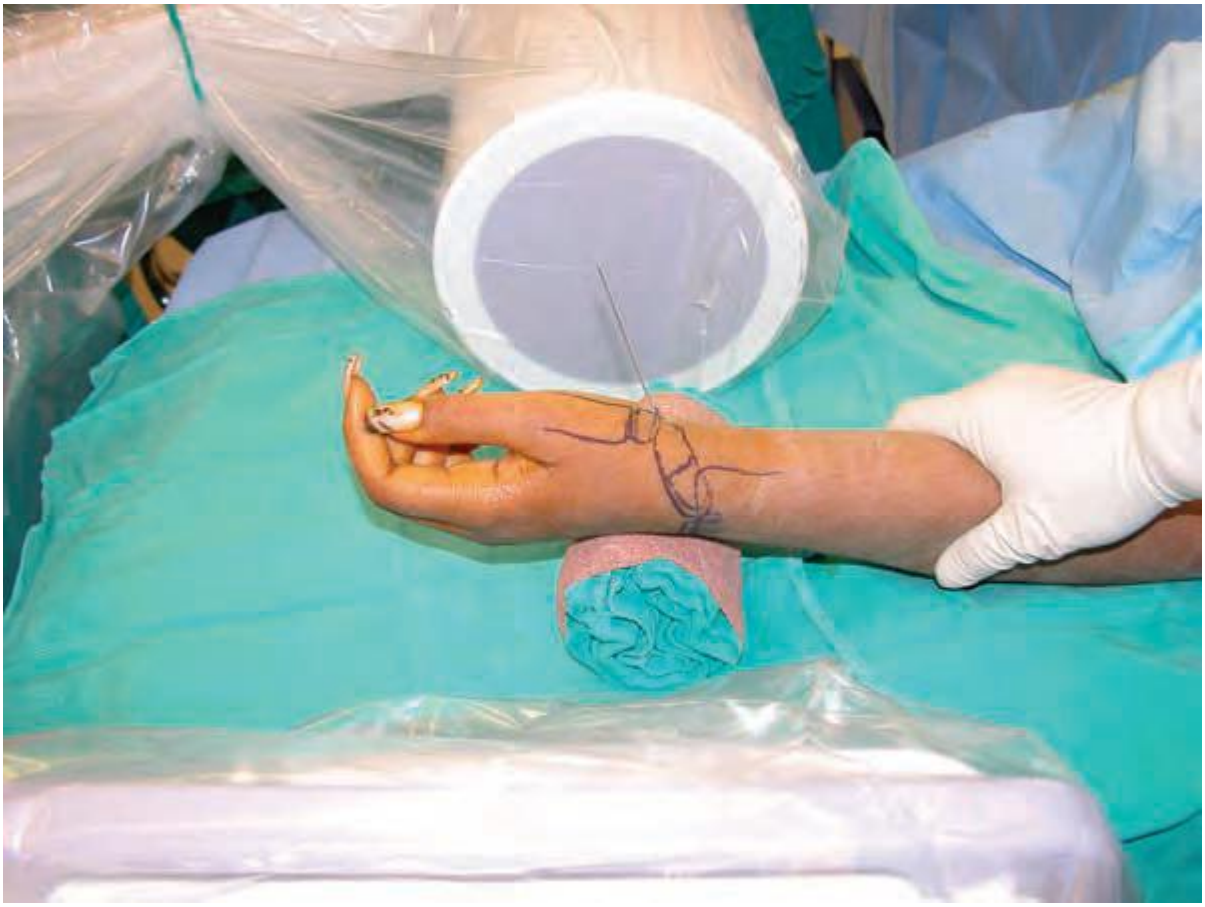


FIGURE 1. Use of a mini C-arm during percutaneous scaphoid fixation. The C-arm is draped out sterilely and used in the horizontal fashion with the wrist close to the image intensifier side.

1.2 Anatomic basis for Hand MIS

The wrists and hands are particularly suitable for minimally invasive procedures because for the most part the anatomic structures are subcutaneous. Additionally, tendon excursion is of major importance to the function of the hand, and procedures that limit postoperative swelling and tendon adhesions, such as MIS, are of great value. The major neurovascular structures in the wrist and hand are located volarly; therefore, the majority of arthroscopic portals, limited incision surgical approaches and locations of percutaneous Kirschner (K)-wire placement for minimally invasive techniques are situated dorsally (Fig. 2).As such, the extensor tendons are most at risk for injury, but most of these injuries are relatively minor.

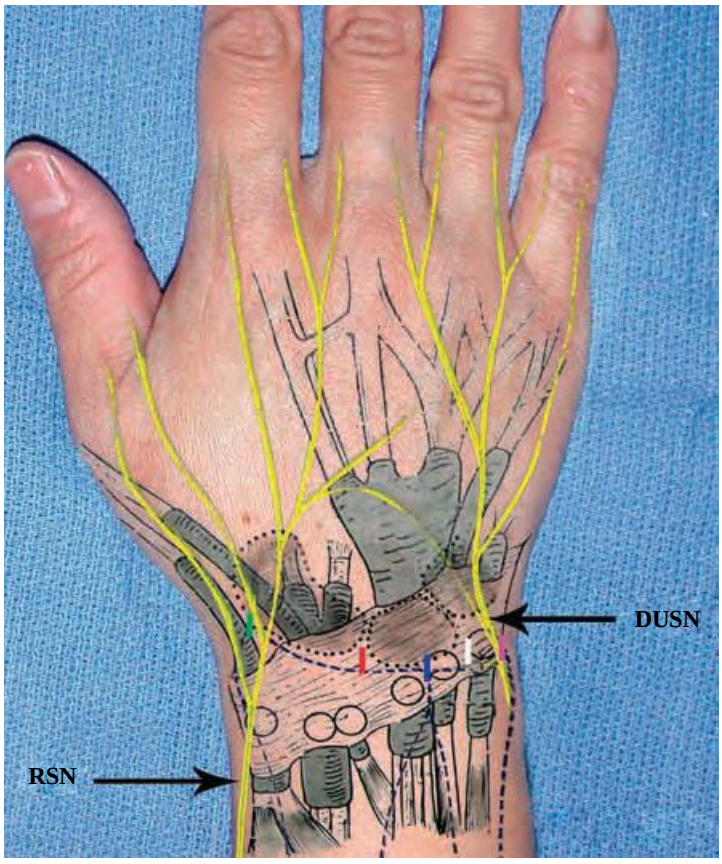


FIGURE 2.Surgical anatomy of the wrist and hand. Injuries to the extensor tendons can be minimized with blunt dissection to mobilize them from the surgical approach. The DUSN and RSN are most at risk of injury at the wrist during radial and ulnar sided approaches, respectively. Abbreviations: DUSN, dorsal ulnar sensory nerve; RSN, radial sensory nerve.

There are only several minimally invasive procedures that utilize the volar side of the hand. Endoscopic carpal tunnel release is performed with small volar skin incision(s) that is in the corridor between the hook of the hamate and the palmaris longus tendon (Fig. 4). Instruments that are placed too farulnarly will potentially injure the ulnar neurovascular bundle in Guyon's canal, and those too radial may injure the median nerve. Kaplan's cardinal line serves as a landmark for the distal edge of the transverse carpal ligament and is proximal to the superficial palmar arch (13). For percutaneous trigger release and palmar incisions for drainage of suppurative flexor tenosynovitis, knowledge of the flexor sheath and pulley anatomy is essential (Fig. 5). Studies have demonstrated that the proximal edge of the first annular pulley coincides with the proximal palmar crease in the index finger, halfway between the proximal and distal palmar creases in the middle finger, and at the distal palmar crease in the ring and little fingers (14,15). In the thumb, the metacarpophalangeal crease overlies the middle portion of the A1 pulley, but specific attention must be given to the radial digital nerve because it traverses from ulnar to radial across the metacarpal in close proximity to the pulley (16).

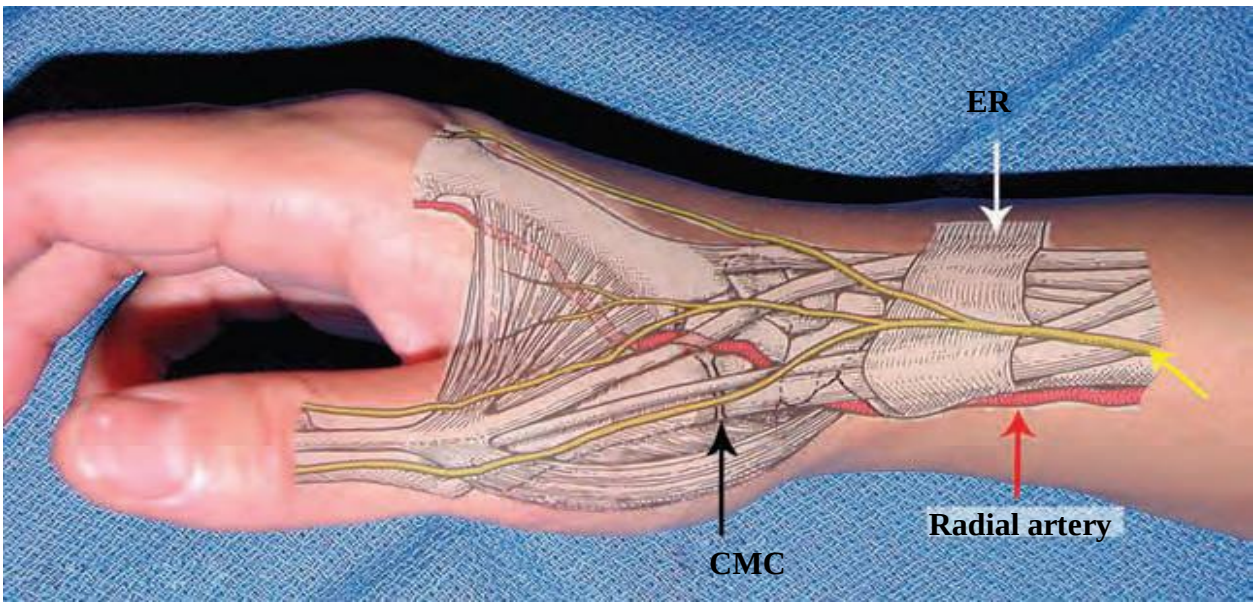


FIGURE 3.Surgical anatomy of the radial side of the wrist, showing the relative position of the RSN in relationship to the extensor tendons and underlying joints. Abbreviations: RSN, radial sensory nerve; CMC, thumb basal (carpometacarpal) joint; RA, radial artery; ER, extensor retinaculum.

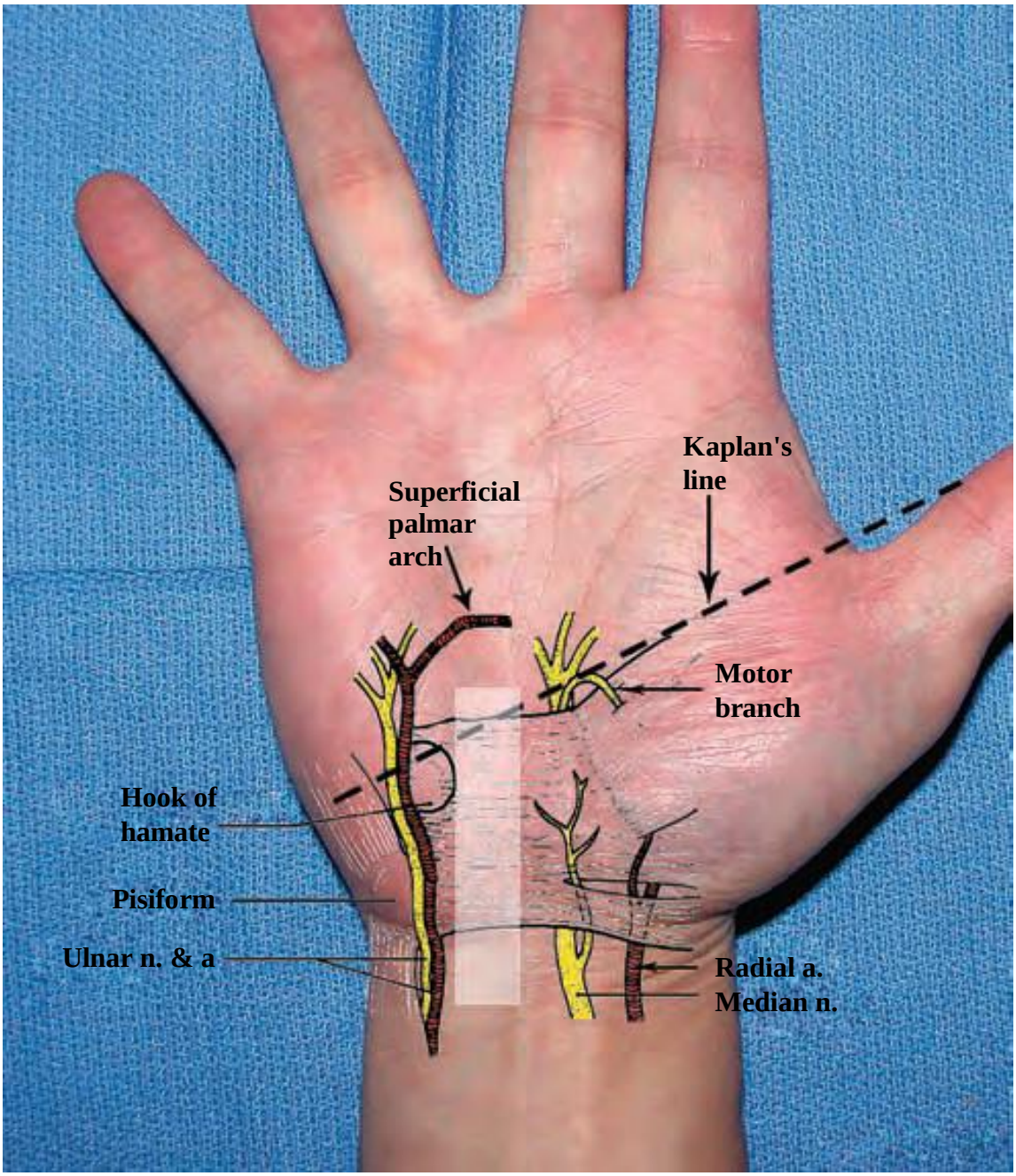


FIGURE 4. Surgical anatomy for endoscopic/minimal incision carpal tunnel release. The "safe zone" is in the corridor (white rectangular area)between the palmaris longus tendon and hook of the hamate.

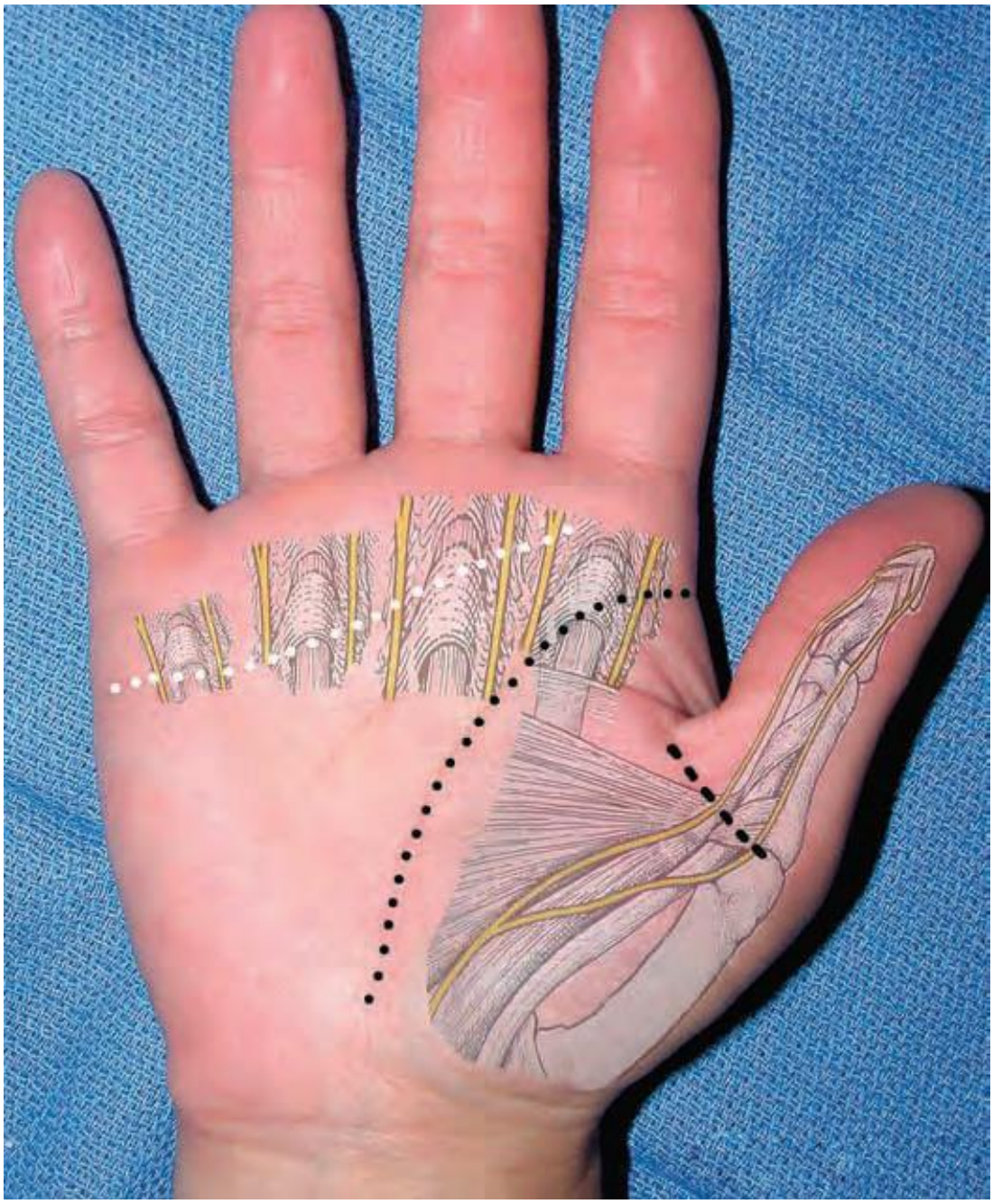


FIGURE 5.Positions of the A1 pulleys relative to the flexion creases in the palm. The proximal edge of the A1 coincides with the proximal palmar crease (black dotted line) in the index finger, halfway between the proximal and distal palmar creases in the middle finger, and the distal palmar crease (white dotted line) in the ring and little fingers. In the thumb, metacarpophalangeal crease (black dashed line) indicates the middle of the A1 pulley.

1.3 Carpal Tunnel Syndrome

Carpal tunnel syndrome is the most common condition surgically treated by hand surgeons. It is interesting to note this condition was only definitively described in the years after World War II. Retrospectively, however, this condition did not appear suddenly at that time but was known under a variety of different names in the past. Patients who appear to have suffered from carpal tunnel syndrome are clearly depicted in the surgical literature going back at least to the mid-1800s. The evolution of the clinical understanding that led to the current knowledge of carpal tunnel syndrome is an interesting one and represents a pattern that may be typical for many medical conditions. Specifically, early on there was confusion as to the pathophysiology, resulting in a variety of etiological theories, which in turn resulted in a variety of apparently different diagnoses being applied to the same clinical entity. Only later did the clinical threads merge and result in a single coherent clinical picture. For carpal tunnel syndrome there were three major threads which needed to unite in order to establish our current understandings. Specifically, these were the threads of acroparesthesia, thenar neuritis, and median neuropathy after wrist fracture. The earliest of these threads was actually median neuropathy after wrist fracture, known at least since 1836 when Gensoul (17)described a case of the median nerve entrapped in an open fracture of the radius. In 1854 Paget (18) described two cases of median neuropathy after fracture of the distal radius. One case was treated by amputation and the other by splinting. Coming closer to our current understanding and therapeutic regimen, Bouilly, in 1884,described a 17-year-old with a Colles fracture and median neuropathy treated by excision of prominent palmarcallus (19). Additional cases were reviewed by Blecherin 1908 (20) and Kirchheim in 1909 (21). By 1926Dickson was describing a case of causalgia after Colles fracture, relieved by median neurolysis (22). Finally, in1933 Abbott and Saunders, in their classic cadaver study, injected dye into the carpal tunnel and noticed increased resistance to dye flow with wrist flexion (23).

As a result of this they condemned the Cotton-Loderposition (Fig. 6), which had been commonly used up until that time for the treatment of Colles fracture. Bunnell later stated that it was this paper by his San Francis co colleagues, Abbott and Saunders, which prompted his own interest in what later came to be known as carpal tunnel syndrome (24). The problem of carpal tunnel syndrome after Colles fracture continues, of course, to remain an important clinical problem (Fig.7).

A related thread was that of median neuropathy associated with lunate dislocation. Speed reported three cases in 1922 (19), which improved with excision of the lunate. Watson-Jones in 1927 (25) and Meyerding in1927 (26) also reported excellent restoration of median nerve function after removal of the dislocated lunate bone. The problem of chronic lunate dislocation and its treatment by lunate excision, of course, remains relevant to the present day (Fig. 8).

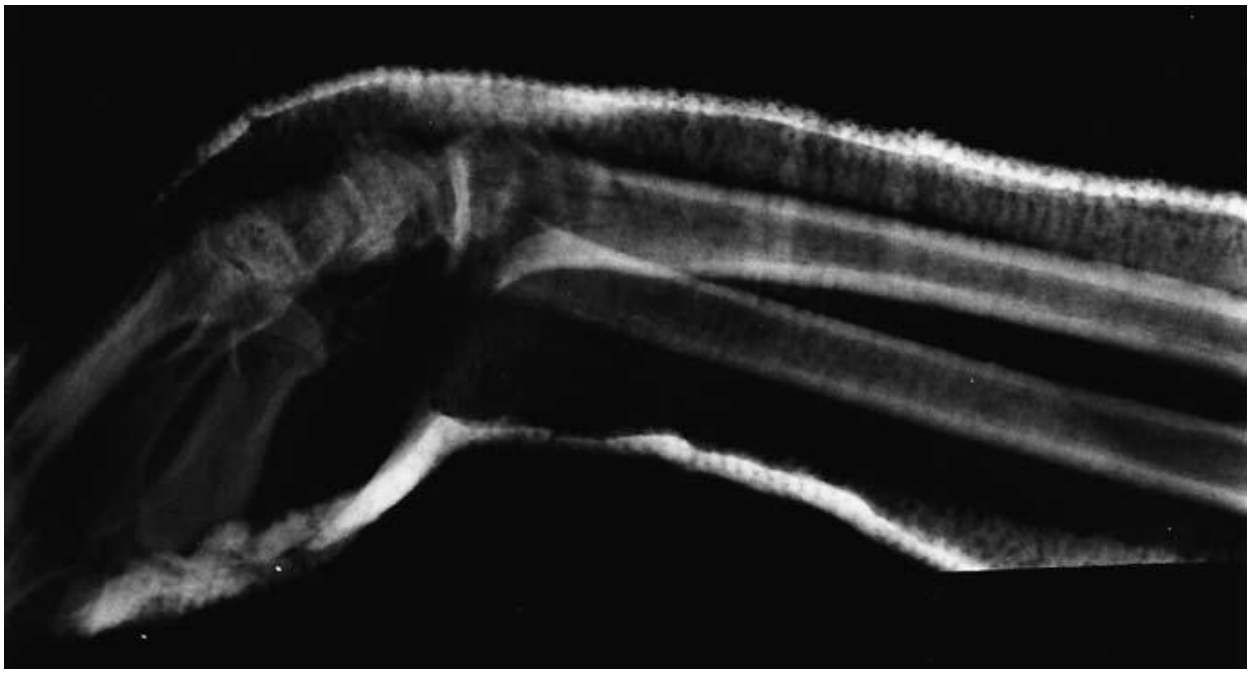


FIGURE 6. The Cotton-Loder position of wrist flexion to maintain reduction after Colles fracture has been justifiably condemned

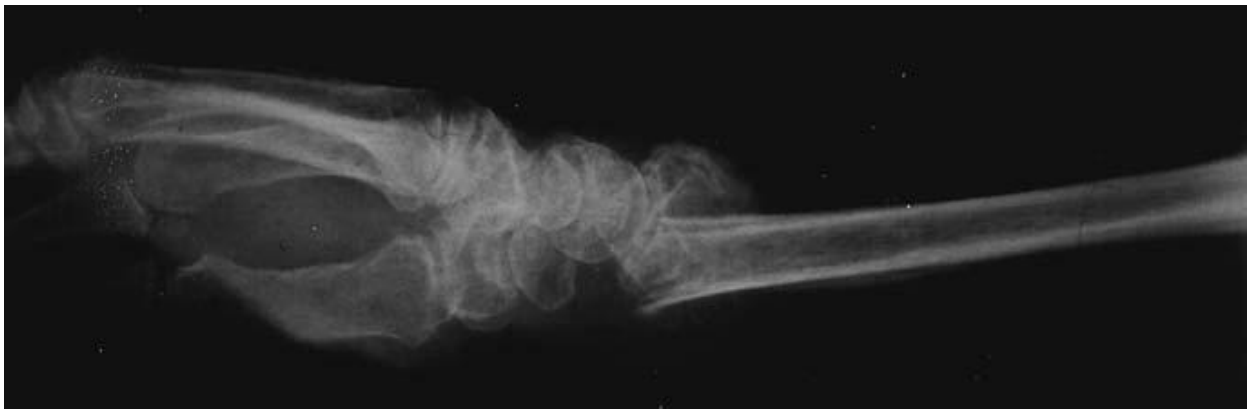


FIGURE 7. Displaced Colles fractures are still a common cause of posttraumatic carpal tunnel syndrome

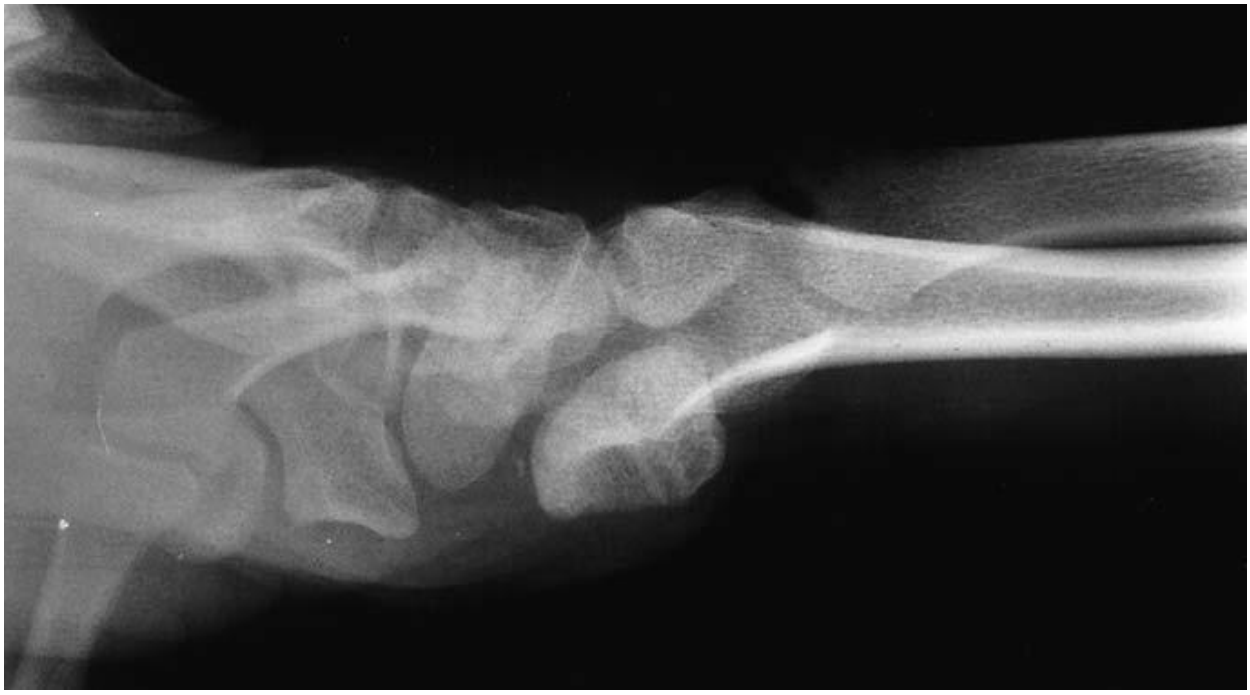


FIGURE 8. Chronic lunate dislocation remains a classic cause of carpal tunnel syndrome, and is still treated by lunate excision. Chronic lunate dislocation associated with symptoms of carpal tunnel syndrome.

Who had the first thought that the numbness of the fingertips might represent a low median neuropathy is of course impossible to know. A review of the Mayo Clinic medial records showed that as early as 1910,Henry Plummer, an outstanding diagnostician of his day, had diagnosed idiopathic low median neuropathy in a 66-year-old man (26). He offered no treatment, however. In 1913 Pierre Marie and Charles Foix in a report to the French Neurological Society described an autopsy case of an 80-year-old woman (27). A large pseudoneuroma was found with distal demyelization of the median nerve. They suggested that "perhaps in a case in which the diagnosis is made early enough…-transection of the ligament could stop the development of these phenomena." Prescient words, but unfortunately, apparently few people read or thought about Marie's and Foix's observation, as the next appearance in the literature of treatment focusing on the carpal tunnel is a report by Learmonth, published in 1933(28). In this report he describes two cases, one patient operated on in 1929 in which he divided the flexor retinaculum in order to treat a median neuropathy secondary to scaphoid nonunion, and another case in

1930where he treated a patient with median neuropathy by division of the flexor retinaculum in a case associated

with wrist arthritis but without any specific carpal injury. This is getting much closer to our current understanding of carpal tunnel syndrome, although Learmonth again apparently thought that the condition was rare. In 1935 Zabriskie thought that "the sensation of tingling suggests more than the thenar branch is affected"(29) . In 1939 Wartenberg wrote that "one point completely ignored by Hunt…the paresthesias of which most patients complained" (30), again, attempting to join the threads of thenar neuritis and acroparesthesias into the final common pathway of carpal tunnel syndrome: Zachary, in 1995, had similar thoughts (31).Finally, in 1946 Cannon and Love published 38 cases of surgical division of the flexor retinaculum for treatment of distal median neuropathy (32). This landmark article also included the first accurate description of a surgical technique (Fig. 9).

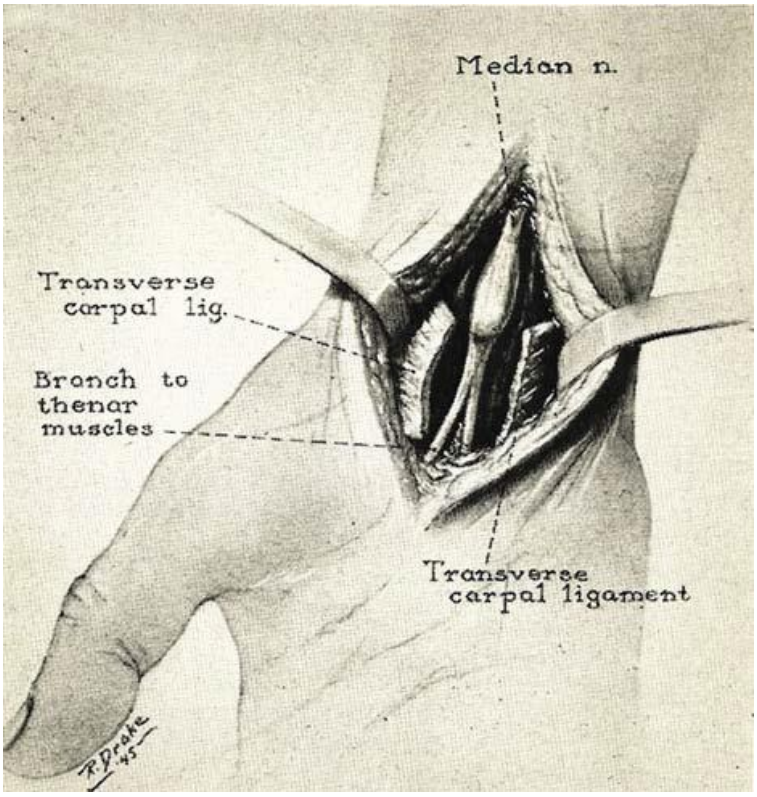


FIGURE 9. This illustration from Cannon and Love's article accurately represents the anatomy of carpal tunnel syndrome and carpal tunnel release surgery. (Artwork copyright Mayo Foundation, previously reproduced in the *Journal of Bone and Joint Surgery*)

The source of the name “carpal tunnel syndrome” is unclear. It was first used in print in 1953 by Kremer et al. (33). They credited, however, a 1949 personal communication by M.J. McArdle. We now understand the pathogenesis of carpal tunnel syndrome to be related to synovial thickening and increased pressure in the carpal canal. This etiology was emphasized by Phalen in the early 1950s (8, 30, 31),but was also noted by Woltman in 1941 (34). Brain (28) and Denny-Brown (35) emphasized ischemia due to external compression. This is certainly a factor in the etiology of carpal tunnel syndrome in some cases of diabetic polyneuropathy, but is not considered to be the most common cause of the condition.

For many years it was considered that Learmonth(Fig. 10) did the first flexor retinaculum release for a diagnosis of median neuropathy.

FIGURE 10. James R. Learmonth. (photo copyright Mayo Foundation)

It is difficult to know for certain, but a case identified in a review of Mayo Clinic medical records suggest that Herbert Galloway, a Canadian

orthopedic surgeon, and one of the early presidents of the American Orthopedic Association, did explore median nerve at the wrist for a post crush median neuropathy, and released the flexor retinaculum in1924 (36) . To date, no earlier cases have been identified.

Steroid injection is a common treatment for carpal tunnel syndrome. It is hard to know again when steroids were first used but as early as 1954, the Mayo Clinic medical records document the use of steroid injections for the treatment of carpal tunnel syndrome (26).Phalen and Kendrick were the first to publish their experience, in 1957 (37).

1.4 Anatomy of Carpal Tunnel

The roof of the carpal canal is the flexor retinaculum, which spans from the hamate and triquetrum on the ulnar side to the scaphoid and trapezium on the radial side. The median nerve and flexor tendons (flexor pollicis longus, four flexordigitorumsuperficialis, and four flexor digitorumprofundus tendons) pass through this tunnel. Although the carpal tunnel is open at its proximal and distal ends, it maintains distinct tissue fluid pressure levels. The diameter of the carpal tunnel is narrowest at a point approximately 2 cm from its leading edge (Fig. 11), and this corresponds to the site of morphologic changes in the nerve in patients with carpal tunnel syndrome. The median nerve lies just beneath the flexor retinaculum. At the distal end of the flexor retinaculum, the median nerve gives off the recurrent motor branch to innervate the abductor pollicis brevis, the superficial head of the flexor pollicis brevis, and the opponenspollicis muscles and then divides into the digital nerves that provide sensation to the thumb, index, middle, and radial half of the ring finger.

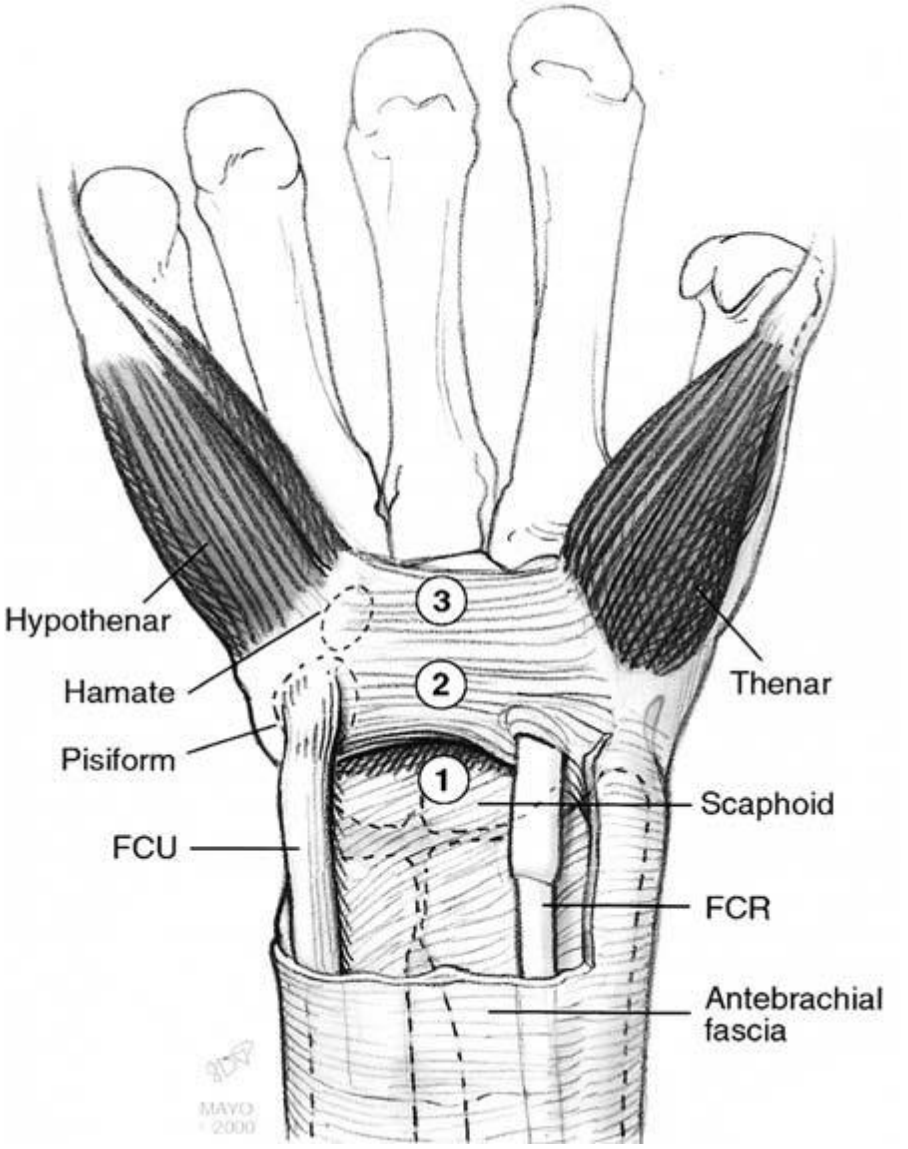


FIGURE 11. The anterior (palmar) anatomy of the carpal tunnel.(1) demonstrates the exposed proximal entrance into the carpal tunnel between the tendons of flexor carpi ulnaris (FCU)and flexor carpi radialis (FCR). The thickest region of the flexorretinaculum is shown as (2), but it continues distally to the level of the carpometacarpal joints as a thinner structure (2)

Knowledge of variations in the branching pattern of the median nerve is important, particularly during surgical decompression (38). Lanz has classified variations of the recurrent motor branch into three subgroups (Fig. 12) (39).In most cases, the motor branch divides from the median nerve distal to the flexor retinaculum in an extraligamentouspattern (46% to 90%). Less common

variations include the subligamentous pattern (31%) and transligamentous pattern (23%). There have been reports of the recurrent motor branch dividing from the medial side of the median

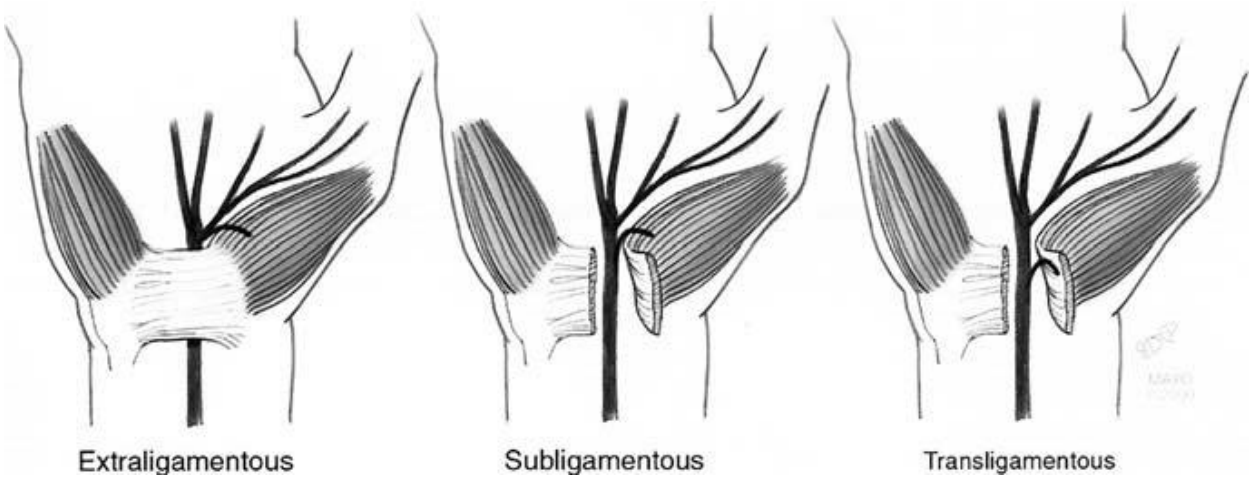


FIGURE 12. Common variations of the path of the recurrent branch of the median nerve in relationship to the flexorretinaculum

The muscles of the nine extrinsic flexor tendons which traverse the carpal tunnel originate from the medial epicondyle of the humerus and the anterior aspect of the radius, ulna, and interosseous membrane. The musculotendinous junctions are found proximal to the proximal edge of the carpal tunnel. The flexor pollicislongus muscle is the most radial structure of the group discussed here; it originates from the radius and the interosseousmembrane and emerges between the superficial and deep heads of the flexor pollicisbrevis muscle where it inserts into the proximal phalanx of the thumb. The flexor digitorumsuperficialis muscle originates from the medial epicondyle of the distal humerus and the coronoid process and proximal diaphysis of the radius, divides into four independent muscle bellies in the mid-forearm, and passes through the carpal tunnel only as deep as the flexor retinaculum into the middle phalanges of the index, long ring, and small fingers. Within the carpal tunnel, the tendons of the flexor digitorumsuperficialismuscle to the long and ring fingers are central and anterior relative to the index and small finger tendons. The flexor digitorumprofundus muscle originates from the proximal two thirds of the ulna and the interosseous membrane. The radial half of the muscle forms the flexor digitorumprofundus to the index finger and the ulnar half of the muscle forms

the profundustendons to the long, ring, and small fingers. All four tendons insert separately into the distal phalanges of the fingers. These four tendons pass through the carpal tunnel at the most dorsal aspect, dorsal to the tendons of the flexor digitorumsuperficialis muscle. The lumbrical muscles originate from the tendons of the flexor digitorumprofundus beyond the level of the carpal tunnel. The tendons are surrounded by mesodermal tissue, which provides vincular blood supply to the tendons as well as extratendinous lubrication and nutrition. It is composed of a continuous layer of mesoderm, forming invaginated loops around the individual tendons. The source of the blood supply to the tendinous vincula is the anterior interosseous artery. Usually there is an ulnar bursa that surrounds the superficial and deep flexors of the fingers and a separate radial bursa that surrounds the flexor pollicislongus (40) .Just above this layer of mesodermal tissue is the fibrouslayer of the anterior wrist joint capsule. This capsule is composed largely of ligaments passing across the anterior surfaces of the radiocarpal, midcarpal, and carpometacarpal joints. The anterior wrist joint capsule is continuous with the periosteum of the carpal bones and the transverse carpal ligament.

1.5 Minimal Invasive Techniques in Carpal Tunnel Syndrome

1.5.1. Endoscopic Carpal Tunnel Release: The Single-Portal Mirza Technique

Indications

The indications for the Mirza carpal tunnel release technique are generally the same as those open carpal tunnel surgery. They include a clinical diagnosis of median nerve compression at the carpal tunnel in patients (41) failing conservative treatment or (42) with thenar weakness or atrophy.

Reported contraindications to date include:

1. Need for extensive neurolysis or tenosynovectomy
2. Mass in the carpal canal
3. Inflammatory arthritis (due to increased risk of aggravating the inflammatory process)
4. Peripheral neuropathy
5. Anatomic abnormalities
6. Vasospastic disorders
7. Prior carpal tunnel release
8. Thenar weakness requiring tendon transfer
9. Pregnancy (due to excessive weight gain and edema)
10. Dupuytren's contracture or other conditions limiting finger or wrist extension
11. Patients on anticoagulant therapy.

Surgical Technique

A. Positioning

The patient is positioned supine with the wrist in neutralposition. Two initial lines of incisions are drawn: one longitudinalin line with the third web space and the other transversely across the radially abducted thumb. A 1.5 cmincision is marked from the intersection of these two lines proximally. An additional marker for the incision is the ulna border of the flexed ring finger which should lie within the1.5 cm incision. Two additional longitudinal lines are drawn in the distal forearm: one radial to the flexor carpi ulnaristendon and the other along the palmarislongus

tendon. The midpoint between these lines is marked with an "x" to aim the cannula between the median and ulnar neurovascular bundles (Fig. 13).

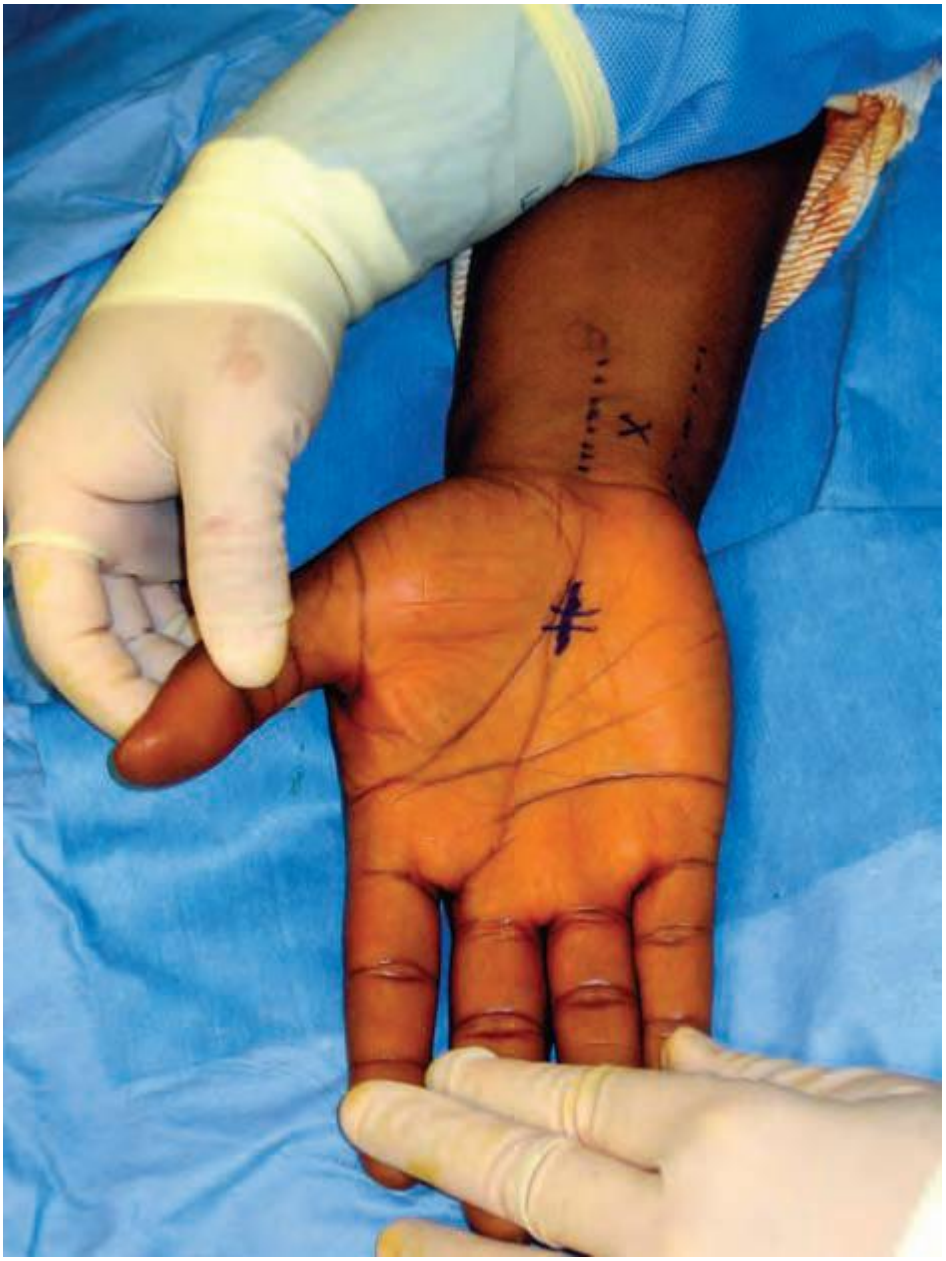


FIGURE 13. The 1.5 cm incision is marked and two additional longitudinal lines are drawn in the distal forearm. The midpoint between these lines is marked with an "x" to aim the cannula between the median and ulnar neurovascular bundles.

B. Technique

The skin is incised and the edges are undermined. A Ragnell retractor is placed on either side of the incision and the skin edges are retracted, pulling the palmar fascia away from the underlying neurovascular bundle. The palmar fascia is divided longitudinally to expose the midpalmar fat. The median nerve, superficial palmar arch, and TCL are then identified (Fig. 14).The retractors are repositioned to include the palmar fascia. A path is then created by blunt dissection (with a blunt hemostat) between the TCL and the contents of the carpal canal, aiming ulnarly towards the "x" in the distal forearm.

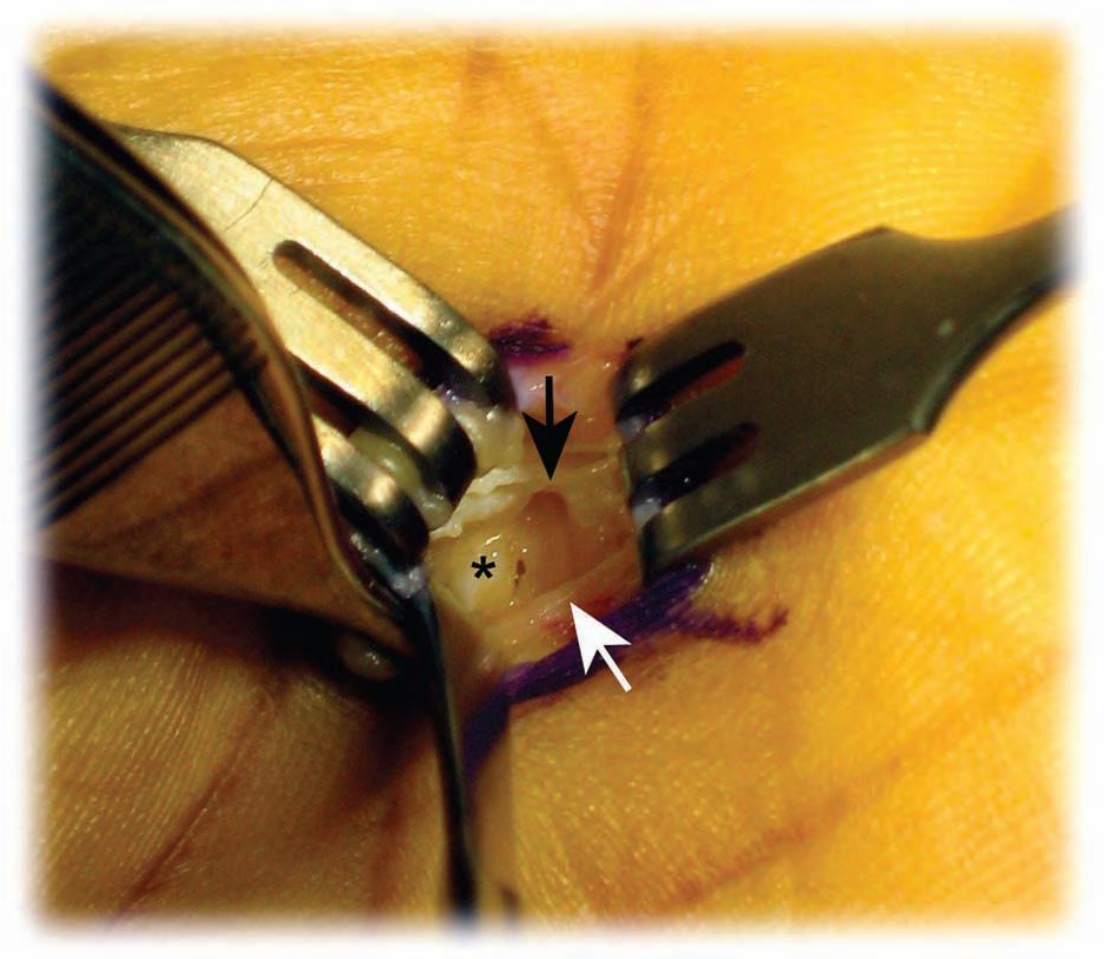


FIGURE 14. Following skin incision, the skin edges are retracted, pulling the palmar fascia away from the underlying neurovascular bundle. The median nerve (asterisk), superficial palmararch (white arrow) and transverse carpal ligament (black arrow) are then identified.

The forearm is then elevated and the wrist extended over a bolster to introduce the dissector (A.M. Surgical, Smithtown, New York). The dissector is aimed between the two lines marked on

the forearm. Once the pathway is created with the dissector, a dissectingobturator is introduced (Fig. 15). The tip of the obturator should rest against the undersurface of the TCL at all times.

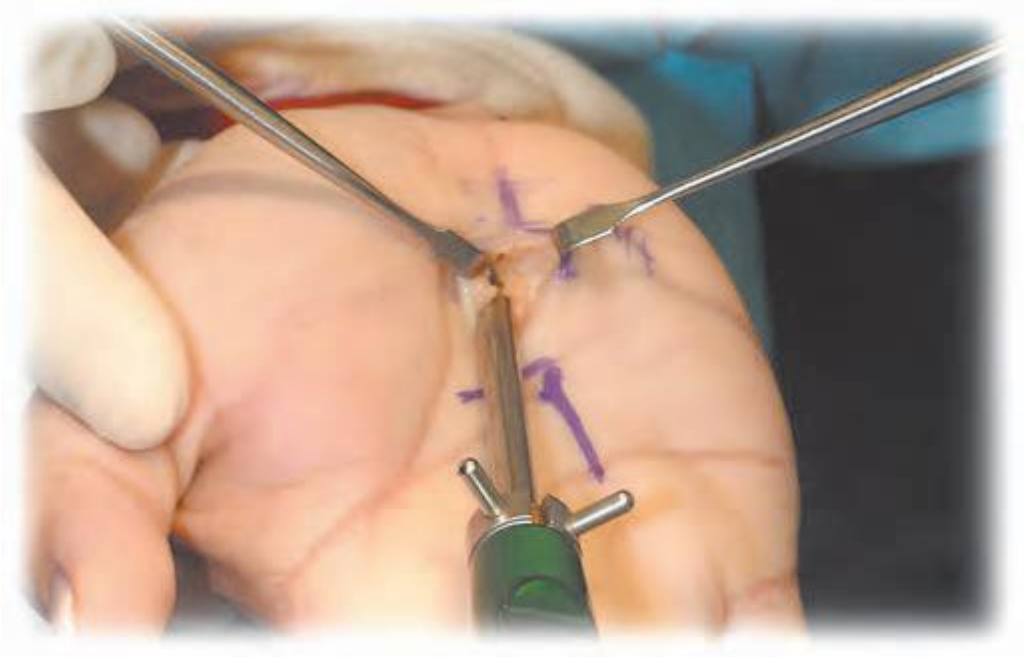


FIGURE 15. The dissector is aimed between the two lines marked on the forearm. Once the pathway is created with the dissector, a dissectingobturator is introduced.

Once the cannula tip is palpable through the skin beneath the "x", the obturator is removed and the cannula is left in place with the slot facing slightly ulnar. A standard 4 mm 308endoscope is introduced through the slotted cannula and oriented toward the slot (Fig. 16 A,B). The TCL is visualized through the endoscope and any remaining tenosynovium is removed with the dissecting obturator (Fig. 17). The median nerve is visualized by rotating the cannula radially (Fig. 18).

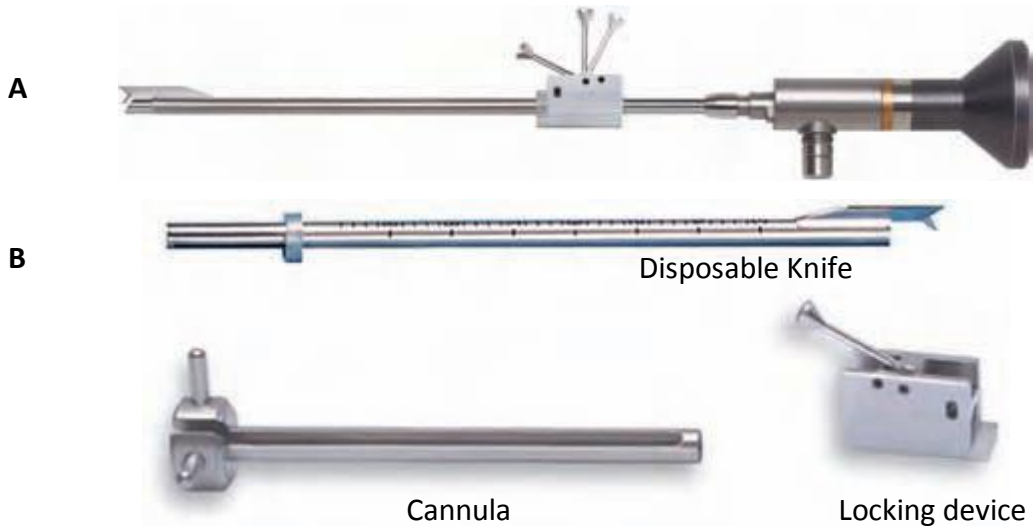


FIGURE 16 (A) A standard 4 mm 308 endoscope is introduced through the cannula. **(B)** The disposable knife, cannula, and locking device unassembled.

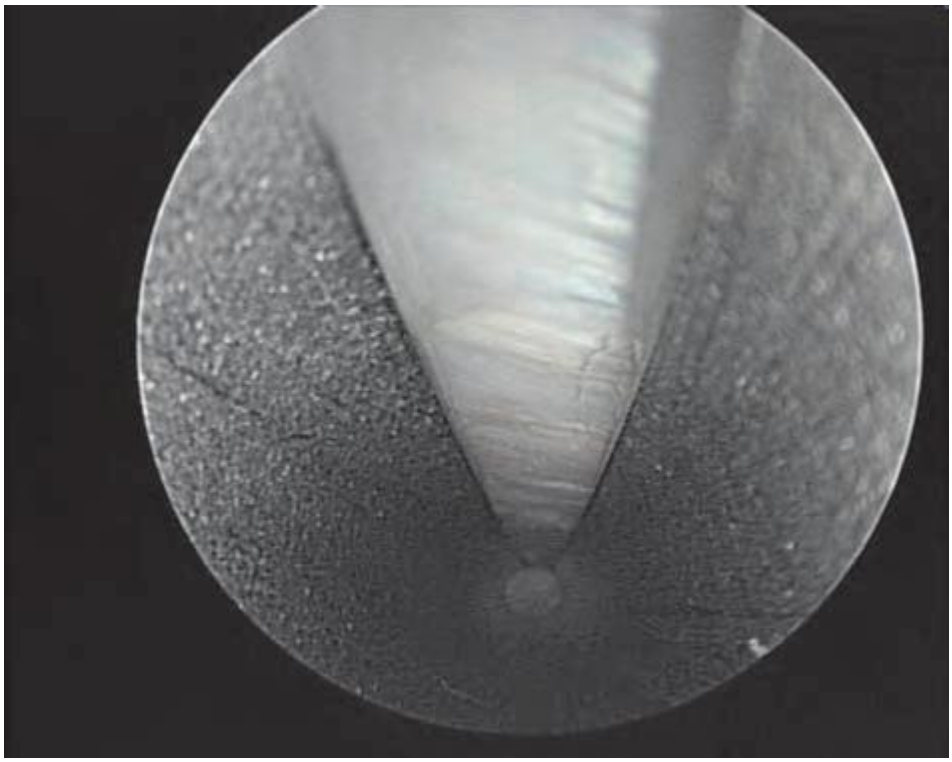


FIGURE 17. The transverse carpal ligament is visualized through the endoscope

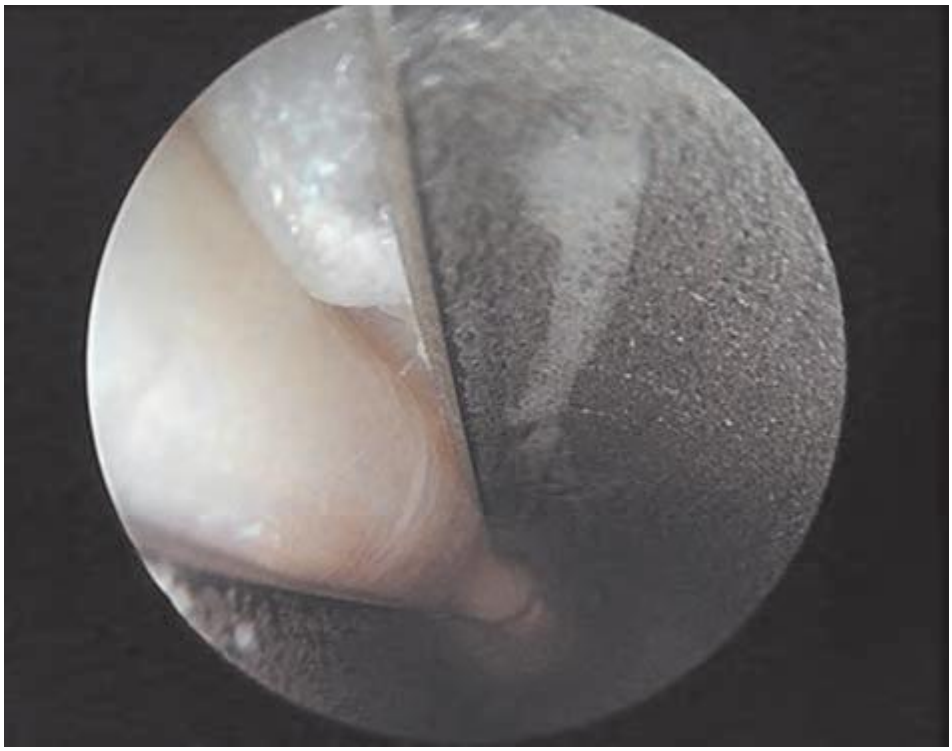


FIGURE 18. The median nerve is visualized by rotating the cannula radially.

Once proper cannula placement is verified, the cannula is once again rotated ulnarly to visualize the TCL and the flexor tendons (Fig. 19). Once a clear view of the TCL is obtained, the endoscope is removed and a mounting blade is attached to the end of the scope with a locking device (Fig.20). The TCL is divided by advancing the blade under direct endoscopic visualization through the cannula from distal to proximal(Fig. 21 A,B). The TCL division is complete when the blade is palpable through the skin in the distal forearm, proximal to the wrist flexion crease. The blade can then be removed and the endoscope reinserted to visualize the divided edges of the TCL(Fig. 22). The median nerve and flexor tendons can also be visualized by rotating the cannula radially and ulnarly, respectively. Finally, the endoscope is removed and the obturator-inserted. The entire assembly is then brought out together.

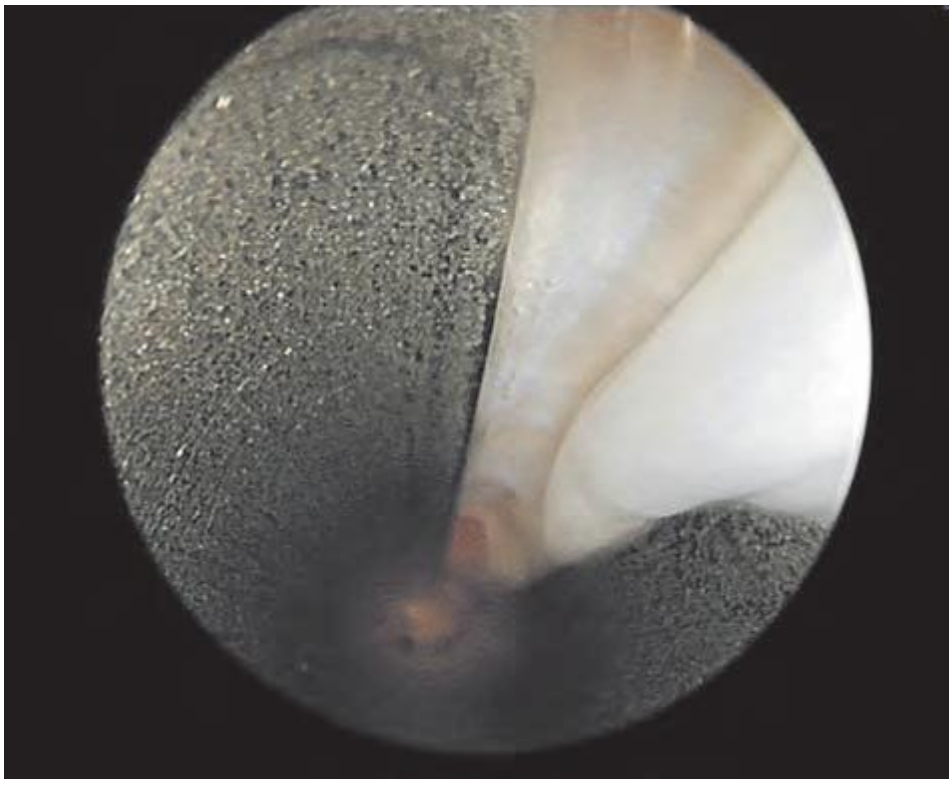


FIGURE 19. The cannula can be rotated ulnarly to visualize the transverse carpal ligament and the flexor tendons.

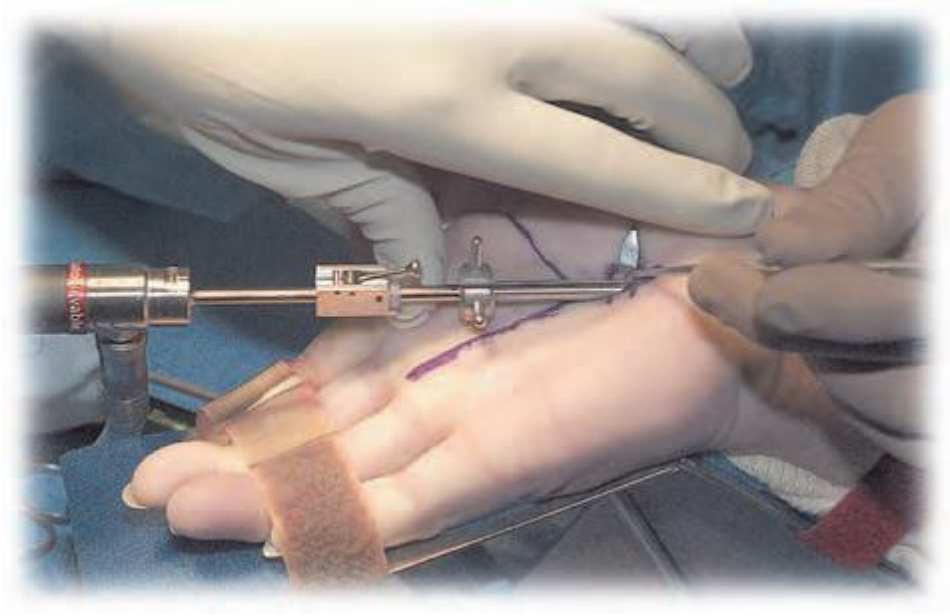
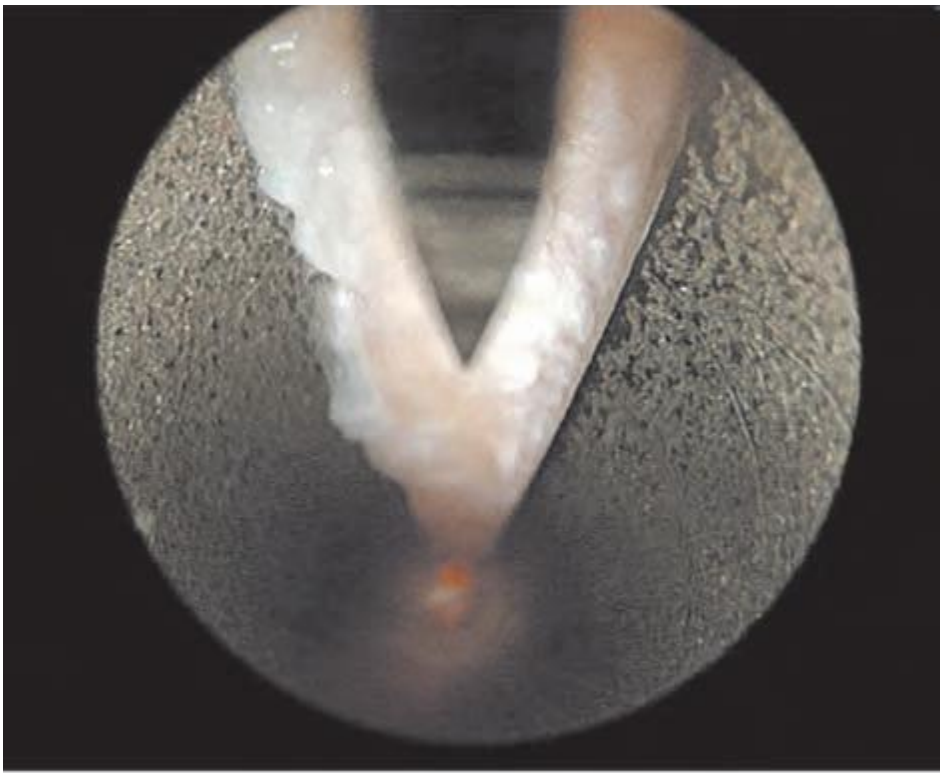


FIGURE 20. The mounting blade is attached to the end of the scope with a locking device.

A



B

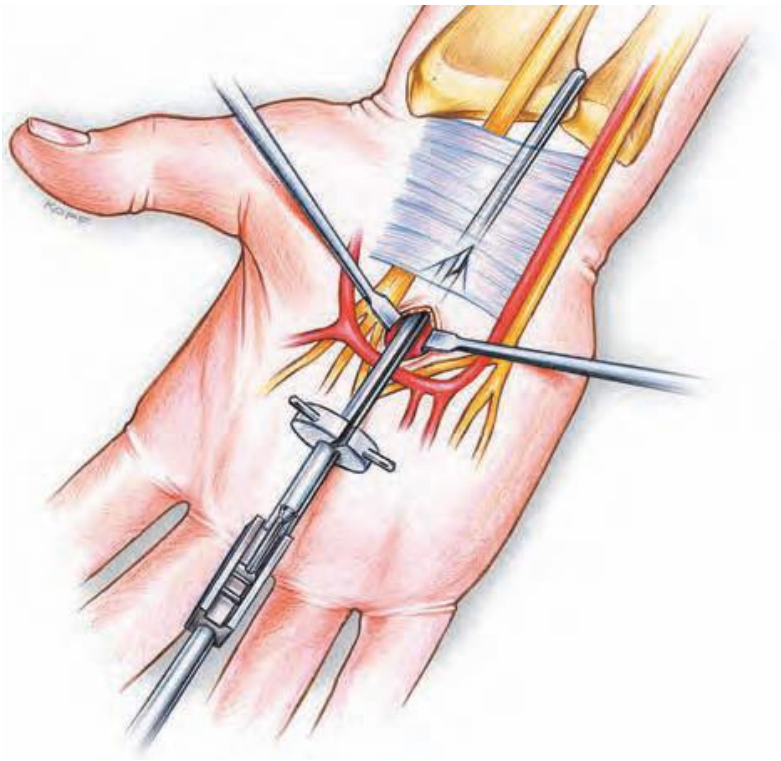


FIGURE 21 (A,B) The transverse carpal ligament L is divided by advancing the blade under direct endoscopic visualization through the cannula from distal to proximal.

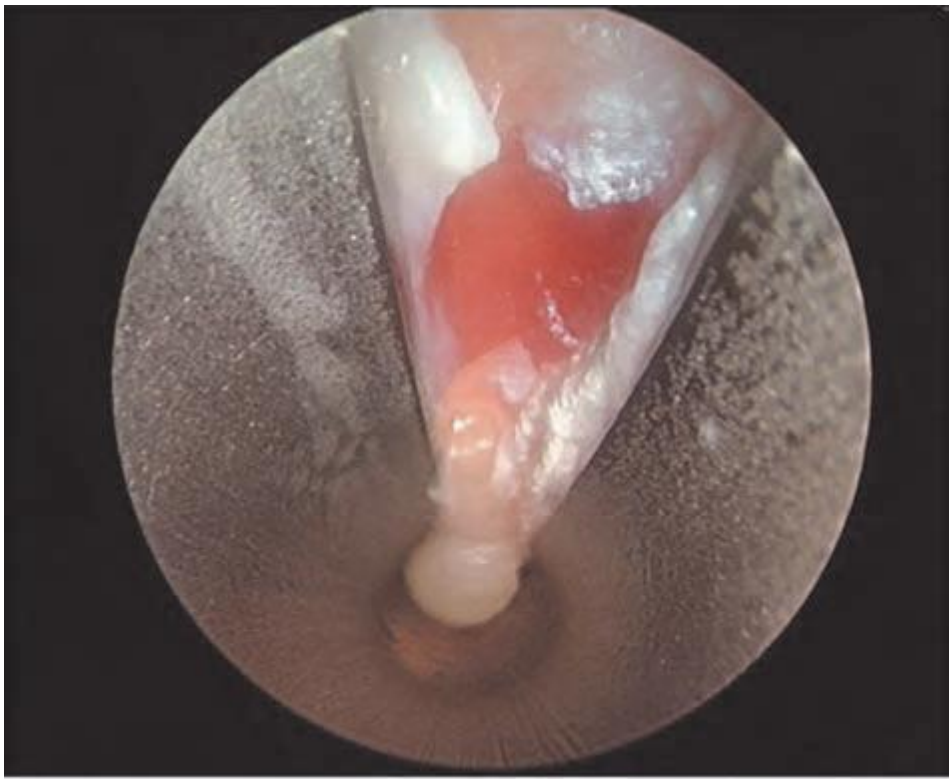


FIGURE 22. The blade is removed and the endoscope reinserted to visualize the divided edges of the transverse carpal ligament.

C. Closure

Following irrigation and hemostasis, the skin is closed with interrupted sutures. A soft compressive dressing is then applied.

Complications

Reported complication rates using the endoscopic technique range from 0.2% to 5% (43). Many of the more dramatic complications, however, occurred during the early development stages of the technique and have been addressed by changes in the design of the instrumentation. The original Agee technique resulted in several cases of nerve transection (44). Since then, the blade assembly has been redesigned and a large multicenter trial using the new device found a complication rate of 1.8% (45). Due to incomplete visualization of the TCL, Chow modified his original transbursal

technique to an extrabursal insertion point. Nagle compared the two methods and found that the complication rate of 11% using the original technique dropped to 2.2% once the new insertion point was utilized (46).Injury to anatomic structures at the distal aspect of the TCL lead Mirza to develop a uniportal technique allowing direct visualization of the superficial palmar arch, median nerve, and flexor tendons. During his early experience, Mirza reported two cases of transient ulnar nerve neuropraxia. In addition, one patient sustained a partial transaction of the median nerve repaired at the time of surgery and the other patient had an incomplete release of the TCL requiring reoperation. After redesigning the instrumentation, a more recent report of 475 patients revealed one case of reflex sympathetic dystrophy, one transient neuropraxia, and one blade failure (47).

There are varying reports in the literature regarding conversion of endoscopic carpal tunnel release to open procedures. Saw et al. reported a 12% conversion rate secondary to fogging of the lens during the procedure and incomplete visualization of the TCL (44). Other authors have reported a conversion rate of 2% (Mirza).

To date, the following complications have been reported with endoscopic carpal tunnel release:

1. Injury to the median nerve: Dheansa and Belcher 4reportedtwo cases of median nerve injury using the original Agee technique in patients under general anesthesia (48).
2. Injury to the ulnar nerve: cases of ulnar nerve transactionhave been reported using the Chow two-portal technique. This type of injury is thought to be the result of entry into Guyon's canal instead of the carpal canal, or of looping under the neurovascular bundle (49,50).More common perhaps are cases of transient ulna nerve neuropraxia.
3. Injury to digital nerves: these range from transient digital nerve neuropraxia to complete nerve transaction (51).
4. Injury to superficial palmar arch (52).
5. Injury to the flexor tendons: this was originally described in a patient with arthritic contractures who was unable to fully extend the wrist and metacarpophalangeal joints. The flexor digitorumsuperficialis to the ring finger was found to be tethered around the arthroscopic sheath (53).
6. Incomplete transection of the TCL leading to recurrence of symptoms and reoperation (43).

1.5.2. Endoscopic Carpal Tunnel Release: Chow Technique

Indications

Whenever a surgeon deals with a pathologic situation that has to be managed surgically, specific criteria must be kept in mind in order to designate the most appropriate surgical technique. These criteria include indications–contraindications, exposure and visualization of the related anatomical structures, reproducibility, a reasonable learning curve, and an acceptable complication rate. Endoscopic carpal tunnel release does have the potential to become a dangerous procedure if performed by inexperienced surgeons (54-59). Considerable intraoperative complications have been reported throughout the United States by surgeons who have used this technique (60-63). This situation has raised a controversy among surgeons regarding the value of endoscopy for carpal tunnel surgery. However, it has also been shown that endoscopic carpal ligament release can be performed safely by experienced surgeons, although its learning curve is steep sometimes, and can give both the patient and the surgeon a great deal of satisfaction (64). The safety of this procedure seems to have improved not only due to the surgical experience that has been gained but also due to the instrumentation that has been developed and the better knowledge of the endoscopic anatomy. The indications for the open surgical release of transverse carpal tunnel ligament have been well established and, in most cases, they apply to endoscopic carpal tunnel release. In most cases, previous conservative management by means of wrist splinting, alteration of daily activities, physical therapy, and no steroidal anti-inflammatory oral medication have failed. A previous performed open surgical release of the carpal ligament was not considered to be a contraindication for the endoscopic procedure. Contraindications to the endoscopic procedure include space-occupying lesions, limited wrist extension, congenital wrist anomalies, and any factor that affects the anatomy of the region. Rheumatoid patients with abundant tenosynovium should be managed with caution as well as patients who had previously sustained a fracture of the hook of hamate. These and other conditions that require direct visualization of the carpal canal are relative contraindications(65,66). Obesity, diabetes, and a previous performed open carpal tunnel release are not considered to be contraindications for the endoscopic release of the carpal ligament.

During the endoscopic procedure, if any pathology or anatomic variation is detected which either limits the view or obstructs the access into the carpal canal, the surgeon should convert to an open procedure. The patient should be well informed before surgery of a possible conversion because of the aforementioned reasons.

The advantages of endoscopic over open carpal tunnel release include no hypertrophic scar or scar tenderness, no pillar pain, less compromise to the pinch or grip strength, and an earlier return-to-work and daily activities. However, the surgeon can be in front of unexpected difficulties, e.g., ganglion, neurofibroma, and neurilemmoma, that limit visualization into the carpal canal. As in any surgical procedure, safety and success are dependent upon a thorough knowledge of the anatomy of the area, adequate training, and familiarity with the use and capabilities of the instrumentation. Surgeons who are not familiarized with endoscopes and arthroscopic techniques may give rise to major iatrogenic complications.

Surgical Technique

Initially, the original technique was described by Chow as transbursal approach to the carpal tunnel requiring penetration of the ulnar bursa (67). Due to the results of a multicenter study (68,69), the original technique has been modified in an attempt to decrease the complications and the learning curve. The conversion to an extrabursal technique has made the surgical procedure much easier and safer offering a better visualization of the proximal transverse carpal ligament(70–72). The following is a description of the extrabursal, dual-portal technique.

Operating Room Setup

The patient is placed in a supine position and a hand table is used. Two video monitors are preferred, although some surgeons can manage the procedure with only one. One of the two monitors should face the surgeon and the other should face the assistant. The surgeon sits on the ulnar side of the patient and the assistant faces the surgeon (Fig. 22A). The arthroscopic equipment consists of a short 4.0 mm X 308 video-endoscope that prevents light guide from interfering with the patient's forearm by having the light post on the same side as the direction of view, a camera apparatus, a light cord, a camera input device, and a light source device (Fig. 22B). Optional equipment includes a DVD video recorder and a video printer for the printing of

any captured images. Water pump and shaver equipment is not used. A standard handset should be available. Specific instrumentation for the procedure, designed by Dr. Chow, comprises an ECTRAe System Kit and an ECTRAe Disposable Kit (Smith& Nephew Endoscopy, Andover, Massachusetts, U.S.A.).

A

FIGURE 22. (A) Operating room setup for the endoscopic carpal tunnel release using the Chow dual-portal technique. (B) Arthroscopic equipment that is appropriate for the performance of this technique.

The ECTRA System Kit includes the video-endoscope, slotted cannula, dissecting obturator, curved blunt dissector, palmararch suppressor, probe, retractors, and hand holder (Fig. 2). The dissecting obturator is attached with a detachable handle that can also take some other types of obturator included in the kit(conical, boat-nose obturator), the latter are not being used routinely. The ECTRA Disposable Kit includes a probe knife, a triangle knife, a retrograde knife, a hand pad, and swabs (Fig. 3).These knives allow the surgeon to determine both the direction and depth of cut. Standard preparations and draping are performed as usual without the application of a tourniquet. Before the introduction of local anesthesia, a skin marker is used
to map landmarks for the entry and exit portals.

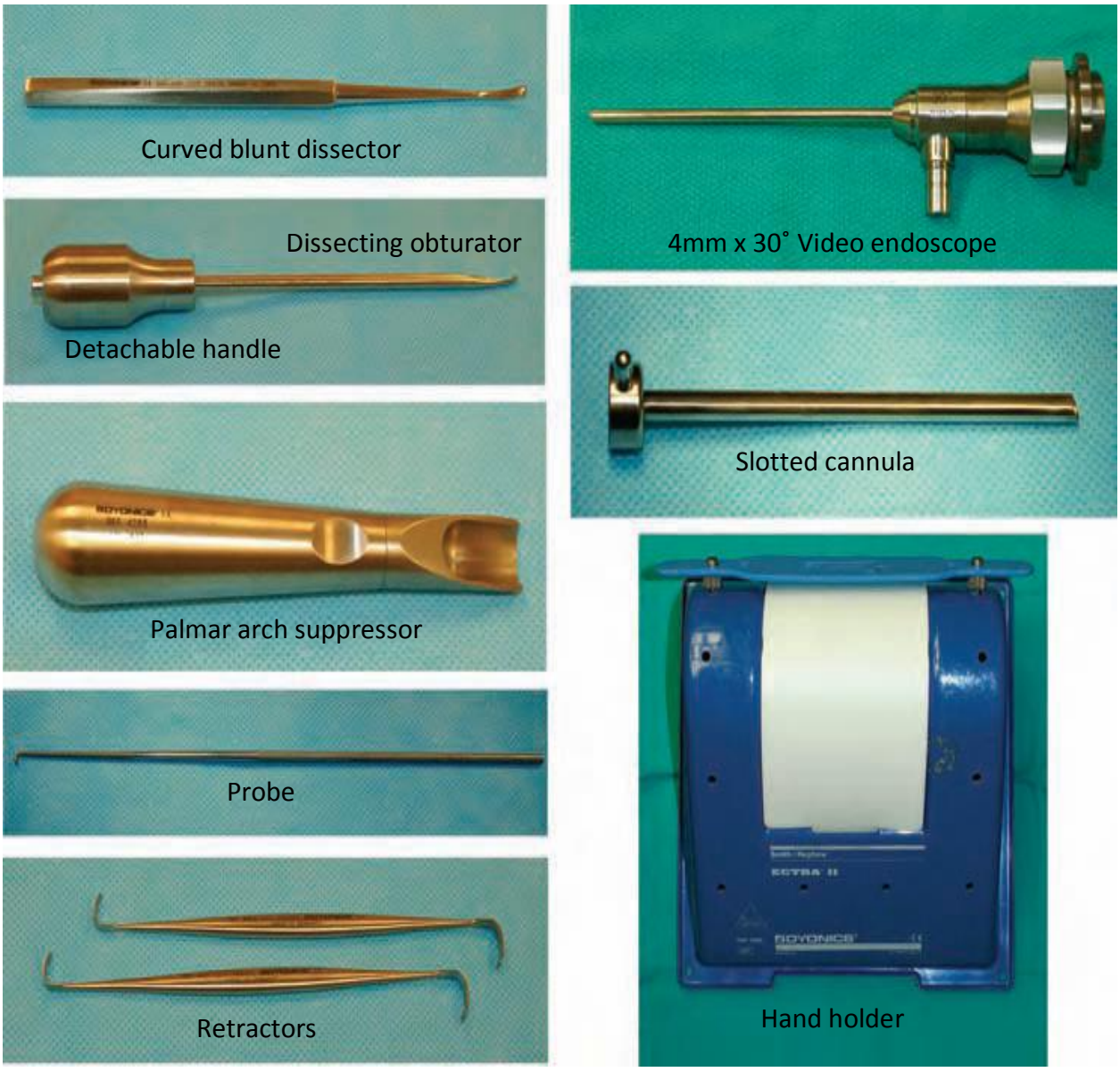


FIGURE 23. Instrumentation included in the ECTRAe System Kit (Smith & Nephew Endoscopy, Andover, Massachusetts, U.S.A.).

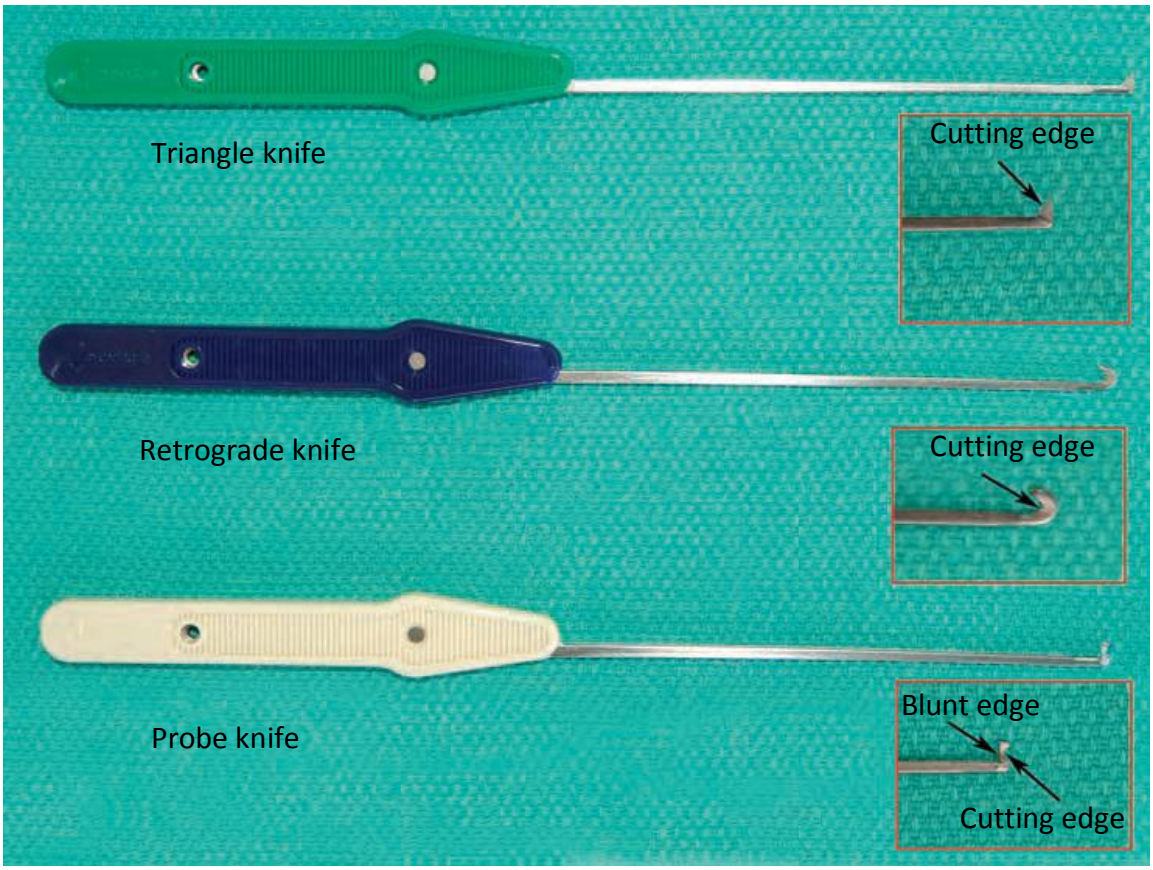


FIGURE 23.Specially designed knives for the release of the transverse carpal ligament. The tip of each knife is shown in detail (red square) on the right side. This instrumentation is included in the ECTRAe Disposable Kit(Smith & Nephew Endoscopy, Andover, Massachusetts, U.S.A.).

Anesthesia

Local anesthesia combined with intravenous medication is recommended for the procedure because it allows the patient and the surgeon to communicate. An alert patient can inform the surgeon, during the procedure, about any abnormal sensation in the hand indicating a potential problem caused from any variance of nerve structure in the wrist and palm region (73–79). Usually, when the patient first comes into the operating room, fentanylcitrate (Sublimaze; Baxter Healthcare Corporation, Westlake Village, California, U.S.A.) 100 mg is given intravenously. This isa narcotic analgesic type of medication with an onset of seven to eight minutes and a peak action of approximately 30 minutes. Normally, the surgical time does not exceed 10 minutes. Xylocaine1% (Astra, Westboro, Massachusetts, U.S.A.) without epinephrine

is injected at the entry and exit portals, approximately 1 to 2 cc at the entry portal and 5 to 6 cc at the exit portal due to the higher degree of sensitivity of the skin on the palmar region. Special

care is taken to place the injection only in the skin and to avoid affecting the nerve by penetrating deeply.

Positioning the Entry Portal

The proximal end of the pisiform bone is palpated on the volarsurface of the wrist within the flexor carpi ulnaris tendon at the distal wrist flexor crease and is marked with a small circle. A line from the proximal pole of the pisiform is drawn radially, approximately 1.0 to 1.5 cm in length. From this point, a second 0.5-cm line is drawn proximally. A third dotted line, approximately 1.0 cm in length, is drawn radially from the proximal end of the second line to create the entry portal(Fig. 24). If the palmarislongus muscle is present, the center of the entry portal should be located at the ulnar border of its tendon almost at the level of the proximal wrist flexor crease. Average dimensions of these lines will vary slightly, depending on the overall size of the hand.

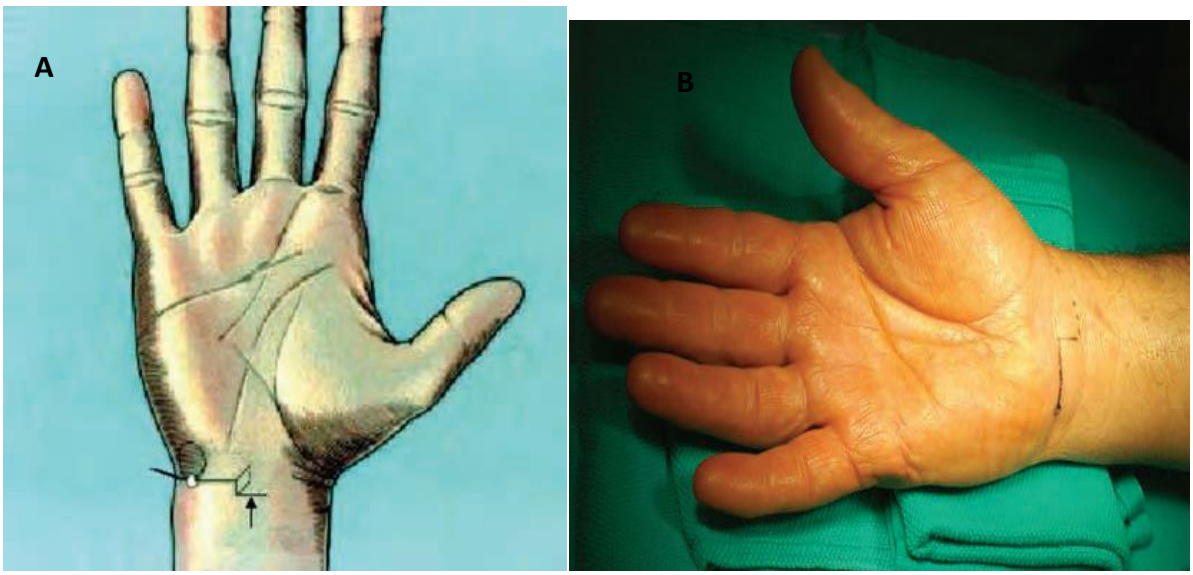


FIGURE 24 (A, B) The entry portal is located by drawing a line 1 to 1.5 cm radially from the proximal pole of the pisiform bone, then drawing an approximately 0.5-cm second line proximally from the end of the first one, and finally, an approximately 1-cm third line is drawn radially from the proximal end of the second line to create the entry portal.

Positioning the Exit Portal

The patient's thumb is placed in full abduction. A line is drawn across the palm from the distal border of the thumb to the approximate center of the palm, perpendicular to the long axis of the forearm. A second line is drawn from the third web space, parallel to the long axis of the forearm, to meet the first line. These two lines should form a right angle. A third line is drawn, bisecting this angle and extending approximately 1.0 cm proximally from its vertex, which serves to establish the site of incision for the exit portal (Fig. 25). The surgeon should be able to palpate the hook of hamate. The exit portal should fall into the soft spot at the center of the palm and should line up with the ring finger, just slightly radial to the hook of hamate.

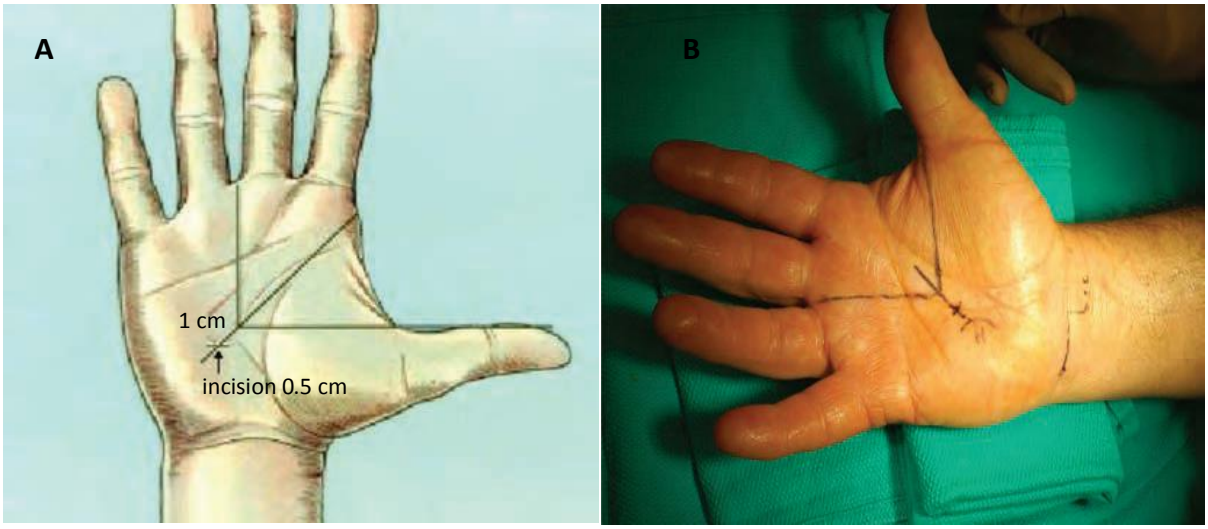


FIGURE 25 (A, B). The exit portal is located by drawing a line from the distal border of the fully abducted thumb perpendicular to the long axis of the forearm. A second line is drawn from the third web space parallel to the long axis of the forearm. These two lines form a right angle. A third line is drawn, bisecting this angle and extending approximately 1.0 cm from its vertex to determine the exit portal.

Creation of Portals and Placement of the Cannula

The procedure begins with the creation of the entry portal. An approximately 1.0 cm transverse incision (Fig. 6A) is made at the marked entry portal site extending just through the skin. Subcutaneous tissue is bluntly dissected off the volar forearm fascia with the use of a hemostat and is retracted with the retractors. Care must be taken to avoid damage to the small subcutaneous blood vessels. A knife is used to make a small longitudinal opening of the ante

brachial fascia that is extended distally with the use of a Stephen's tenotomy scissors(Fig. 6B,C). If the palmarislongus muscle is present, the longitudinal cut should be along the ulnar border of palmarislongus tendon. Care should be taken, as sometimes there are two layers of fascia that both must be cut. Retractors are passed just beneath the fascia with one of them lifting the skin distally to create a vacuum that will separate the transverse carpal ligament from the ulnar bursa. A blunt curved dissector is gently slipped into the carpal tunnel just under the transverse carpal ligament. Maneuvering the dissector back and forth should result in a type of "washboard" feeling due to the rough undersurface of the carpal ligament. The curved dissector is then removed. A dissecting obturator/slotted cannula assembly unit can now be guided into the space vacated by the curved dissector. The slotted cannula assembly is advanced into the carpal tunnel on the underside of the transverse carpal ligament to the level of the hook of hamate, staying to the ulnar side of the carpal tunnel (Fig. 6D). With the tip of this unit touching the hook of the hamate, the surgeon gently picks up and hyper extends the hand. The hand and cannula assembly are now moved as a unit (Fig. 6E) and placed on the hand holder with the wrist and fingers in full hyperextension. The cannula assembly is advanced along the undersurface of the carpal ligament, while the assistant keeps the hand onto the hand holder, until the tip of the cannula assembly can be easily palpated in the palm area where the mark for the exit portal was previously made. A small transverse or oblique incision is made just over the palpable cannula assembly tip cutting only the skin (Fig. 6F). The palmar skin and soft tissue is depressed using the palmar arch suppressor and the cannula assembly is then pushed into the receptacle of the palmar arch suppressor to exit through the distal portal (Fig. 6G). The obturator is then removed from the cannula which should lie just below the transverse carpal ligament and the hyperextended hand is strapped onto the hand holder (Fig. 6H).Hyperextension of the wrist brings the superficial palmar arch to a level lower than the exiting point of the slotted cannula assembly, thereby protecting it from injury. The creation of two portals is very essential, as they serve to stabilize the slotted cannula while it passes through both of them and thus, ensuring the reproducibility of the technique. The slotted portion of cannula allows a safe cutting zone, while delicate structures such as the median nerve and flexor tendons are being protected by the walls of the cannula.

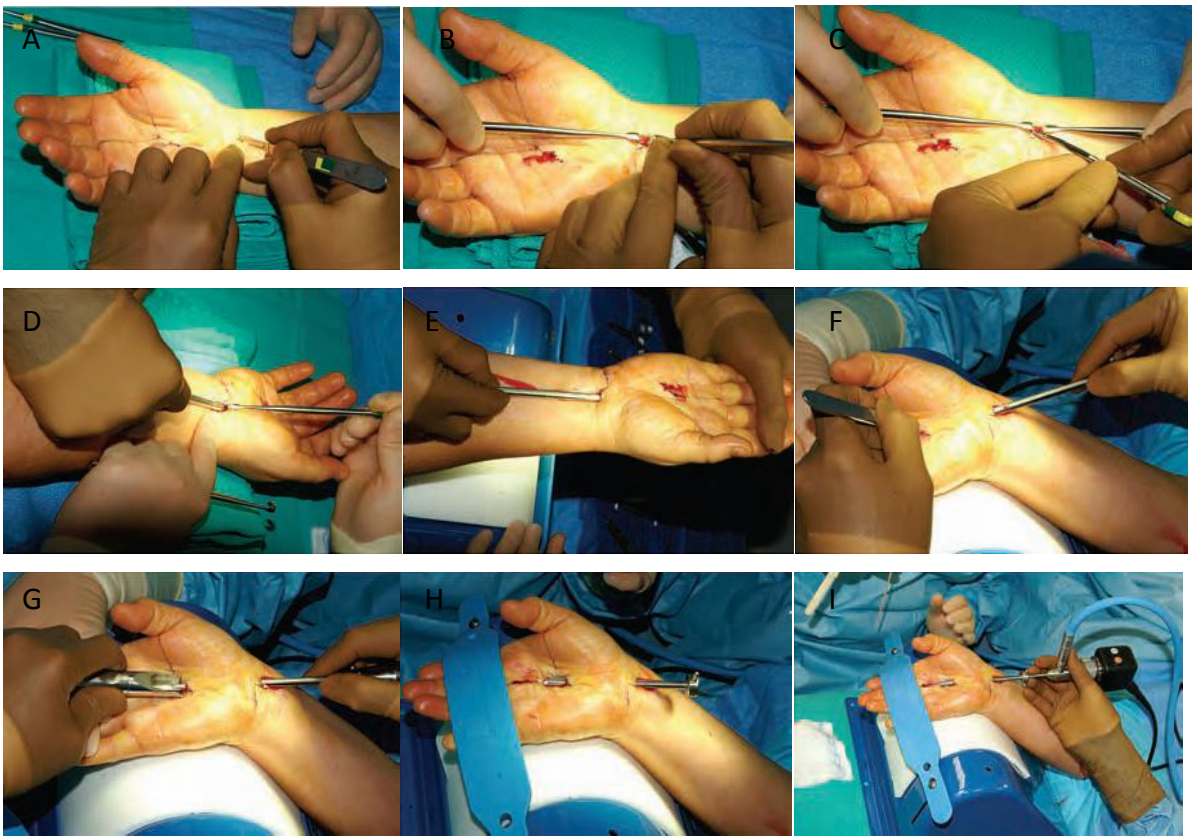


FIGURE 26.Step-by-step procedure for the creation of portals and placement of the slotted cannula. (A) Skin incision. (B, C) A small longitudinal opening of the ante brachial fascia is created and is extended distally using a tenotomy scissors. (D) Insertion of the dissecting obturator/slotted cannula assembly into the carpal canal.(E) Placement of the hand onto the hand holder. (F, G) Skin incision and use of the arch suppressor in order for the cannula assembly to exit through the distal portal. (H) The dissecting obturator has been removed leaving the slotted cannula into the carpal canal. (I) The scope is inserted into the carpal canal through the proximal portal.

Endoscopic Examination

The video-endoscope is inserted into the slotted cannula at the proximal portal. The camera and scope should rest comfortably in the first web space of the surgeon's hand. A cotton swab can be inserted into the tube from the distal portal to clean the lens while focus is adjusted to the best visualization. A blunt probe is inserted to palpate the undersurface of the transverse carpal ligament proximally to distally and in case a thin bursa membrane is seen above the cannula's slotted opening, this is carefully dissected with the probe to gain access to the ligament which has an "ivory type" white appearance with its fibers running transversely (Fig. 7). If the median nerve is present, the patient will feel sharp pain radiating to the fingers when the nerve is probed

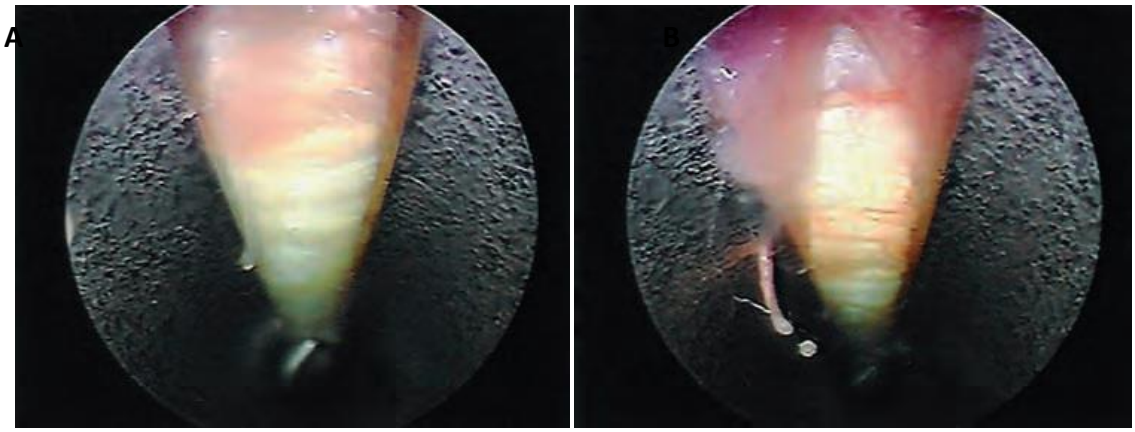


FIGURE 27 (A) Endoscopic normal appearance of the transverse carpal ligament with its fibers running transversely. (B) The thicker bursal membrane that sheaths the undersurface of the proximal portion of carpal ligament has been probed proximally depicting the fibers of ligament.

and this should alert the surgeon. If abundant soft tissue is noted in the opening of the cannula, the procedure should not be performed. The slotted cannula may need to be reinserted to ensure a better visualization; however, to avoid irreversible damage, surgery should not be carried out if tendons or other important structures are entrapped between the slotted cannula and the undersurface of the carpal ligament. If there is only a minimal amount of synovium obstructing the view, the obturator is replaced into the slotted cannula. The slotted cannula assembly unit can then be rotated radially about 355^0 to 360^0 to provide the visualization and protection required. It has to be emphasized that surgeons should not hesitate to convert an endoscopic procedure to an open one, if they are not able to obtain adequate visualization.

Technique for the Release of the Transverse Carpal Ligament

With the scope in the proximal portal and the probe in the distal portal, the distal border of the transverse carpal ligament is identified. The probe knife, which permits forward cutting only, is inserted into the distal portal. The blunt edge of the knife can be used to probe proximally to distally along the ligament. The cutting edge is then used to release the distal border of the ligament by drawing the knife distally to proximally (Fig. 28A).Anything beyond the distal border of the carpal ligament should not be excised. The scope is withdrawn proximally about 1 cm and the triangle knife is used to make a small upward cut in the midsection of the ligament (Fig. 28B).

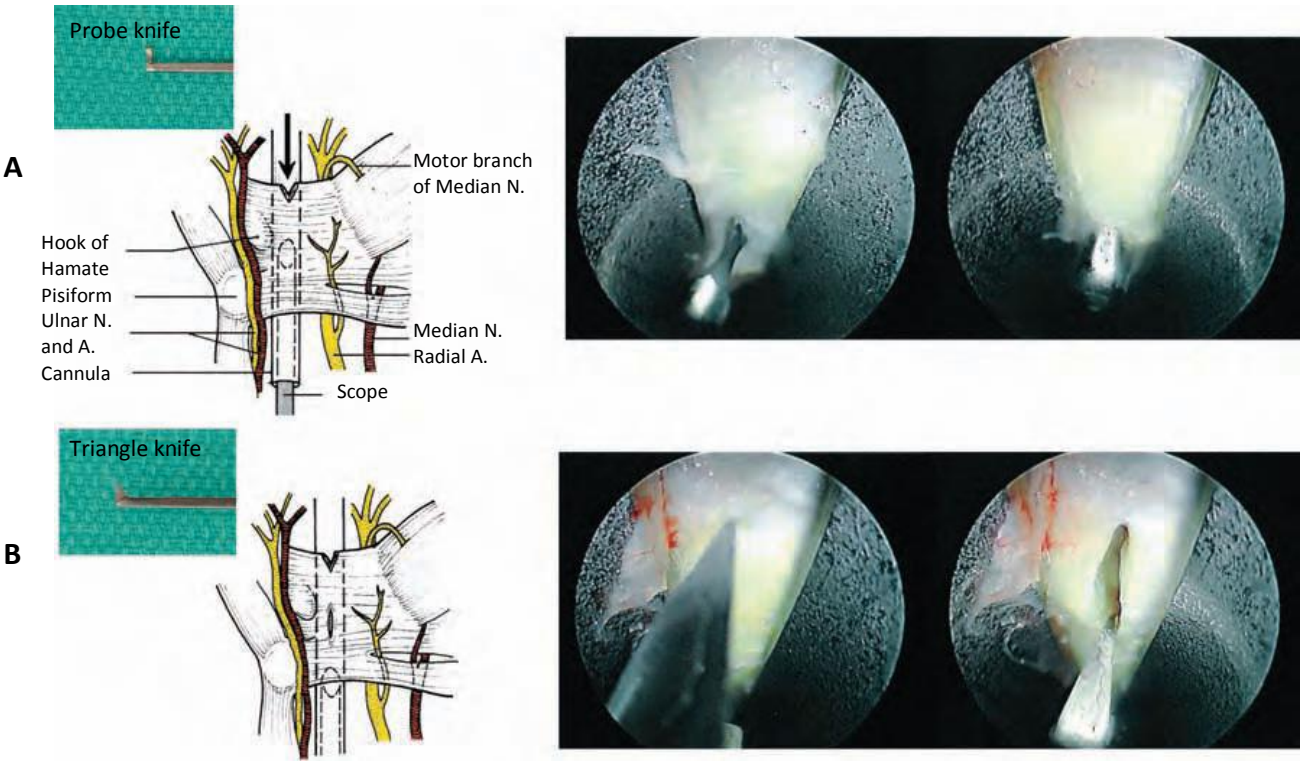


FIGURE 28 (A) After identifying the distal border of transverse carpal ligament, the probe knife is used to make the first cut distally to proximally. (B) The scope is withdrawn proximally about 1 cm and the triangle knife is used to make a small cut in the midsection of transverse carpal ligament.

The retrograde knife is now inserted through the distal portal and its blunt tip is gently positioned at the incision made by the triangle knife (Fig. 29B1,B2). The proximal cutting edge of the retrograde knife is drawn distally, making an incision that joins the previous two cuts, thereby completing the release of the distal portion of transverse carpal ligament (Fig. 29B3,B4).

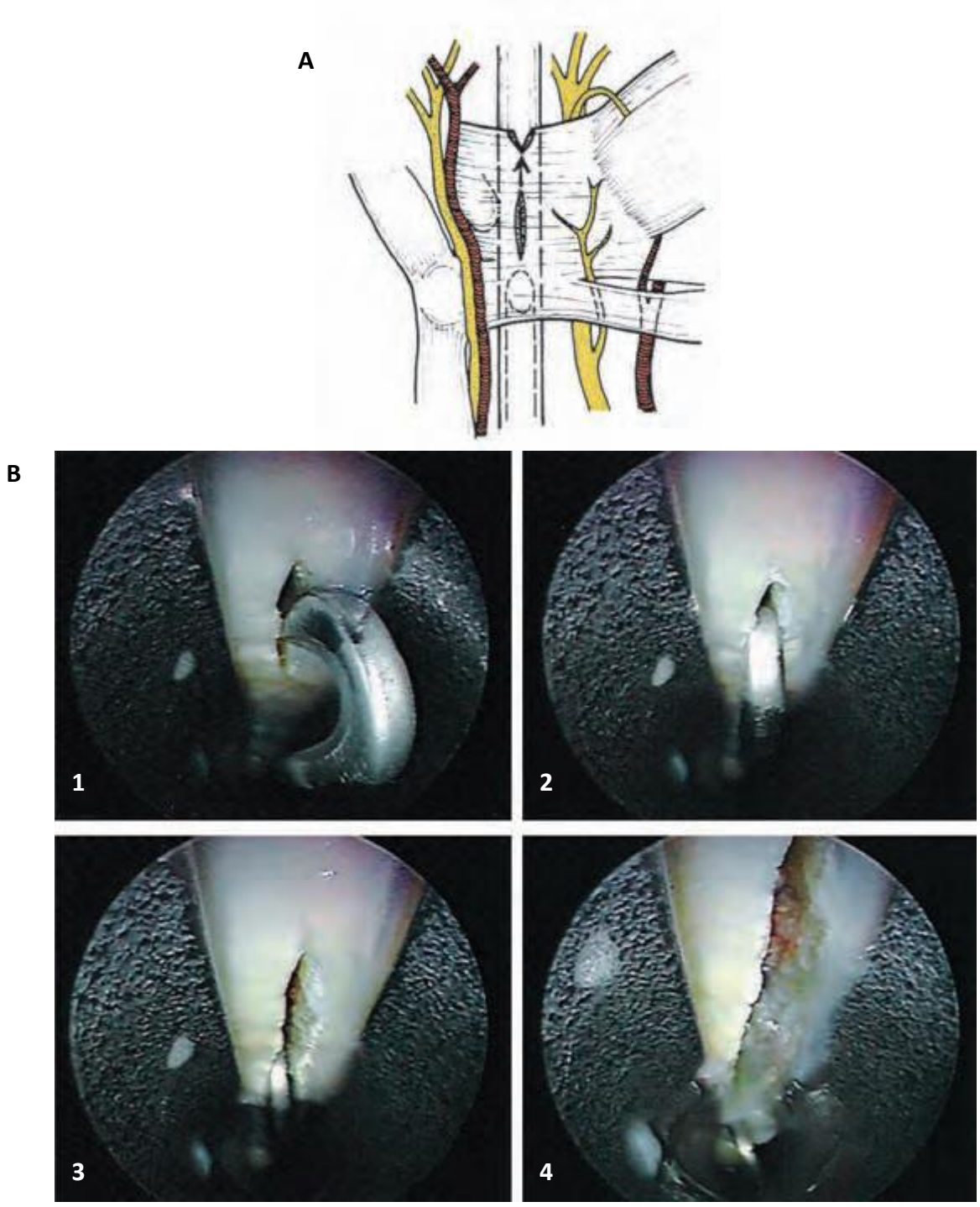


FIGURE 29 (A, B) The retrograde knife is placed in the incision made by the triangle knife (B1, B2) and it is drawn distally to make an incision that joins the previous two cuts (B3, B4).

The scope is removed from the proximal and inserted into the distal opening of the slotted cannula. The camera view on the screen now forms a mirror effect. The surgeon should realize

that the previous ulnar side is now the radial side. By moving the scope proximally and distally, the previous distal cut is identified. The probe knife is inserted into the proximal portal and is drawn toward the level of the previous distal cut with its blunt tip touching the underside of the transverse carpal ligament, just before the beginning of the distal cut(Fig. 30B1). From this point, the blunt edge of the knife is used to retract the thick bursal membrane, which sheaths the proximal portion of the carpal ligament, distally to proximally along the ligament's undersurface (Fig. 30B2). When the cutting edge of the knife has engaged to the proximal border of the ligament, the knife is advanced distally to make an incision that joins the previous cut and thus to accomplish the release of the transverse carpal ligament (Fig. 30B3,B4). This is a slight modification of the technique that was described in previous textbooks (72,80) where the retrograde knife was used to complete the release of the ligament. The thick bursa membrane contains small vessels and it should be preserved to avoid bleeding into the carpal canal. Finally, the slotted cannula is gently rotated about a few degrees, clockwise and counterclockwise sequentially, enabling the surgeon to view the edges of the transected carpal ligament. If there are any additional fibers remaining, the triangle knife, or any other knife that feels appropriate, can be used to release these fibers until the surgeon is satisfied. Due to the position of the patient's hand, the cut edges of the transverse carpal ligament should spring apart and disappear from the slotted opening of the cannula. If the edges can still be seen through the opening, the release is incomplete.

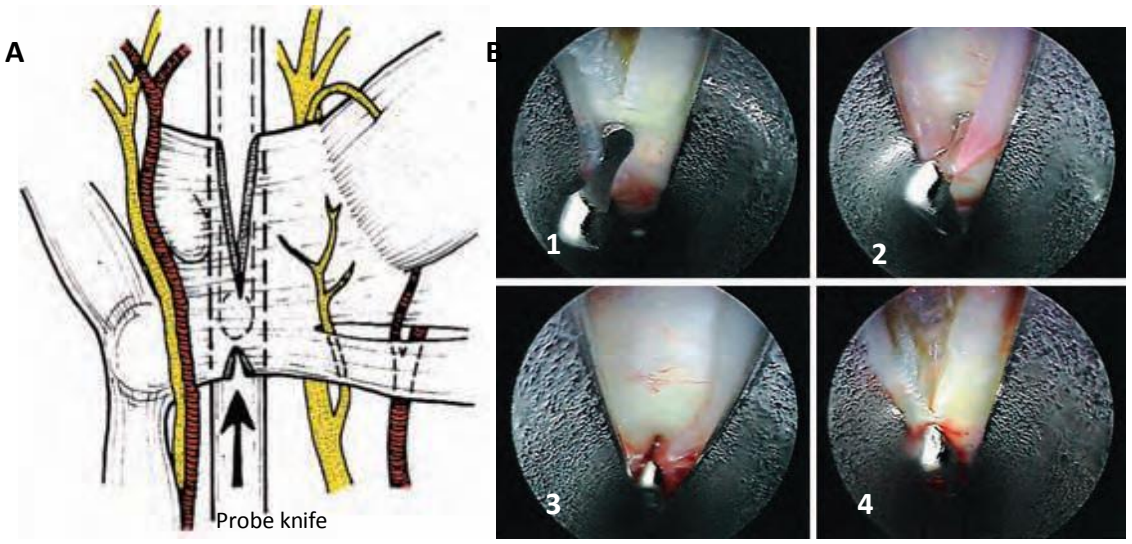


FIGURE 30 (A, B) Once the scope has been switched from the proximal to the distal opening of slotted cannula, the tip of the probe knife is placed just before the beginning of the distal cut (B1). From this point, the knife's blunt edge is used to retract the thick bursal membrane distally to proximally (B2). When the knife has engaged to the proximal border of transverse carpal ligament, it is advanced distally to complete the release of the ligament (B3, B4).

While the assistant fully abducts the patient's thumb, the uncut portion of the ligament can be identified and the surgeon is able to complete the transection. There is a soft-tissue band that bridges the thenar and hypothenar musculature lying volar to the transverse carpal ligament that has to be preserved, as well as the palmaris brevis muscle, if present. This soft-tissue band prevents bowstringing of the flexor tendons after surgery, thereby maintaining their strength during contraction (81–83). Only one suture is required for the closure of each portal. Immediately after the procedure, the surgeon should clinically examine the patient while still in a sterilized environment. If there is any dysfunction indicating intraoperative damage to the median nerve or tendons, exposure and exploration of the carpal tunnel can be performed at the same time.

Postoperatively, active range of motion is encouraged immediately after the effects of local anesthesia have subsided. The patient is advised to avoid heavy lifting or pressure on the palm region until the discomfort disappears, usually in two to three weeks. Active movement of the fingers decreases the formation of scar tissue in the wrist region and therefore prevents adhesions on the tendons or nerve at the surgical site. Sutures are usually removed in one week. If the

patient engages in hard occupational activities, such as heavy lifting, too soon after surgery, there might be swelling and prolonged pain in the palm region. If these occur, fluid therapy treatment 20 minutes daily helps to decrease the condition within one week.

Complications and their management

Several complications after endoscopic carpal tunnel release with the use of the Chow technique have been reported in the literature (60). Nagle et al. (69) performed a multicenter prospective review study on a total of 640 cases. The initial transbursal technique was used in 110 cases and the modifiedextrabursal technique was used in the rest of 530 cases. An overall (perioperative and late) complication rate of 11% was found in the cases that were done with the trans bursa technique compared with 2.2% in the cases that were done with the extrabursal technique. There were 21 out of the total640 cases (3.3%) in which perioperative complications occurred. Fourteen of these 21 cases involved neuropraxia, all of which resolved without sequelae, and no nerves were lacerated or transected. There was one laceration of the superficial flexor tendon of the ring and small fingers, four incomplete releases, and two cases with hematoma and laceration of the superior palmar arch, respectively. Late complications included three cases of reflex sympathetic dystrophy (0.5%). This complication resolved in all cases without the use of sympathetic nerve blocks. The authors of this study concluded that endoscopic carpal tunnel release using the dual-portal extrabursal technique reliably decompresses the carpal tunnel and can be effectively performed with low perioperative and late complication rates. Malek and Chow (63) in a national study of the complications of 10,246 cases in 9562 patients using the dual-portal Chow technique found a complication rate of 2.3% (240 cases with complications were reported). Of these, there were 154nerve-related complications (median or ulnar nerve neurapraxias, lacerations, and transections), 38 complications related to blood vessels, 15 tendon injuries, 18 incomplete releases of the transverse carpal ligament, and 6 reflex sympathetic dystrophy complications. The remaining nine were listed as miscellaneous complications, including hematoma or superficial wound infection. The majority of intraoperative nerve injuries occurred in cases where general or regional anesthesia was used. The complication rates of endoscopic carpal tunnel release that have been reported compare favorably with published

series of open carpal tunnel release. Complications of the latter include incomplete ligament release, nerve injuries, palmar hematomas, bowstringing of the flexor tendons, adhesions between nerve and tendons, reflex sympathetic dystrophy, deep wound infections, scar tenderness, pillar pain, tendon lacerations, and vascular injuries (86–95). Most of the damages to the surrounding anatomical structures that occur during carpal tunnel surgery, either open or endoscopic, usually require a second surgical procedure in order to be repaired. Surgeons, who are interested in performing endoscopic carpal tunnel release, should be aware of the steep learning curve and should realize that many details must be followed to avoid serious iatrogenic complications. Normal wrist anatomy and its variances must be well-known. Visualization is also a critical portion of the procedure. Regardless the etiology, when the surgeon is unable to obtain a clear view of the undersurface of carpal ligament, the endoscopic procedure should be abandoned. A common pitfall is the ulnar placement of the entry portal. To avoid this situation, helpful guidelines have been established for the correct estimation of portal placement. These are based on years 'experience and are as following:

1. Watch the entire width of the wrist to ensure the central location of the entry portal.
2. Make sure that the landmarks of both the entry and exit portals are aligned along the long axis of forearm.
3. Palpate and mark the hook of hamate. Both portals should be located radially to the hook of hamate.
4. Palpate the pulse of ulnar artery before making the skin incision for the entry portal to avoid damage of the ulna neurovascular bundle. If a tourniquet is applied and inflated, this significant guideline is lost.
5. During the entire procedure, surgical instruments that are introduced in the wrist and hand should follow the long axis of the forearm.

1.5.3. Limited Incision Carpal Tunnel Release with the Indiana Tome

Indications

LICTR with the Indiana Tome is indicated for patients with primary idiopathic CTS for whom no operative treatment options have failed to relieve symptoms to satisfaction. We do not recommend the use of this system for revision carpal tunnel release. We also emphasize caution for patients with significant anatomic alterations, such as those with major posttraumatic deformity. It is also our belief that a relative contraindication would include any patient with a suspected mass, dense median nerve motor and/or sensory deficit, or any other situation that would necessitate complete exploration of the median nerve and carpal tunnel contents. Essentially, indications and contraindications are not appreciably different from those for other minimally invasive carpal tunnel release methods.

Surgical technique

Operating room setup is identical to routine hand procedures. We typically use local anesthesia and sedation as a minimum anesthesia requirement, though as with all cases we tailor this to the individual patient's needs. We often have our anesthesia colleagues perform intravenous regional Bier block anesthesia using a well-padded double forearm tourniquet. The surgeon should ensure that all of the necessary tools are available in the set (Figs. 31 and 32).

FIGURE 31. The single pilot, double pilot, and palmar stripper.

FIGURE 32. The single-use cutting tome.

The complete kit includes the blunt single pilot, the palmar stripper, the blunt double pilot, and the single use Indiana Tome cutting instrument. There is also an optional tome guide. The operative approach is based on anatomic landmarks. The first landmark is defined by visualizing a line extending proximally from the radial border of the ring finger. The second landmark is found by envisioning a line extending ulnarly from the distal edge of the thenar musculature (Kaplan's cardinal line). Where these two imaginary lines cross marks the center of the approximately 2.0 cm longitudinal palmar skin incision (Fig. 33). Dissection is carried through the skin elements to the level of the palmar fascia, with a gentle bias toward angling the dissection radially. The palmar fascia is incised slightly radial to the skin incision. This slight radial progression of dissection allows the healing skin and ligament wounds to be staggered. A small self-retaining retractor (e.g., Heiss retractor)is placed in the wound. A blunt right angle retractor(e.g., Ragnell retractor) placed in the proximal axilla of the skin incision can aid in obtaining a clear view for safe release of the distal TCL. Next, the distal edge of the TCL is identified. Using a scalpel, the distal edge of the TCL is incised for approximately 1.0 cm in a distal-to-proximal direction and along a line that is ulnar to the longitudinal midline of thewrist so as to avoid the underlying tendons and median nerve.

Before using the Indiana Tome preparatory instrumentation, it is possible to determine whether a transligamentous motor branch of the median nerve is present. If the origin of the thenar muscles is more ulnar than expected upon initial dissection and is in line with the path of release of the

TCL, this should raise suspicion for a possible transligamentous motor branch. If this is the case, blunt scissors are used to decide whether such a branch exists and should be protected.

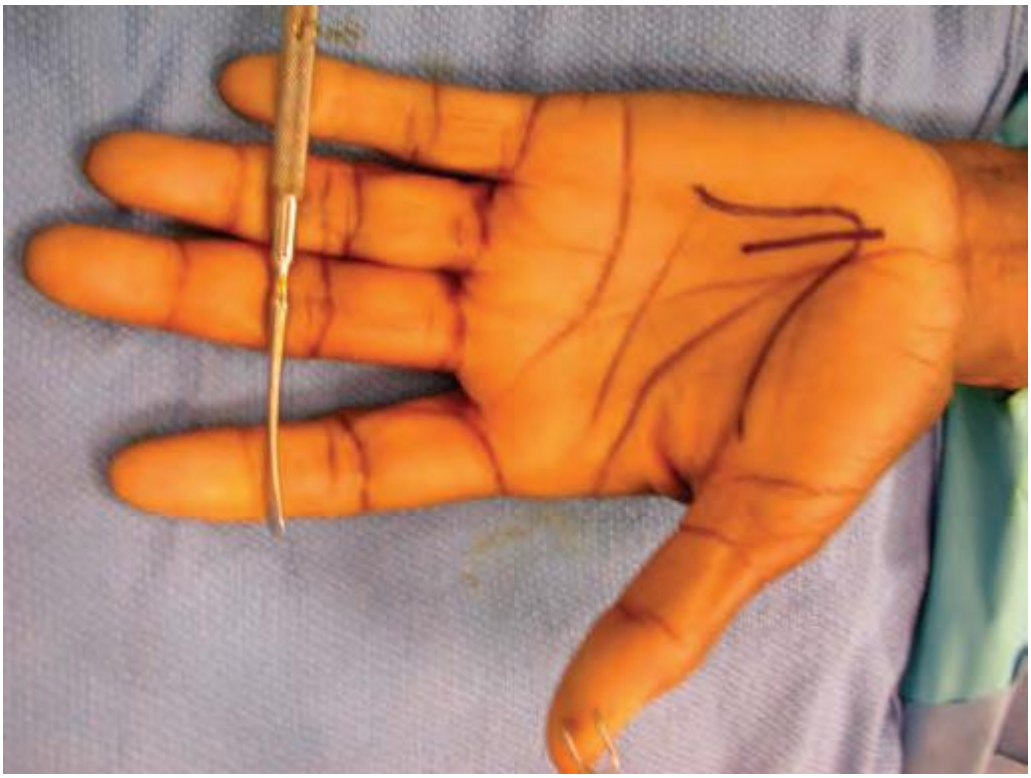


FIGURE 33.Operative markings of limited palmar incision and distal border of thenar/hypothenar arch. The curved line represents the distal margin of the pressure-bearing region of the carpal arch. The LICTR procedure maintains the integrity of this arch. Abbreviation: LICTR, limited incision carpal tunnel release.

The blunt pilot (Fig. 34) is introduced beneath the TCL distally. The surgeon should drop the instrument handle toward the patient's hand during introduction such that the tip of the blunt pilot is angled in a volar direction, thus hugging the undersurface of the TCL. Passage of this blunt pilot should be smooth and not at all aggressive. All of the instruments should be passed longitudinally along the imaginary line extending proximally from the radial border of the ring finger.

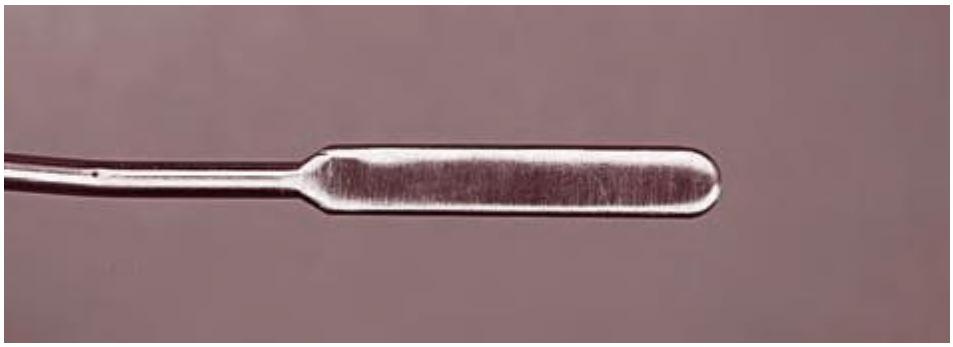


FIGURE 34. The blunt pilot.

As the blunt pilot is passed, the tip will be felt as it exits the undersurface of the TCL proximally. A surgical pen is then used to mark the skin overlying the pilot tip, roughly two fingerbreadths proximal to the proximal volar wrist crease (Fig. 35).

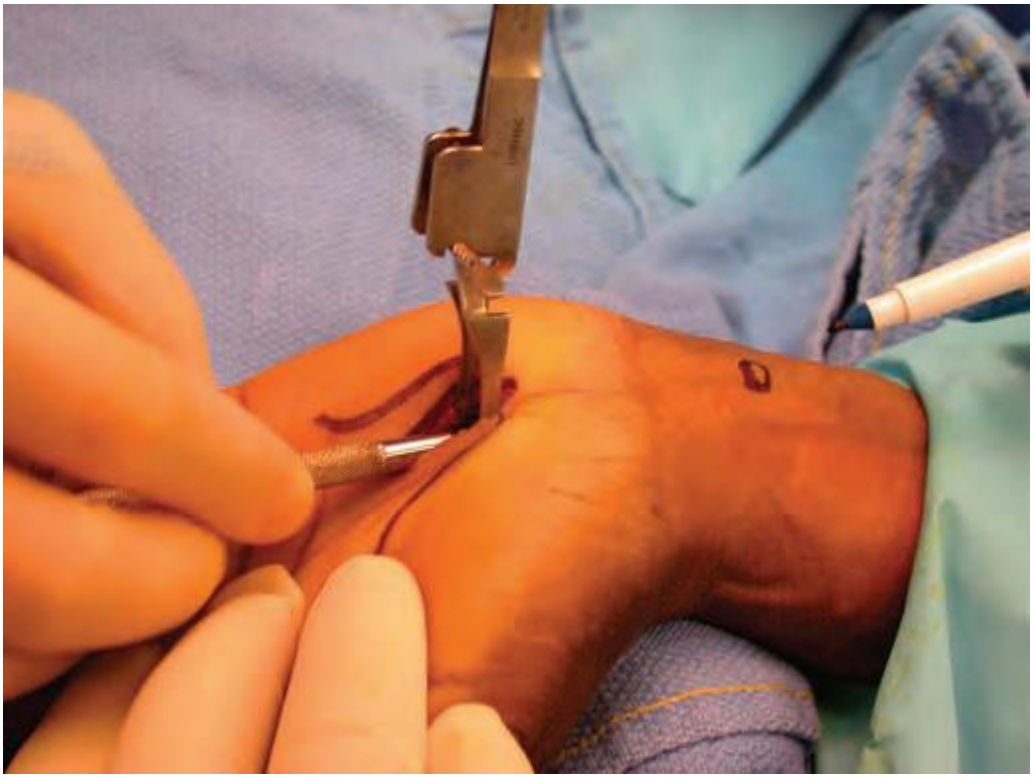


FIGURE 35. Marking the position of the blunt pilot tip to create a goal for orientation for subsequent instrumentation.

This skin marking is used as a target for later instrument passes and ensures release of the TCL and the distal forearm fascia. The palmar stripper is the next tool to be used (Fig. 36). It consists of a blunt skid, which is longer, and a sharp blade, which is shorter.

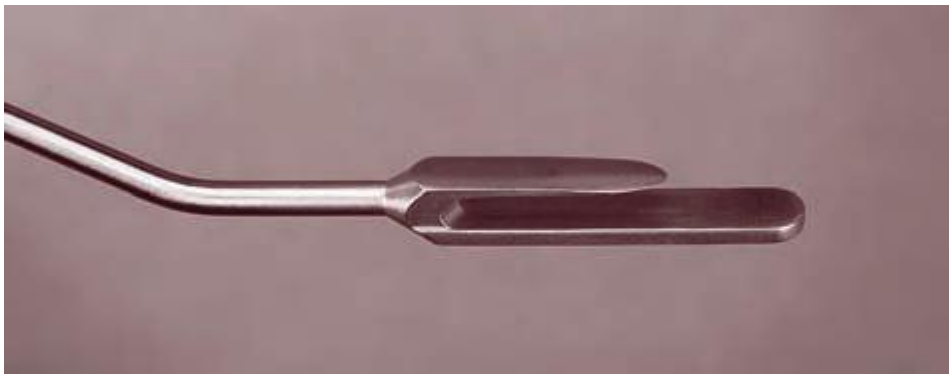


FIGURE 36.The palmar stripper.

The palmar stripper should be oriented such that the blunt skid will be inserted in a deeper position than the sharp blade. The blunt skid is passed under the TCL in the identical pathway as the previously passed blunt pilot, sliding along the undersurface of the TCL. This allows the sharp blade of the palmar stripper to pass superficial to the TCL and to free the dense connections to the overlying palmar fascia (Fig. 37).

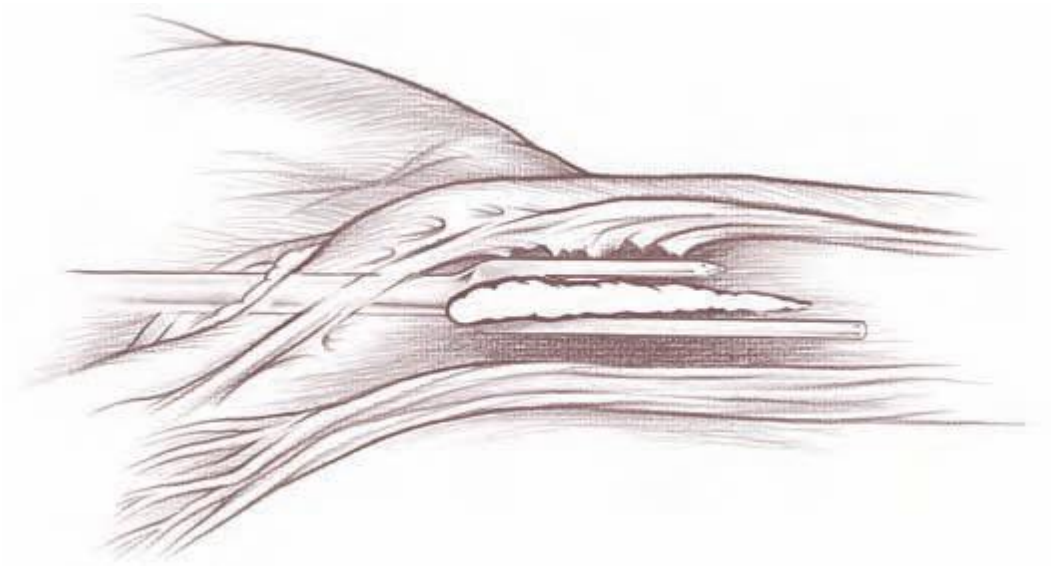


FIGURE 37. Using the palmar stripper, the TCL is dissected free of its dense connections with the overlying palmar fascia. Abbreviation: TCL, transverse carpal ligament.

The palmar stripper is passed proximally until the blunt skid hits the skin target marked earlier on the volar forearm. The double pilot is the final instrument to be passed in preparation for the cutting tome (Fig. 38).

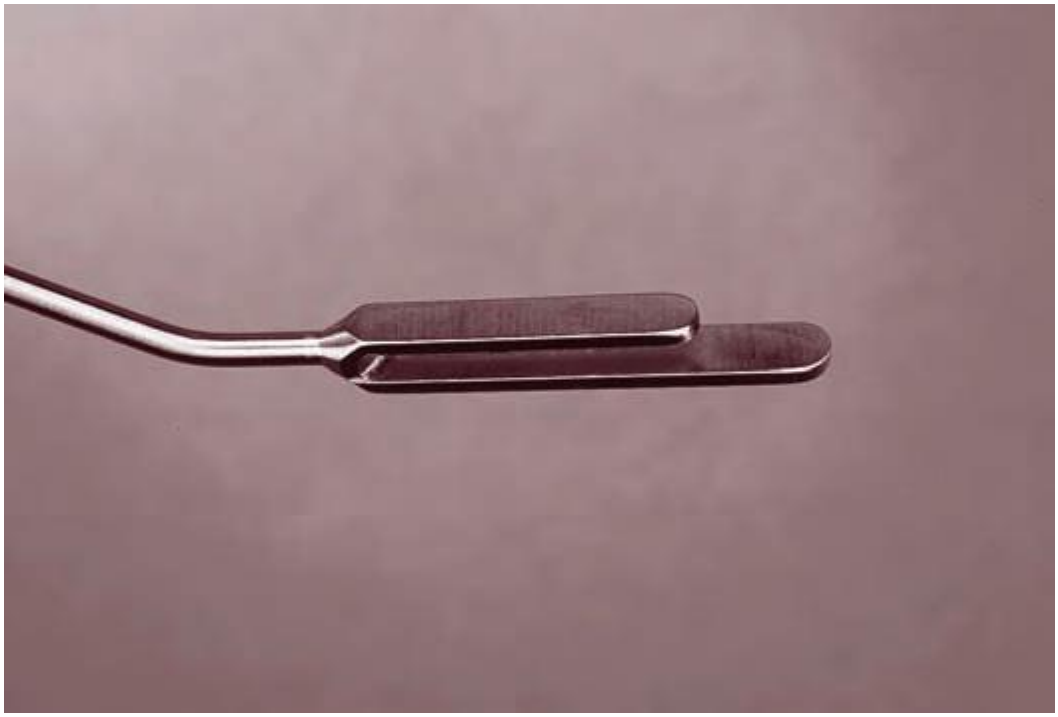


FIGURE 38. The double pilot.

It has two blunt skids to straddle the TCL superficially and deep. The skids are slightly wider than the cutting tome, therefore preparing a pathway for smooth passage of the cutting tome (96). The double pilot is passed in the same distal-to-proximal direction, with the skids straddling the TCL, until the tip is again seen and felt at the volar forearm skin mark. The single-use cutting tome may now be safely employed(Fig. 32). The longer blunt skid of the tome is inserted just deep to the TCL. The vertically oriented cutting blade is allowed to engage the axilla of the incision of the previously released distal edge of the TCL. Using a single, smooth, steady motion, the tome is passed proximally until the blunt skid reaches the skin mark, thus releasing the TCL and the distal volar forearm fascia. Any meeting of resistance should alert the surgeon to the possibility that the cutting tome is drifting from the pathway defined by the preparatory

instruments. Again, it is absolutely critical that the cutting tome, as with the preparatory tools, bypassed along the same line visualized as extending proximally from the radial border of the ring finger.

Once the cutting tome is removed from the wound, the TCL may be inspected under direct visualization to ensure complete release. Also, the carpal tunnel can be explored to evaluate for tenosynovitis, masses, and median nerve condition (96).For closure, tourniquet release is at the surgeon's discretion.

We do not routinely let down our tourniquet prior to closure. Skin is closed with a suture of the surgeon's choice. No deep structures are repaired. A splint may be used if the surgeon desires, though we typically do not use one. Instead, we allow the patient to begin active range of motion in a postoperative soft dressing applied to the hand and wrist. Stitches are removed in one to two weeks and activities are gradually increased as tolerated. Patients may return to work when comfortable, some preferring to return even prior to the first postoperative visit if heavy labor is not part of their profession.

Complications

As with any procedure, complications may be divided into major and minor categories. Complications that would likely be considered minor would include superficial wound healing difficulties, superficial infections, scar sensitivity, incomplete symptom relief, and pillar pain. Major complications would include deep infection, wound dehiscence, and nerve, tendon or arterial vessel injury. If these problems are encountered, standard treatments may be implemented as they are for open carpal tunnel release postoperative complications. The outcomes section below discusses published series that define complication rates with the LICTR system. As mentioned above, the most effective manner of eliminating iatrogenic damage to major structures is to follow the steps as outlined. If a technical impasse is encountered during the procedure, the surgeon must recognize the situation and either correct it so that the technique may proceed or transition into a complete open carpal tunnel release. As with any "minimally

invasive "technique, we discuss with patients preoperatively the possibility of conversion to a larger exposure open procedure if obstacles arise.

1.5.4. Minimally Invasive Carpal Tunnel Release Using the Security Clip

Indications

Patients whose CTS symptoms are unresponsive to conservative treatment after two to three months may be considered for operative release using the Security Clip or a standard open incision. Contraindications for the Security Clip include patients with a known palmar carpal canal mass, previous displaced wrist fracture, or any other condition that may have altered wrist morphology. A relative contraindication is a patient requiring concomitant open palmar flexor tenosynovectomy.

Surgical technique

Carpal tunnel release (CTR) with the Security Clip system is performed as an outpatient using local, regional, or general anesthesia. Instruments required for the procedure include a hand set, a small Holzheimer type self-retaining retractor, the soft tissue preparatory instruments, the Security Clip and the disposable blade that tracks in the Clip. The patient is placed supine on the operating table. A well- padded tourniquet is placed around the brachium. The operated arm is then placed on a hand table.

Ten to Fifteen cc's of 1% local anesthesia without epinephrine are placed into the midline of the proximal palm and across the wrist and distal forearm. Additional anesthetic is administered into the deeper tissues palmar to the TCL. Three to five cc's of local anesthetic should also be placed within the carpal canal staying ulnar to the midline to avoid injury to the median nerve.

The landmarks for the surgical incision are the distal border of the thenar muscles and the radial border of the ring finger. A line is drawn over the proximal extent of the TCL in line with the longitudinal axis of the radial border of the ring finger. A second line is drawn diagonally from the proximal thenar musculature. The point of intersection of the two lines approximates the most distal edge of the TCL (Fig. 39).

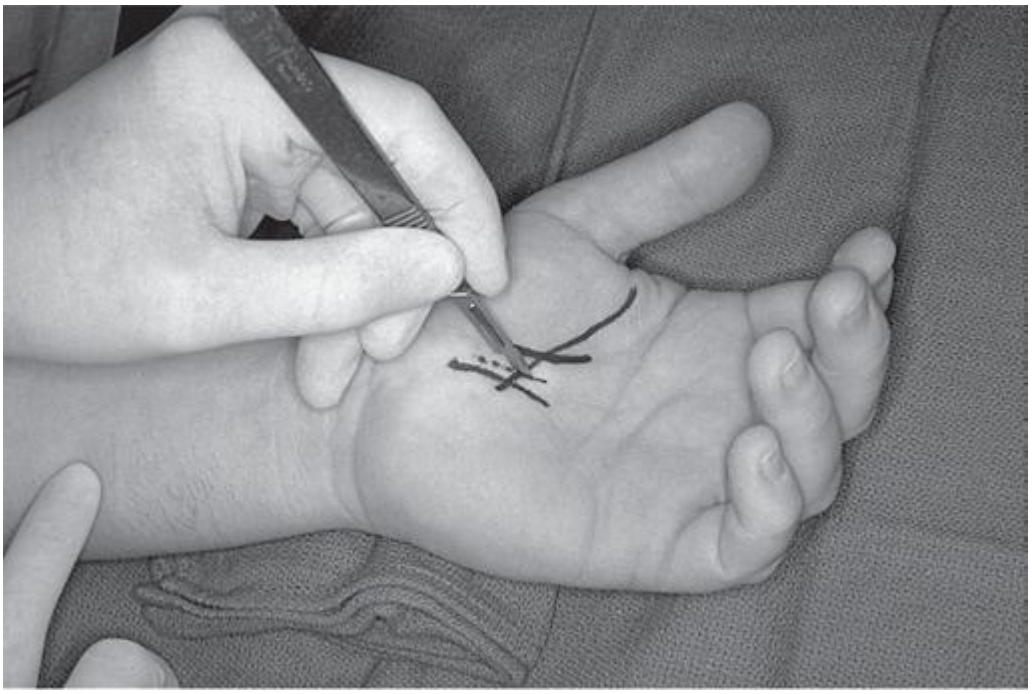


FIGURE 39. Landmarks for the surgical incision. The incision is about two-thirds proximal and one-third distal to the extended thenar muscle line and slightly ulnar to the midpoint between the two creases.

The skin incision is approximately 1.5 cm in length. It is designed to be about two-thirds proximal and one-third distal to the extended thenar muscle line. The arm is elevated briefly or an Esmarch wrap is utilized and the tourniquet usually inflated to 250 mmHg. The skin is incised down through the palmar fascia. A self retaining retractor (Holtzheimer or Biomet CTR retractor) is positioned in the wound. The Biomet (Biomet, Warsaw, Indiana, U.S.A.)retractor has a slight palmar bend which is helpful for the slightly extended wrist. The retractor is gradually deepened by pushing the tissue walls away with an elevator and repositioning. The proximal component of the Biomet retractor or a Ragnell retractor is utilized to retract the soft tissue proximally exposing the leading edge of the TCL. With careful dissection within the distal

portion of the carpal canal, anomalous or penetrating branches of the recurrent motor branch of the median nerve are identified. The superficialpalmar arterial arch is usually visualized and easily protected throughout the procedure. When the distal portion of the TCL has been identified a scalpel blade is then used to longitudinally divide the distalulnar 1.5 cm of the ligament under direct vision (Fig. 40).

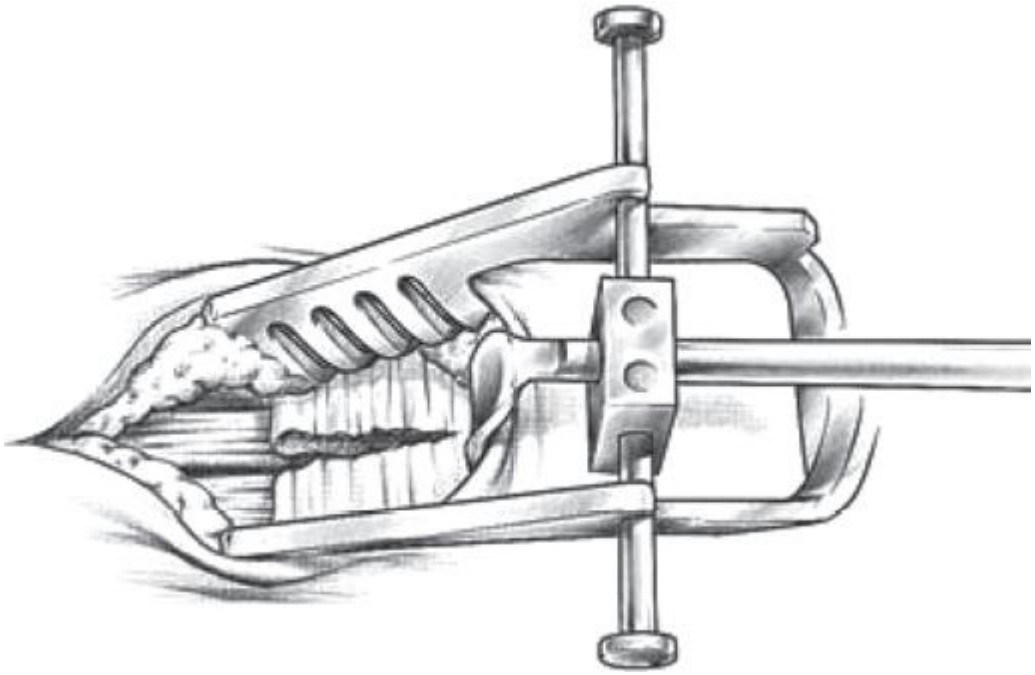


FIGURE 40. Incision of the distal 1.5 cm of the transverse carpal ligament under direct vision. The specially designed, three-sided Biomet retractor facilitates exposure.

Three instruments are utilized to clear any tissues adherent to the TCL. The first instrument the blunt single pilot, has a smooth edge and flat plane (Fig. 41). The purpose of the tool is to create a clear plane between the ligament and the underlying contents of the carpal tunnel. The pilot is placed just deep to the "V" shaped notch created by incising the distal 1.5 cm of the TCL. The instrument is passed from distal to proximal deep to the ligament. The pilot and all subsequent instruments must be directed slightly ulna ward to avoid injury to the radially vectored median nerve.

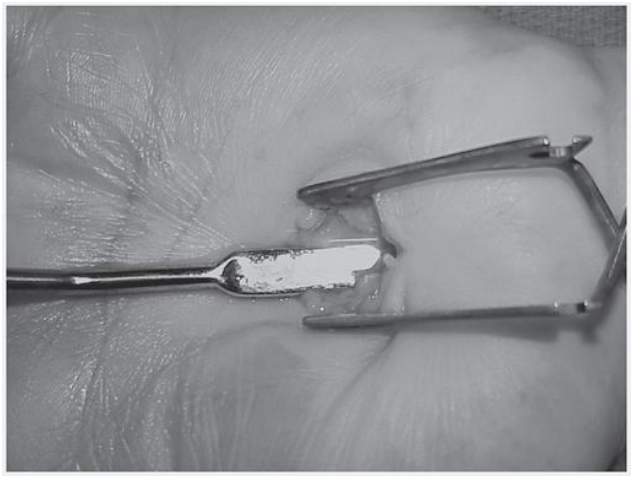


FIGURE 41. The blunt pilot is passed beneath the carpal ligament.

After removal of the pilot, the palmar stripper is placed into the wound. It is a double sided instrument with a blunt lower skid and a sharpened upper edge 15 mm in length(Fig. 42A). The tool is designed to prepare a channel through the dense connective tissue immediately palmar to the ligament.

The distance between the two skids is 3 mm approximating the thickness of the ligament at its distal third. This allows the instrument to straddle the ligament as it is passed from distal to proximal. Under direct visualization, the tool is inserted into the notch created by distal division of the ligament. The lower skid is placed deep to the ligament and passed proximally. The sharper shorter upper skid will pass palmar to the ligament. The stripper is passed until the blunt center post meets the edge of the "V" shaped defect of the ligament (Fig. 42B).

A

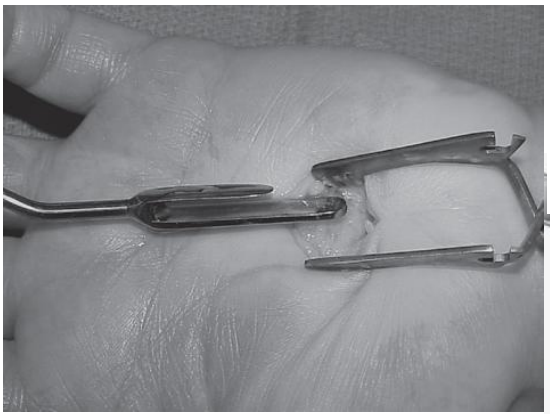


FIGURE 42 (A) The configuration of the palmar stripper with its short sharp upper component and long blunt lower skid. (B) Drawing of completed passage of the palmar stripper after it has prepared a channel through the dense palmar connective tissue.

B

After withdrawing the palmar stripper, the double pilot is introduced. The tool has long blunt upper and lower skids (Fig. 43A). There are no sharp edges on the skids which could injure surrounding anatomical structures. The double pilot enters the "V" notch created by the incision

in the distal ligament. It straddles the ligament and is passed proximally to establish a pathway for the Security Clip. The tool is passed until the blunt center post is fully engaged against the distal edge of the ligament (Fig. 43B). It is critical that the instruments are passed sequentially using the same ulna vector. All instruments are moistened prior to passage to provide better sliding characteristics. If some difficulty is encountered when passing the double pilot, it may be passed several times in a slightly different direction to be sure that there is an adequate channel for Security Clip passage.

A

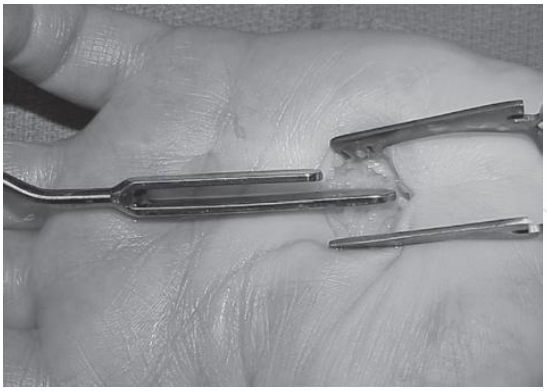
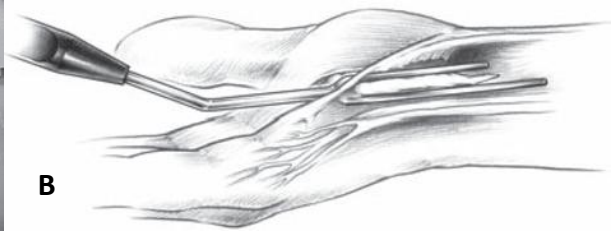


FIGURE 43 (A) Introduction of the double pilot with its blunt upper and lower skids. (B) Drawing of completed passage of the double pilot with the skids straddling the transverse carpal ligament.



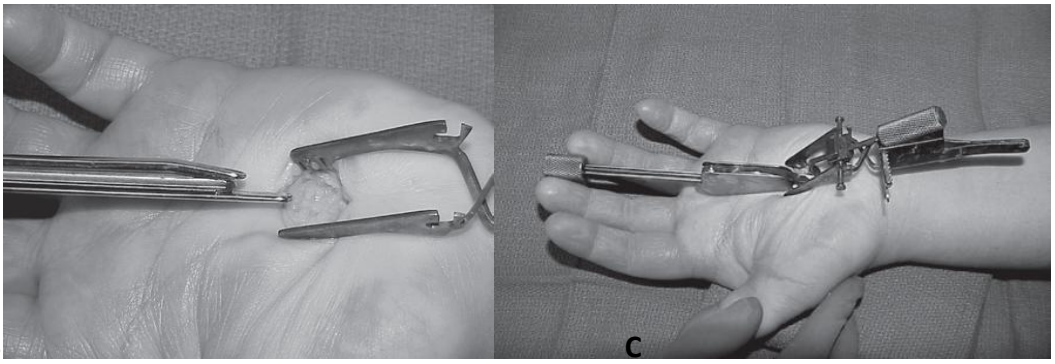
B

The Security Clip is designed to protect the soft tissues on both the palmar and dorsal sides of the ligament. The lower skid has the same length as that of the double pilot. An upper skid ispresent which converges on the lower skid terminally (Fig. 44A).

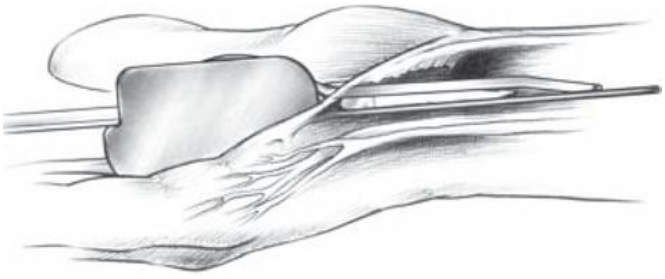
The distance between the proximal end of the clip and the terminal closure of the upper skid is 3.5 cm. With this configuration, the Security Clip straddles the ligament creating a closed system that is consistent with the usual morphology of the TCL; thin proximally and thicker distally. Prior to passing the Security Clip, a stylus is introduced into its central track creating a 3 mm separation between the lower and upper skids (Fig. 44B). This facilitates positioning of the Security Clip into the prepared channel across the ligament. As the assembly is advanced from distal to proximal across the TCL the stylus will automatically be backed out by the edge of the ligament, and the distal tips of the instrument will close together on the ligament (Fig. 44C). When fully seated, the Security Clip will contain the entire TCL between its skids and all other adjacent tissues will be safely out of harm's way (Fig. 44D).With the Security Clip straddling the ligament a disposable blade is inserted into the track of the device and passed from distal to proximal between the upper and lower skids (Fig. 7A).The blade is passed down the Security

Clip completely dividing the TCL. The upper and lower skids serve to protect the tissues dorsal and palmar to the ligament. Advancement of the blade continues until the disposable device fits flush with the Security Clip (Fig. 7B,C). Once the blade is fully seated, it is withdrawn. The Security Clip is then removed from the wound. The soft tissues are carefully retracted proximally to confirm complete decompression of the TCL. A Freer elevator may also be used to confirm the interval between the transected edges of the TCL. Hemostasis is achieved with bipolar cautery. The wound is irrigated and the skin closed with 5.0 no absorbable horizontal mattress sutures. A well-padded dressings applied with the fingers left free for full motion and the tourniquet is deflated.

A

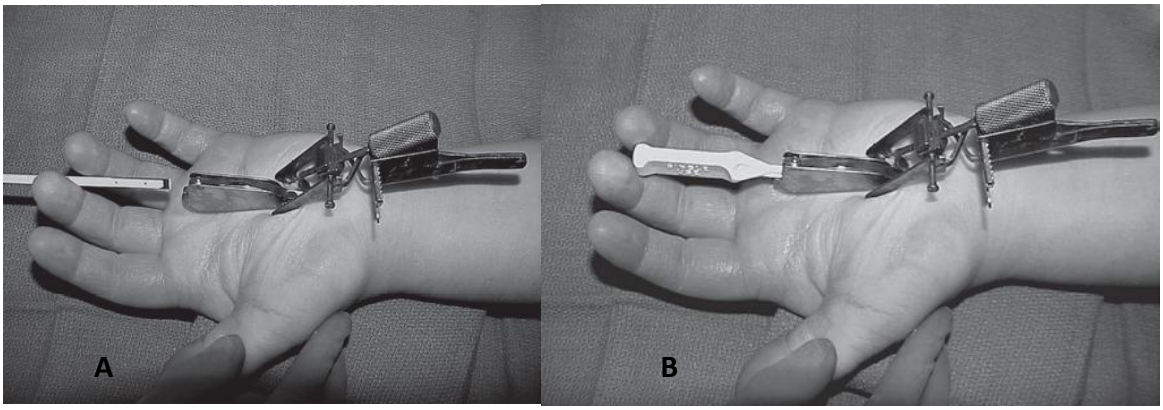


B C



D

FIGURE 44 (A) The appearance of the Security Clip with the stylus in place (upper). The disposable blade fits into the midline of the Clip device. (B) The Security Clip with the stylus in place is passed from distal to proximal, positioning the lower skid deep into the transverse carpal ligament. (C) As the Security Clip is fully seated the stylus is automatically backed out of the device. (D) Drawing of the Security Clip fully engaged with the TCL contained between the upper and lower skids.



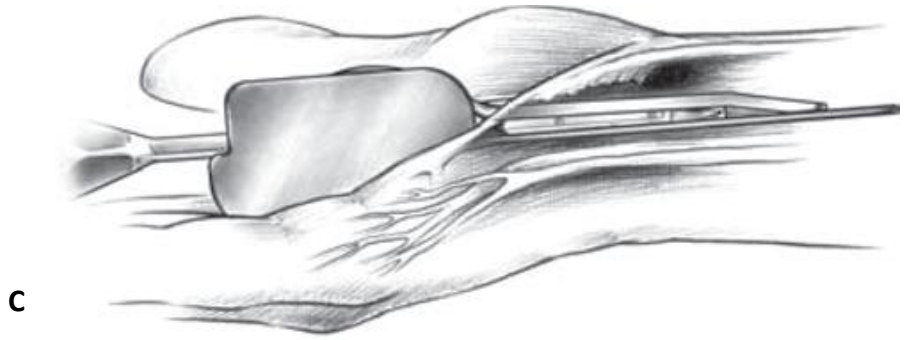


FIGURE 45. (A) The disposable blade is positioned into the clip and passed distal to proximal between the upper and lower skids. (B)Advancement of the blade continues until it is fully seated within the Security Clip. (C) Drawing of the Security Clip with the disposable blade fully seated within the device. The blade is positioned between the upper and lower skids protecting the surrounding tissue. The transverse carpal ligament has been transected at this point.

Complications

The overall complication rate of open CTR is estimated to vary between 2% and 10% (10–12). Reported complications include: median, ulnar, and digital nerve lacerations, vessel and tendon injuries (95). Although the Security Clip is designed for protection of the surrounding anatomical structures, the possibility of median nerve injury still exists. There are two important technical tips to help minimize the risk of median nerve injury. No instrumentation should be passed until the distal portion of the TCL is well visualized and divided. The pilots and the Security Clip

should always be angled slightly ulnar to the midline when passed from distal to proximal. If at any time there is concern regarding the possibility of nerve injury then the limited palmar incision should be extended proximally for exploration. CTR utilizing a standard incision should be performed if an anomalous branch of the median nerve or an intracarpal ganglion cyst is discovered at the time of the operation. Occasionally, some resistance may be noted while attempting to pass the Security Clip. In these cases, the steps of ligament preparation are repeated with passage of the palmarstripper and double pilot. Once again the Security Clip is passed making sure to maintain the same passageway and direction created by the pilots. If necessary, the skin incision may be lengthened proximally for a short distance and the incision into the distal TCL extended proximally.

1.5.5. Endoscopic Carpal Tunnel Release: Agee Technique

Indications

The general indications for surgical treatment (whether endoscopic or open) for CTS are failed conservative management and advanced stage with thenar atrophy or weakness. There are instances when ECTR should not be carried out, such as in cases where synovectomy or biopsy is needed. Although data has shown some success for ECTR for recurrent CTS after prior open release, this data is limited (96). Therefore, revision CTR, regardless the primary mode of release (open or endoscopic), may be best approached by an open release because neurolysis of the median nerve may also be necessary(97). Other relative contraindications for ECTR include calcified tendinosis, hamate hook fractures, and congenital anatomic anomalies.

Surgical technique

A standard surgical setup for wrist procedure is used with the patient supine and the arm abducted on a hand table. The instruments (MicroAire Surgical Instruments, Charlottesville,VA) are opened and assembled on a sterile field (Figs. 46 and 47).

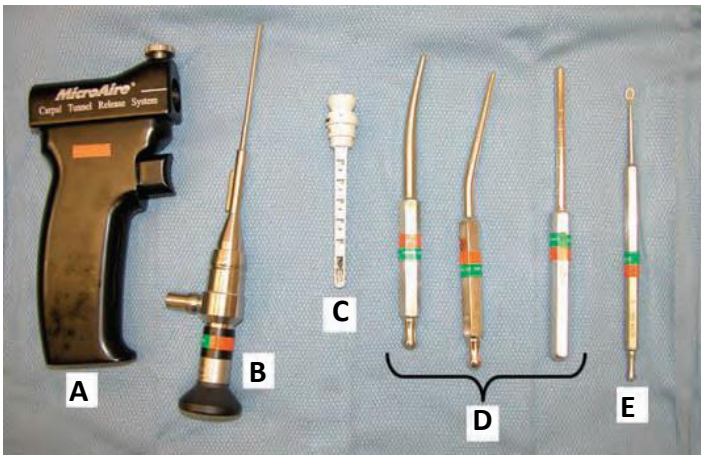


FIGURE 46 MicroAire instruments for Agee endoscopic carpal tunnel release technique. (A) Handpiece, (B) standard endoscope, (C) Disposable Blade Assembly, (D) Hamate Finders, and (E) Synovium Elevator.

FIGURE 47. Assembly of handpiece, endoscope, and disposable blade.

Surgery is usually performed with intravenous sedation and local anesthetic under tourniquet. Care is taken to use the local anesthetic for only cutaneous and subcutaneous injection at the site of proximal wrist crease incision. Injection within the carpal tunnel and deep into the ante brachial fascia is avoided because it can lead to fogging of the camera lens and poor endoscopic visualization.

After surgical markings and inflation of the tourniquet, a transverse skin incision is made within the long axis of the ring finger metacarpal (Fig. 48).

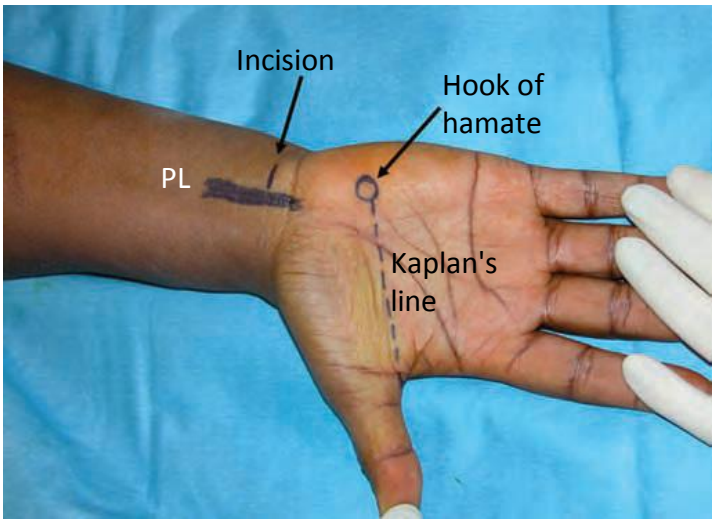


FIGURE 48. Surgical markings for Agee technique of endoscopic carpal tunnel release.

The ante brachial fascia is divided in transverse fashion. The distal margin of the fascia incision is used for traction to allow initial blunt dissection between the synovium and undersurface of the ante brachial fascia, permitting entry into the carpal tunnel. A Hamate Finder is introduced through the incision into the carpal canal, deep into the TCL and radial to the hook of the hamate (Fig. 49).

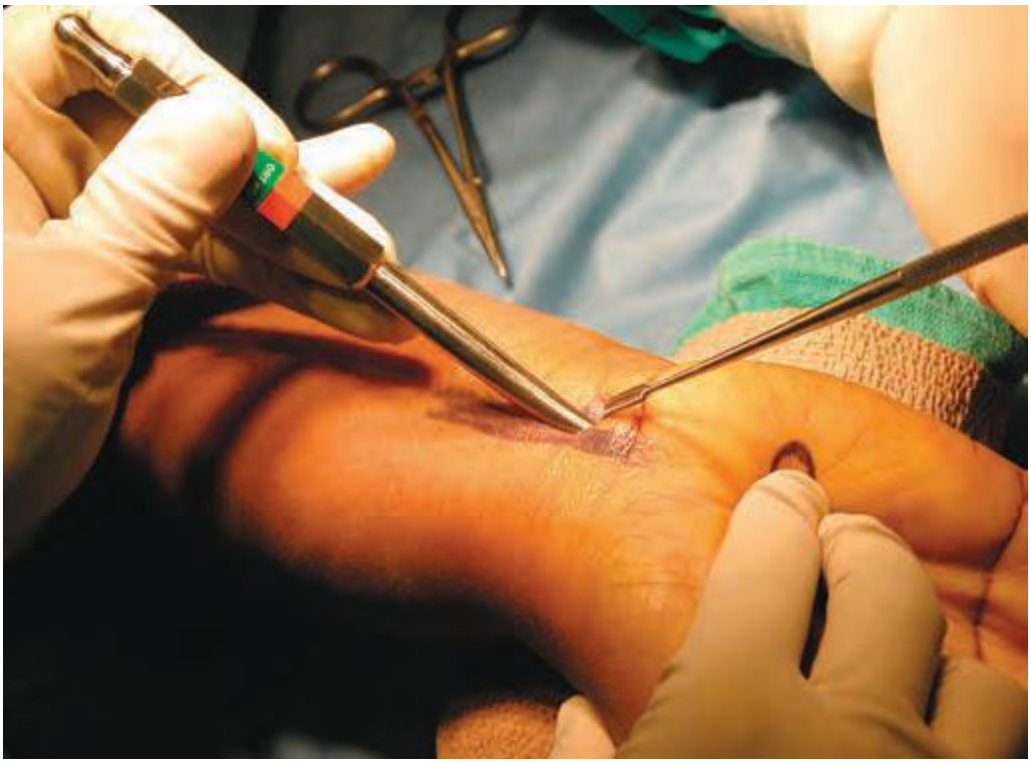


FIGURE 49. Introduction of the Hamate Finder into the carpal canal, staying deep into the transverse carpal ligament and radial to the hamate.

Gentle serial passes with the Hamate Finders can be done to prepare the path. The undersurface of the TCL is then cleared of synovial tissue with the Synovium Elevator. This step is performed blind but guided by knowledge of surgical anatomy and tactile feedback. Adequacy of dissection can be determined by feeling the "ridges" on the undersurface of the TCL. At this point, the endoscope is inserted (Fig. 50).

The majority of times, the endoscope can be inserted without resistance. If resistance is met, this may be addressed with further dissection with the Synovium Elevator and serial insertion of the Hamate Finders. Confirmation of adequate exposure of the undersurface of the TCL is made with direct endoscopic visualization. Light intensity is set to allow discrimination of the transverse ridges of the deep surface of the TCL. Inadequate or too much brightness will lead to suboptimal ability to discern any crossing structures, including anomalies of the motor branch of the median nerve. The endoscope can be used to bluntly push tissue away for better visualization.

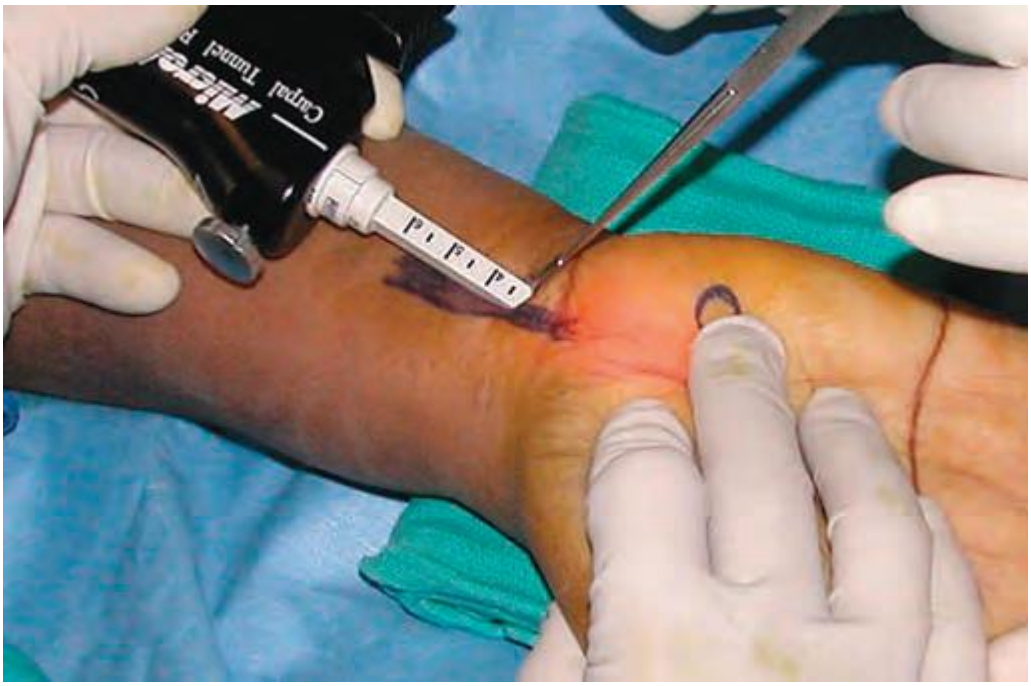


FIGURE 50. Insertion of the assembled endoscope into the carpal tunnel.

Several options are available to create a clear path before incision of the TCL. Slight rotation of the endoscope in an ulna direction can increase the distance from the median nerve or anomalous motor branch. Cautious blunt dissection with the endoscope by scraping away the synovium may increase visualization. Simple removal and reinsertion of the endoscope while providing traction on the distal ante brachial fascial edge at the site of incision may allow clearance of tissues(fat and synovium) from the endoscope line of sight. Finally, the subfascial path at the level of the ante brachial fascia should be well dissected to allow the Synovium Elevator to be inserted deep into the fascia at the level of the incision. Deliberate dissection at the undersurface of the fascia and TCL is necessary to allow optimal exposure.

Once the TCL undersurface is well-exposed (Fig. 51), the trigger on the Handpiece is pulled to deploy the blade at the end of the Disposable Blade Assembly. The distal margin of the ligament is divided first which allows the surgeon to assess the thickness of the TCL and to verify the distal extent of the true carpal ligament. The cross-section is often obvious in defining the distal TCL. Thereafter, serial, distal to proximal,

division of the ligament is carried out. The surgeon's contra lateral hand is used to position the wrist and provide external counter-pressure to juxtapose the endoscope blade with the undersurface of the TCL. The TCL is divided by engaging the blade on the undersurface of the ligament and slowly withdrawing it proximally. Complete division of the ligament is confirmed with protruding fat or visualization of the palmaris brevis muscle (Fig. 52). Division of the muscle is not needed as it adds to postoperative pain and prolongs recovery. Engaging the blade too deeply may result in injury to the palmaris brevis, intramuscular vessels, cutaneous nerves within the palm, or even the ulnar neurovascular bundle. After endoscope removal, another centimeter of ante brachial fascia can divided proximal to the incision under direct visualization with tenotomyscisscors, as warranted. Often this proximal ante brachial fascia can result in persistent carpal tunnel symptoms, especially after minimally invasive or short-incision open CTR.

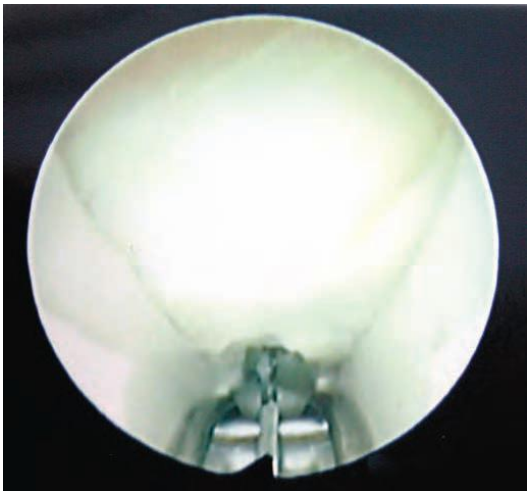


FIGURE 51. Endoscopic visualization of the undersurface of the transverse carpal ligament.

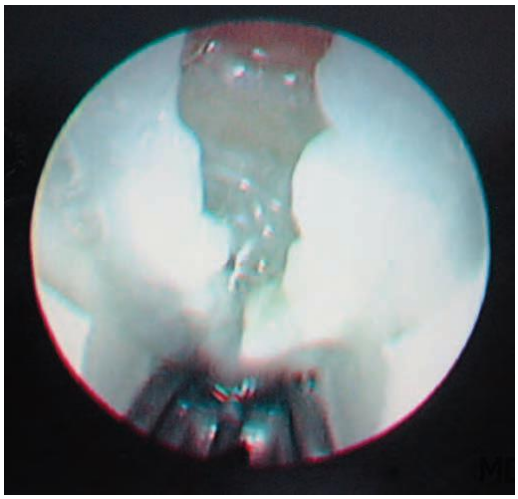


FIGURE 52.Endoscopic visualization after division of the TCL, showing a gap between the two ends. The subcutaneous fat and palmaris brevis muscle can be seen superficial to the divided TCL. Abbreviation: TCL, transverse carpal ligament.

At the end of the procedure, the tourniquet is deflated. Any bleeding can be controlled with manual pressure applied to the area of surgery for five minutes while elevating the hand above

the level of the heart. Remaining cutaneous bleeding atthe incision site may be controlled with bipolar electrocautery.

The wound is irrigated and bupivicaine injected around the incision. Skin is closed in a simple, single-layered fashion. A soft dressing is applied. Postoperatively, the patient is encouraged to use the hand immediately for light tasks such as handling paper or holding a cup. The surgical dressing is removed after twenty-four hours. At two weeks, the patient may carry up to ten pounds. The patient is allowed to return to work between 10 and 14 days with the above restrictions. Full, unrestricted activity is allowed at four weeks and the patient is also instructed on scar massage.

Complications

As with any arthroscopic or endoscopic procedure, ECTR is vitally dependent on the surgeon's ability to visualize structures through the scope. Any impediment in visualization can render the procedure impossible to safely complete without conversion to an open technique. Various causes exist for inadequate endoscopic visualization: faulty camera hardware, inadequate light source, fogging of the lens, inadequate ex sanguination of tissues, and anomalous anatomy. Progressing with the procedure with less than optimal visualization is unsafe and increases the risk of complications and incomplete division of the TCL. If the endoscopic procedure cannot be performed safely, it should be abandoned and converted to an open CTR.

When converting to an open procedure, the transverse skin incision should be incorporated into a zigzag incision across the wrist flexion crease to decrease the risk of scar contracture postoperatively. Alternatively, a skin bridge can be left between the endoscopic and open carpal tunnel incisions. Other reasons for conversion to an open technique include uncontrollable bleeding after tourniquet deflation, intraoperative tendon or nerve laceration, inability to confirm complete division of the TCL, unclear or abnormal anatomy, or unexpected discovery of carpal tunnel pathology (mass, extensive synovitis). Any known intraoperative complication should be addressed during the open procedure.

1.5.6. Percutaneous Trigger Finger Release

Introduction

Trigger finger is one of the most common problems seen in the clinical practice of orthopedic surgery. It is caused by a disproportion between the flexor tendons and their sheath, and it presents with painful triggering or locking of the affected digit during finger motion. The most common form of trigger finger is the primary type, which is found most frequently among middle-aged women, two to six times more commonly than it is observed in men. The most commonly affected digit is the thumb, followed by the long, ring, index, and little fingers. The involvement of several fingers is not unusual. Secondary trigger finger can be found in patients with diabetes, gout, renal disease, and rheumatoid diseases, and it is associated with a worse prognosis after conservative management.

The main pathology of entrapment is mechanical impingement of the flexor tendons as they pass through the narrowed first annular (A1) pulley at the level of the metacarpal head. Thus, the goal of treatment is to provide a painless, smooth, and full range of finger motion. As a conservative method of treatment, steroid injection has been commonly recommended (98). Although this treatment is simple and has low morbidity, it may be associated with a high failure rate, and repeated injections are usually required because of a high recurrence rate. In reported series of injection therapy, the success rate varied from 37.5% to 84% (98–101). This therapy appears to be less useful in more advanced cases. Rhoades et al. observed that patients with symptoms of less than four months' duration achieved a success rate of 93% after steroid injection, while those with symptoms of greater than four months achieved a 41% success rate (102). Newport et al. reported that patients who had symptoms for more than six months were more likely to require surgery (101).

When conservative treatments fail to relieve the symptoms, surgical release of the A1 pulley by open technique is generally recommended (103,104). The most attractive aspect of operative management may be its ability to provide a permanent cure. Open trigger finger release is considered a simple and reliable procedure, but entails making a 1 to 2 cm incision in the palm

directly the A1 pulley. The subcutaneous tissue is dissected bluntly off the pulley, which is then released under direct visualization. Successful results have been reported with this technique, but it is not without complications. These include infection, digital nerve injury, joint stiffness, hand weakness, scar tenderness, and bowstringing of the flexor tendons (105–107).

Since Lorthioir described a technique of percutaneous

release of the A1 pulley using a fine tenotome in 1958 (108),several techniques for percutaneous release using a variety of cutting instruments have been described as simple office procedures (109–118). Percutaneous release, if it is equally effective and safe, would avoid the time and expense of an open surgical procedure. It also has the advantage of avoiding complications that are closely related with the open procedure, such as infection, incisional pain, hypertrophic scarring, and delayed use of the hand, which may be due to the development of reflex sympathetic dystrophy or stiffness.

Indications

The clinical course of trigger finger is generally divided into four stages as follows, depending on the degree of the tendon catching during the motion of the affected digit

- Grade 1: No triggering, only uneven movements during

finger motion

- Grade 2: Triggering, actively correctable
- Grade 3: Triggering, passively correctable by the other hand
- Grade 4: Locked and uncorrectable. Patients who have a locked trigger digit can present either with a fixed flexion contracture at the proximal interphalangeal (PIP) joint or with an inability to fully flex the affected digit from an extended position.

Percutaneous release of the A1 pulley is mainly indicated when the symptoms fail to be relieved by conservative treatment, including steroid injections. As the procedure can be simply performed in the office under local anesthesia without specific preparations, it is relatively indicated as a first-line treatment in patients with severe or longstanding symptoms, who are more likely to require surgery.

Percutaneous technique is recommended in those patients who have had symptoms for more than four months, or have Grade 3 or 4 triggering at thetime of their initial presentation. Others find

locked trigger digits (i.e., Grade 4) as a contraindication to percutaneous techniques because of a higher failure rate (119). Although the percutaneous release of the locked digits seems to have a higher failure rate than that of other trigger digits, it is believed that locked trigger digits can be released safely and effectively by percutaneous method if several technical points are considered, which are discussed below.

Another issue with respect to indications of the percutaneous technique is whether it can be performed in children with a trigger digit. Although some authors have reported successful results (120), it should be performed cautiously for the following reasons:

(i) due to anxiety pediatric patients may not be able to stay still and confirm complete release with just local anesthesia, which risks safety during the procedure,

(ii) if general anesthesia is required, the patient will not be able to actively move the digit intraoperative to determine that a complete release has been achieved, and

(iii) almost all trigger phenomena in children occur at the thumb, which has the increased risk of nerve injury due to the proximity of the digital nerves to the A1 pulley. The potential for nerve injury is significantly increased in children because of the small size of their thumbs.

In patients with secondary triggering, such as tenosynovitis, percutaneous release is generally not recommended because of unpredictable results.

Surgical technique

Since Eastwood et al. described the percutaneous method using a hypodermic needle to section the A1 pulley (112), the hypodermic needle has been used most frequently among a varietyof cutting instruments. Following is the brief description of this hypodermic needle procedure.

The A1 pulley is palpated directly over the metacarpal head in the palm, and the skin and flexor tendon sheath are infiltrated with 1 to 2 mL of 1% lidocaine using a 27-gaugeneedle.With the affected metacarpophalangeal joint held firmly in hyperextension, a 19- or 21-gauge needle is placed percutaneously through the A1 pulley. Placement of the needle tip within the flexor tendon is confirmed by asking the patient to slightly flex the digit and observing movement of the hub of the needle. The needle is then withdrawn slowly and rotated to align the beveled edge along the longitudinal axis of the tendon. A sawing motion is used to section the A1 pulley

proximallyand distally to the site (Fig. 53). Disappearance of a grating sensation indicates complete sectioning of the A1 pulley.

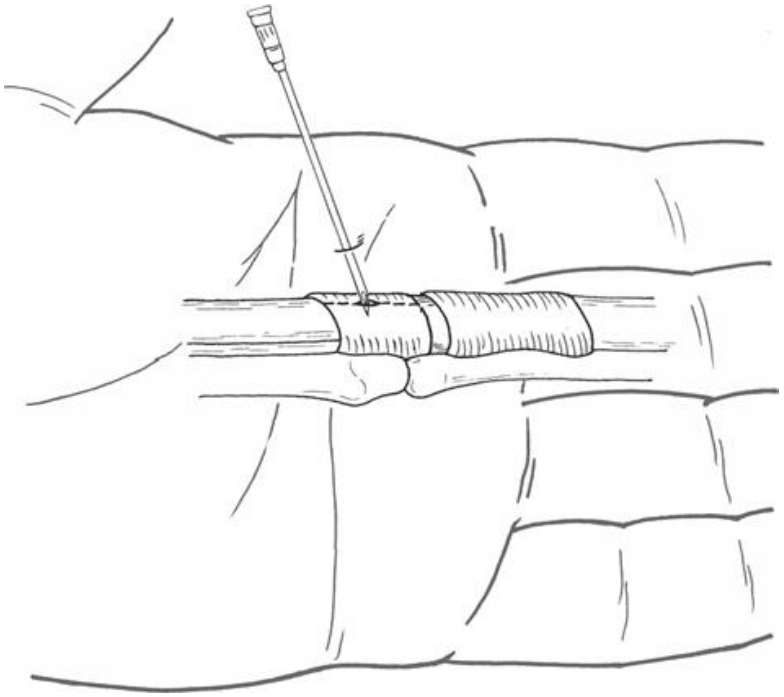


FIGURE 53. Percutaneous release of a long finger first annular (A1) pulley using a hypodermic needle. The bevel of the needle is oriented longitudinally with the tendon, and a sawing motion is used to section the A1 pulley.

Eastwood technique is not always successful because the needle bents easily and did not cut well when the A1 pulley was thickened and stenotic. It was also not easy to handle the needle because of the small hub and there was a steep learning curve. As a modified technique, a specially designed knife (HAKI knife; BK MeditechInc., Seoul, Korea) has been developed (114), which has a hook shaped end with a blade only on the inner side and a pointed end to facilitate its insertion into the skin without making an incision. The depth of the blade which is for section of the A1pulley is less than 1 mm to prevent injury to the flexor tendons(Fig. 54).

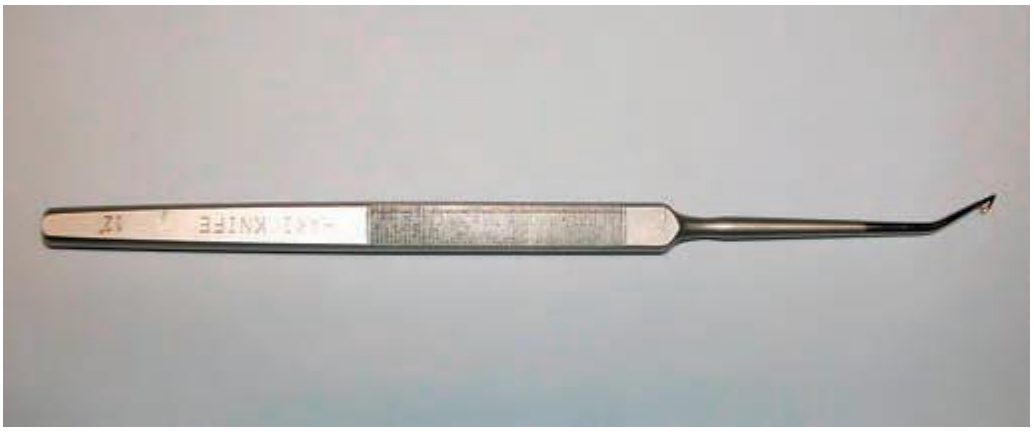


FIGURE 54.A specially designed knife (HAKI knife; BK Meditech Inc., Seoul, Korea) for percutaneous first annular pulley release. It has a hook shaped end with a blade on the inner side and a pointed end to facilitate its insertion into the skin.

It is designed to cut the transverse fibers of the A1pulley longitudinally from a proximal to distal direction after it is inserted distal to the A1 pulley (Fig. 55).

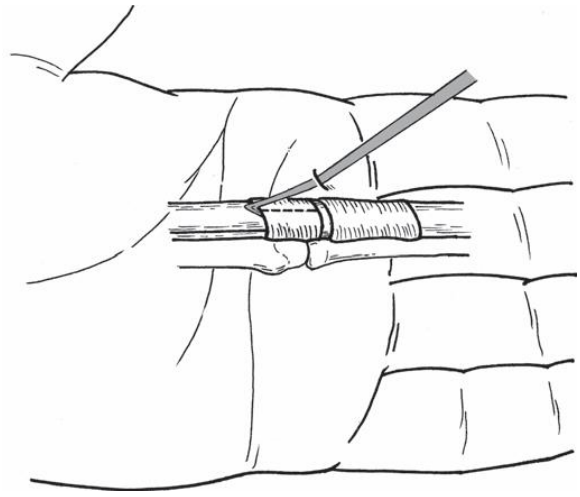


FIGURE 55. The technique of first annular (A1) pulley release using HAKI knife. After the knife is introduced distally to the pulley, the blade is advanced to its proximal margin and hooked over the border. The A1 pulley is divided by moving the knife from a proximal to distal direction.

The procedure is generally performed in the outpatient setting under local anesthesia. The patient is placed in a supine position with the affected hand on the examination table. The surgeon sits on the distal side of the affected hand. The point of triggering at the A1 pulley is located by palpation (Fig. 56).

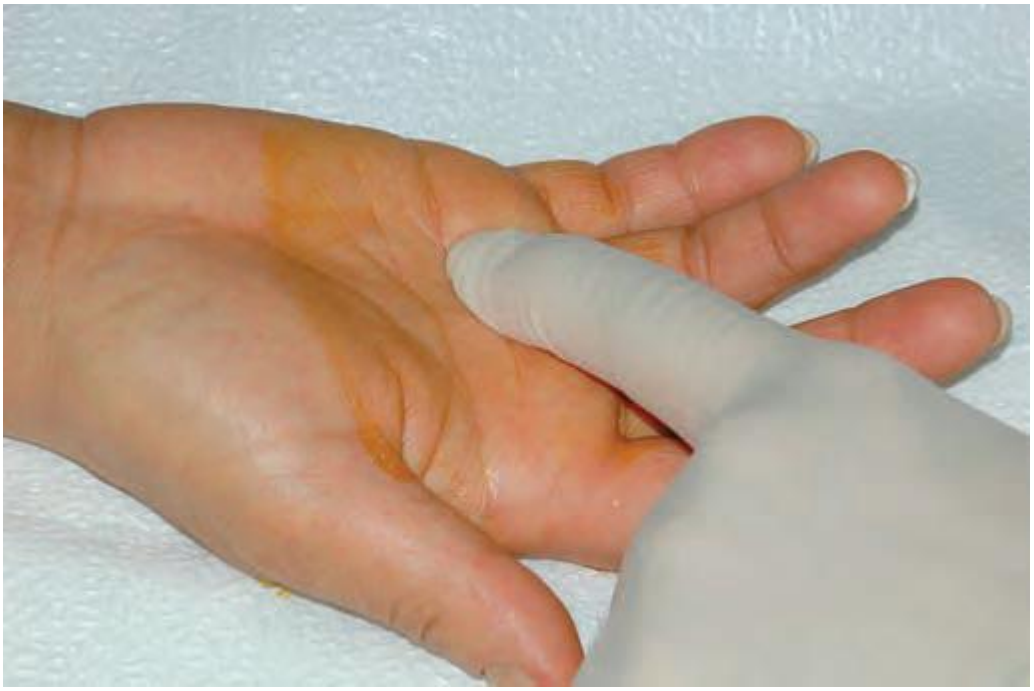


FIGURE 56. Percutaneous first annular (A1) pulley release of a ring finger in a patient with longstanding triggering. The point of triggering at the A1 pulley is palpated after skin preparation.

The skin of the palm is thoroughly cleaned and 1 mL of 1%lidocaine without epinephrine is infiltrated into the skin and subcutaneous tissue by means of a needle inserted directly over the point of knife entry (Fig. 57).

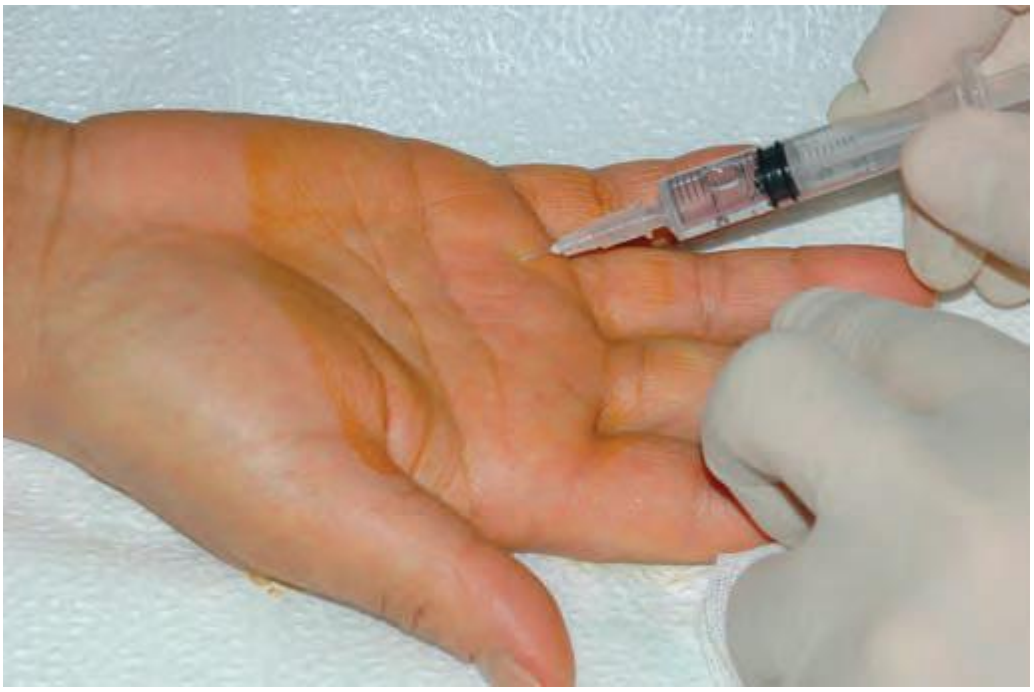


FIGURE 57. One percent of lidocaine is infiltrated into the skin, subcutaneous tissue, and tendon sheath using a 27-gauge needle inserted over the point of knife entry.

The relationship of the surface anatomy of the palm to theA1 pulley needs to be reviewed in order to identify the exact point of knife entry. Several studies (108,121) have demonstrated that the proximal edge of the A1 pulley coincides almost exactly with the proximal palmar crease in the index finger, halfway between the proximal and distal palmar creases in the middle finger, the distal palmar crease in the ring and little fingers. In the thumb, metacarpophalangeal crease indicates the middle of the A1 pulley (Fig. 58).

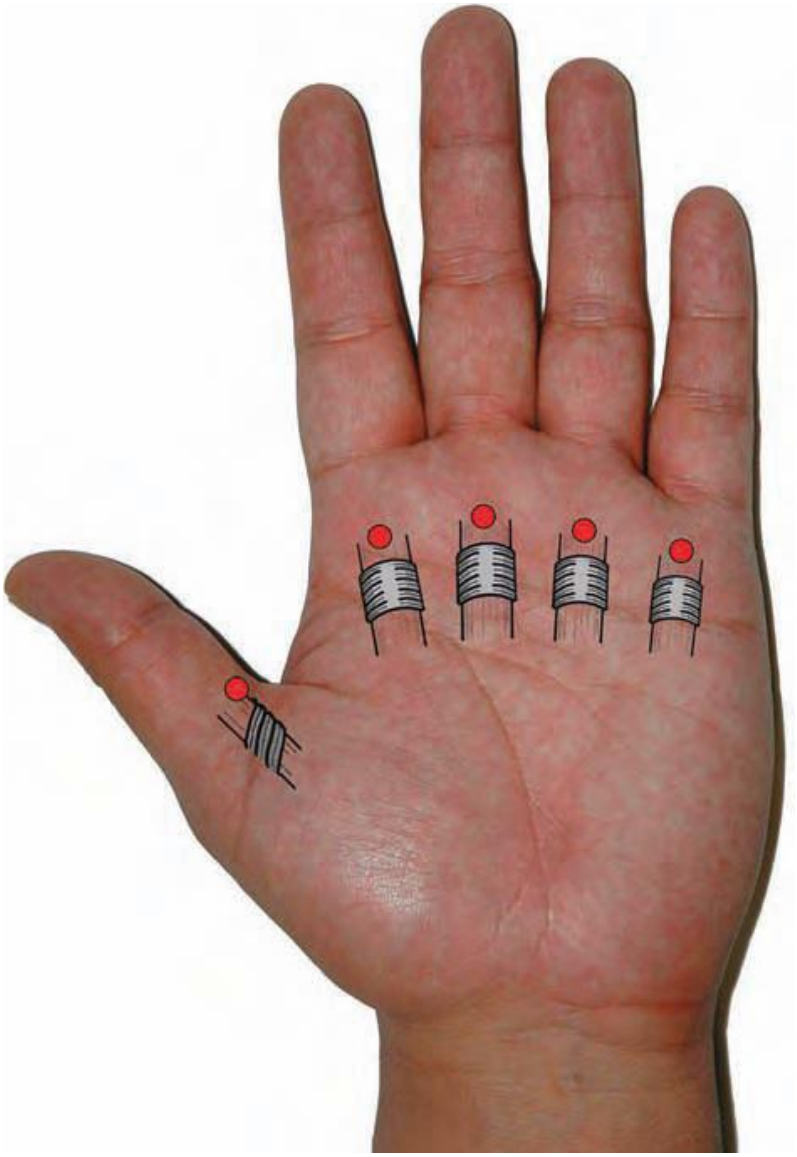


FIGURE 58. Surface anatomy of the palm to the first annular (A1) pulley. The proximal edge of the A1 pulley coincides with the proximal palmarcrease in the index finger; halfway between the proximal and distalpalmar creases in the middle finger; at the distal palmar crease in the ring and little fingers. In the thumb, metacarpophalangeal (palm digital)crease indicates the middle of the A1 pulley. The knife is introduced1.5 cm distal to the landmarks that indicate the proximal edge of the A1pulley (round dot). The precise locations of the knife entry are important for successful release.

The knife is introduced a few millimeters distal to the A1 pulley, which coincides with the point approximately 1.5 cm distal to the landmarks that indicate the proximal edge of the A1 pulley. The precise locations of the knife entry are important for successful release. An incomplete

release might result from an inaccurate proximal insertion of the knife. If the knife is inserted too distally, excessive cutting extending to the A2 pulley would be a risk.

Once the hook-shaped point is inside the skin (Fig. 59),the knife is extended to the proximal edge of the A1 pulley, palpating the surface of the pulley with the tip of the knife. The tip of the knife is used to identify the step-off of the proximal margin of the fibrous pulley and the blade is placed at the proximal margin.

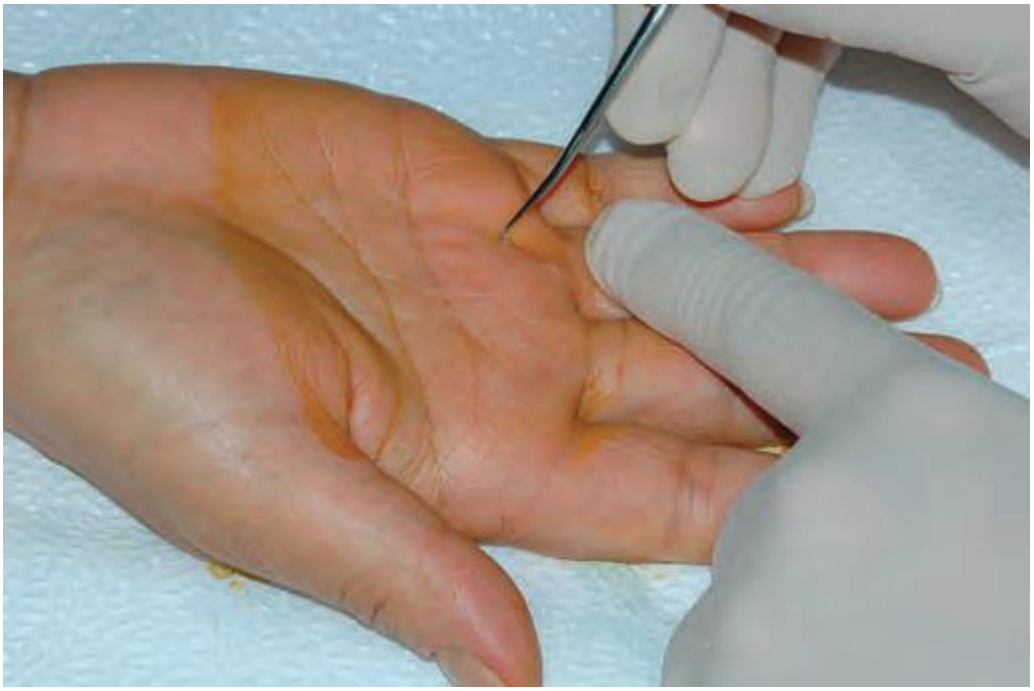


FIGURE 59. The knife can be easily inserted into the skin with its pointed end. After its insertion, the knife is advanced proximally to the proximal edge of the first annular pulley while palpating the surface of the pulley with the tip of the knife. The hook-shaped blade is placed at the proximal margin.

The A1 pulley is sectioned longitudinally by moving the knife from proximal to distal (Figs. 55 and 60).It usually requires several repeated motions to complete the section. A grating sensation and sound indicate the cutting of the A1 pulley. When the grating sensation and sound stop, the knife is withdrawn and relief of clicking or locking is confirmed by the patient during active flexion and extension of the digit. The surgeon should confirm complete release by digital

palpating over the metacarpal head and observing full active finger motion without any sense of triggering or uneven motion(Fig. 61).

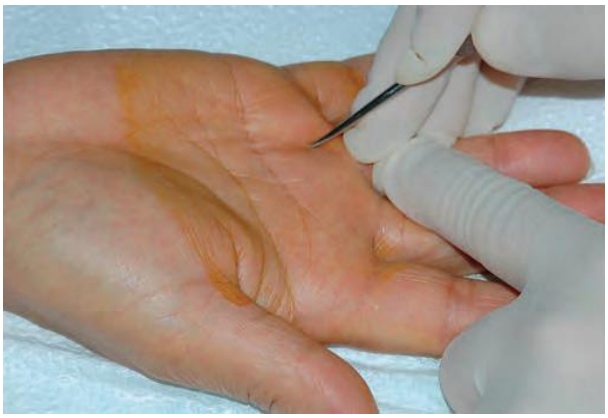


FIGURE 60. The first annular (A1)pulley is sectioned longitudinally by moving the knife from proximal to distal. A grating sensation indicates the cutting of the A1 pulley.

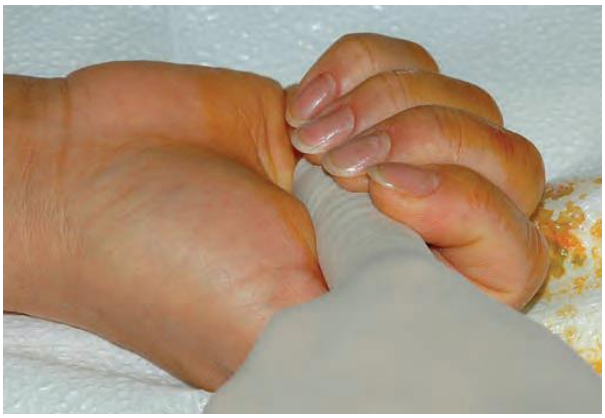


FIGURE 61. Complete release should be confirmed by the surgeon by palpating with the finger tip over the metacarpal head and observing full active finger motion without any sense of triggering or uneven motion.

If the release is incomplete, the procedure might be repeated one or two times until the clicking or locking is relieved. Conversion to an open surgical procedure is recommended when it fails after three attempts. The procedure usually takes two to four minutes. For percutaneous release of the trigger thumb, the location of the A1 pulley needs to be outlined carefully. By positioning the patient's thumb in abduction, slightly flexing the wrist, and hypersupinating the forearm, the volar surface of the thumb is positioned facing the surgeon. The knife is inserted 1 cm distal to the metacarpophalangeal crease, in the center of the thumb after local infiltration of the subcutaneous tissue and the flexor tendon sheath (Figs. 62 and 63).

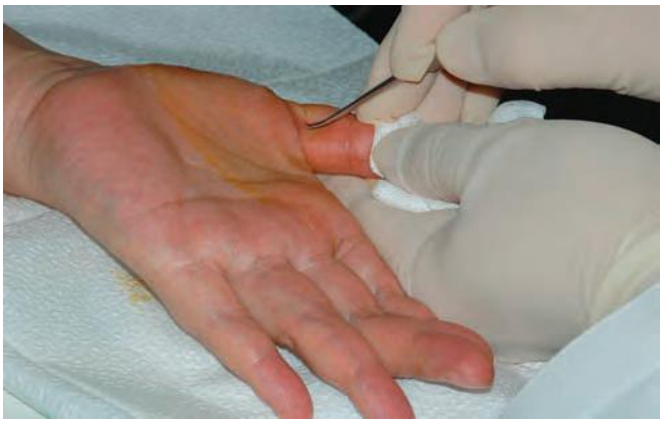


FIGURE 62. Percutaneous release of the trigger thumb. Note the position of the patient's hand with the thumb in abduction and the forearm in hypersupinating to make the volar surface of the thumb facing to the surgeon. The knife is inserted 1 cm distal to the metacarpophalangealcrease in the center of the thumb.

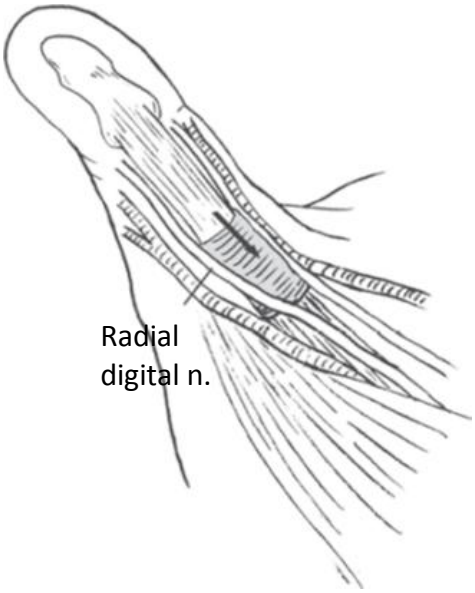


FIGURE 63. The radial digital nerve of the thumb has a potential risk of injury due to its proximity to the first annular pulley during percutaneousrelease. Distal insertion of the knife (arrow) is helpful in avoiding nerve injuries, but care must be taken to keep the knife tip in contact with the pulley surface during its proximal advancement, and not to advance the knife too proximally.

The proximal edge of the A1pulley is identified with the tip of the knife blade proximal to the metacarpophalangeal crease level. It is important not to extend the tip of the knife too proximally because of the proximity of the radial digital nerve. The remaining procedure is the same as that for the fingers as described above. After the procedure, an adhesive strip bandage is applied and the patient is advised to flex and extend the digit several times a day until full movement is restored. The patient is recommended to passively assist full flexion and extension of the affected digit with the opposite hand when the finger joint is stiff after the procedure. Some

patients require hand therapy for residual stiffness of the joints. Several technical points need to be remembered for patients with locked digits. In contrast to an open release, complete sectioning of the A1 pulley cannot be confirmed by visualization during the percutaneous method. In the percutaneousrelease, adequate release of the A1 pulley is confirmed by complete disappearance of a triggering phenomenon. However, when the digit is locked instead of merely triggering, it is difficult to accurately evaluate the status of the A1 pulley after the percutaneous release. This may have caused some to believe that the percutaneous method is not indicated for locked trigger digits. During the initial trial period of the HAKI knife technique, locked cases accounted for the majority of failed cases among the percutaneous trigger releases performed by this author. For a successful release in the locked digits, it is essential to accurately locate the insertion point to prevent an inadequate release because it is difficult to confirm the site of triggering by palpation alone. Confirmation of a successful release must be made by both the surgeon and the patient while the affected fingers are anesthetized by intrathecal injection. As it can be difficult to differentiate incomplete release from a painful stiff interphalangeal joint, a local infiltration of anesthetic into the flexor sheath (intrathecal) is helpful. Even in the setting of a secondary stiff finger joint, near active full range of motion can be achieved when the pain is eliminated with the
intrathecal injection. If stiffness is severe but passively correctable, the surgeon can take the digit through a passive range of motion to assure that there is no “clicking” or “catching”. Once the surgeon and the patient are assured about the complete release, the patient is advised to perform vigorous passive flexion and extension exercises of the released digit with the opposite hand until full painless motion is restored.

Complications

Several authors have pointed out the potential risk of nerve injury when the percutaneous technique is used in the thumb due to the proximity of the digital nerves to the A1 pulley (112,121,122). The radial digital nerve passes diagonally across the flexor pollicislongus tendon from the ulnar to the radial side.

The site of the crossing is a few millimeters proximal to the metacarpophalangeal flexion crease of the thumb (Fig. 63).

Digital nerve injuries have been reported as infrequent but serious complications of an open release (105,107), but there have been no reported instances of digital nerve injury after percutaneous release. The author believes that HAKI knife is particularly effective in avoiding nerve injuries, since the knife is introduced through the skin at a point distal to the pulley where the nerve is located well on the lateral side of the thumb (Fig. 63). This is in contrast to the techniques of other authors, who inserted the needle or knife more proximally over the metacarpophalangeal crease. However, care must be taken to keep the tip of the knife in contact with the pulley surface during its proximal advancement, and not to extend the knife too proximally. The author does not recommend more than three repeated trials of the percutaneousrelease. Since the percutaneous technique was started in 1995, no nerve injuries were encountered after more than1200 procedures.

Injuries to the flexor tendon have been described in articles reporting the results of the percutaneous technique (113,116). Bainet al. observed some form of injury to the majority of tendons, ranging from simple lacerations to significant injuries on exploration after trials of percutaneous release on cadaveric hands using a 14-gauge angiocath needle (121). They recommended keeping the needle in a superficial position in order to minimize the flexor tendon injury. However, it is difficult to maintain the needle at a constant level in the soft tissue to minimize tendon injury and achieve the pulley release. The blade portion of HAKI knife has a constant depth of less than1 mm, which would help prevent injury to the flexor tendon by a cutting blade. Flexion contracture of the PIP joint with pain observed at the postoperative period is not uncommon, particularly in diabetic patients. These patients may not be fully satisfied with their results because they still have painful limited joint motion. The main reason is due to inadequate hand therapy after the procedure. If a complete release is confirmed after the procedure, it is also important to inform the patient that the triggering will not occur and that the stiffness of the interphalangealjoint should recover by repeated passive motion exercise. This postoperative care is essential, particularly for diabetic patients.

Care needs to be taken not to violate the proximal edge of the A2 pulley in order to prevent the potential for bowstringing and loss of digital flexion. Precise localization of the entry point of the knife is essential to avoid this. If the knife is inserted too distally, excessive cutting extending to

the A2 pulley would-be a risk. Discomfort or pain associated with the procedure can persist, but they usually disappear within several days or weeks after the procedure.

1.5.7. Endoscopic DeQuervain's Release

Introduction

There are three reasons to consider an endoscopic approach to first dorsal compartment release rather than a traditional open release. First, the results of open release, when viewed critically, still have a number of complications. Second, the incisions for an endoscopic release are outside the area of maximal sensitivity. Third, we hypothesize that an endoscopic release may allow for a localized neurectomy.

On the first point, a study by Harvey et al. demonstrates scar adherence to the underlying tendon in two out of 20surgical patients and temporary paresthesias of the radial sensory nerve in three patients (123). Arons et al. describes 14complications in 16 consecutive patients including three hypertrophic painful scars, one tendon subluxation, two neuroma's,and three adhesions (124). A study by Ta et al. shows 2% with severe scar tenderness, a 5% recurrence rate, and a 2% sensory nerve injury out of 43 patients (125). There have been other case reports of palmar subluxation of the tendon following operative release (126). Clearly, although surgical treatment of DeQuervain's is perceived as a simple and effective surgical procedure, when examined closely, there is a need for improvement.

The endoscopic approach allows us to keep our incisions outside of the hyper sensitized zone of injury. Additionally, an arthroscopic approach allows for an extensiveneurectomy of the tiny branches of the superficial radial nerve (SRN), which may innervate the first dorsal compartment.

Therefore, the minimally invasive approach along with this neurectomy may result in faster and more complete pain relief, with less risk for painful scar development. Finally, with the proper training, this can be a safe technique.

Indications

Any patient with a first dorsal compartment tenosynovitis who has failed conservative treatment of splinting and/or injections and has not previously undergone a release would be a candidate for endoscopic release.

Surgical technique

The wrist is placed over a towel roll in a neutral position with a tourniquet inflated. A 5 mm superficial transverse incision just distal to the thumb carpometacarpal (CMC) joint establishes the distal portal. The incision is in line with the first dorsal compartment at the insertion of the abductor pollicislongus(APL) tendon, 2 to 3 cm distal to the end of the radial styloid. A small hemostat is used to clear the overlying subcutaneous tissue off the fascia enveloping the thumb CMC joint. A small right angle retractor elevates the subcutaneous tissue off the tendons of the first dorsal compartment. A long narrow hemostasis next used to bluntly create a working space between the skin and subcutaneous tissue down the length of the first dorsal compartment. A trocar and cannula are inserted above the fibrous fascial sheath of the first dorsal compartment, proximal to the radial styloid and the extensor tendon retinaculum. Next, a second 5 mm transverse incision is made over the trocar tip, approximately 4 to 6 cm proximal to the radial styloid (Fig. 64).

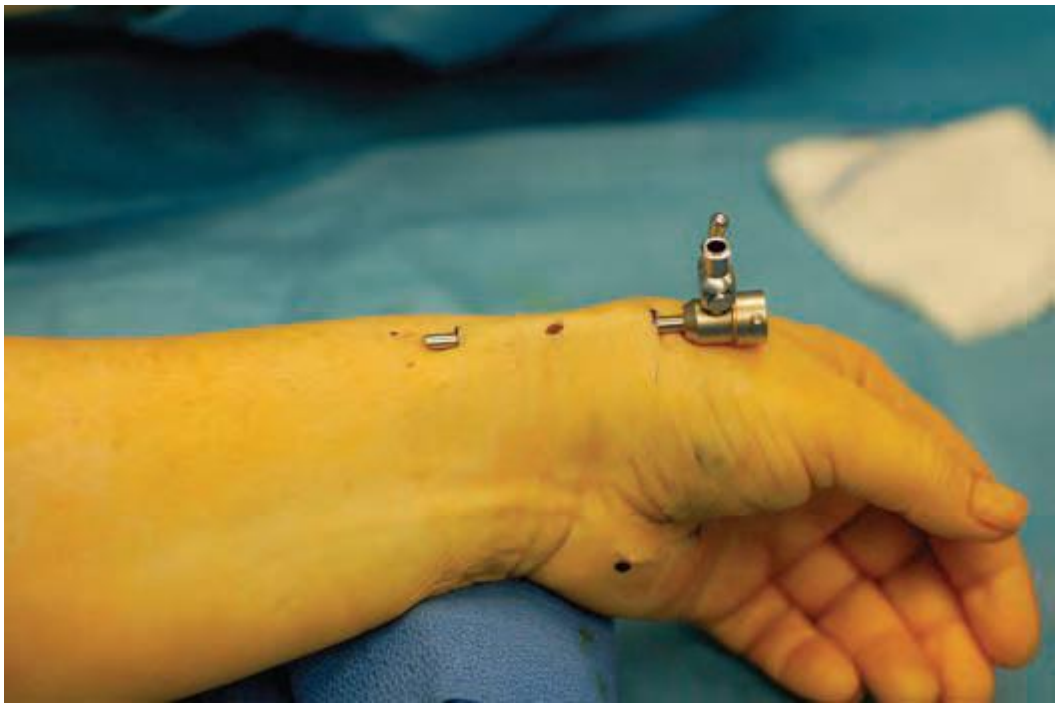


FIGURE 64. Incisions for endoscopic DeQuervain's release.

A 2.7 mm 308 angled scope is inserted into the cannula through the proximal portal. The scope is inserted into the cannula until the tip of the scope is visible through the distal portal. The cannula is then removed. A small right angled retractor elevates the proximal portal to maintain a working space and a dry endoscopic inspection of the first dorsal compartment is performed beginning distally over the CMC joint. The SRN is identified as it sweeps down crossing the fascia below (Fig. 65). Long thin Mueller scissors are introduced into the distal portal and used to bluntly dissect the overlying subcutaneous tissue off of the fascia. We hypothesize that this blunt dissection sweeps off small neurofibrils from the SRN which innervate the fascia of the first dorsal compartment. We believe this procedure serves as a neurectomy as well. Although there are some corroborating anatomical studies published, much of this needs further substantiation. Next, incise the fascia of the first dorsal compartment starting proximal to the radial styloid and moving distally (Fig. 66).

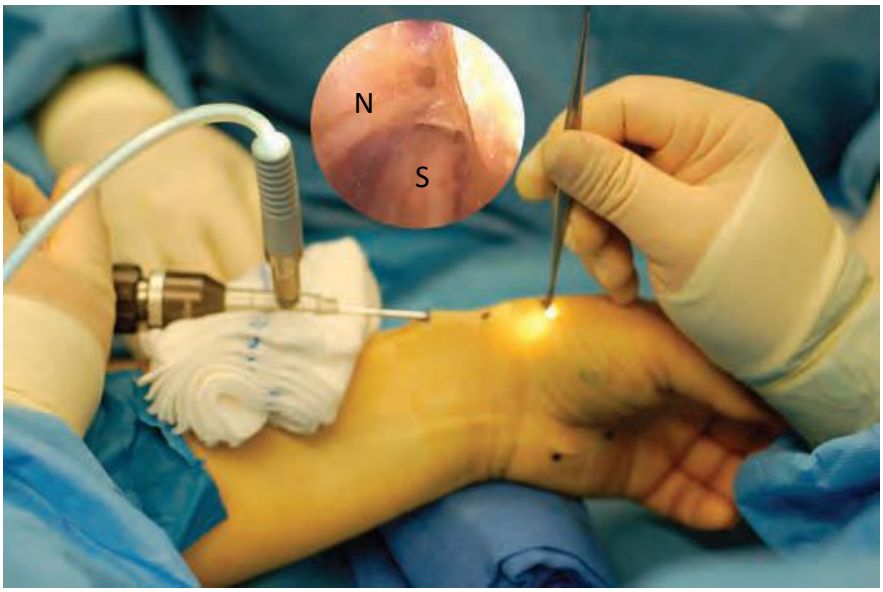


FIGURE 65. A small right angle retractor is used to elevate subcutaneous tissue off the fascial sheath of the first dorsal compartment. Endoscopic visualization of SRN and first dorsal compartment sheath below. Mueller scissors used to dissect soft tissue and microscopic innervations to the first dorsal compartment sheath from the SRN under direct vision. Abbreviations: N, nerve; S, sheath; SRN, superficial radial nerve.

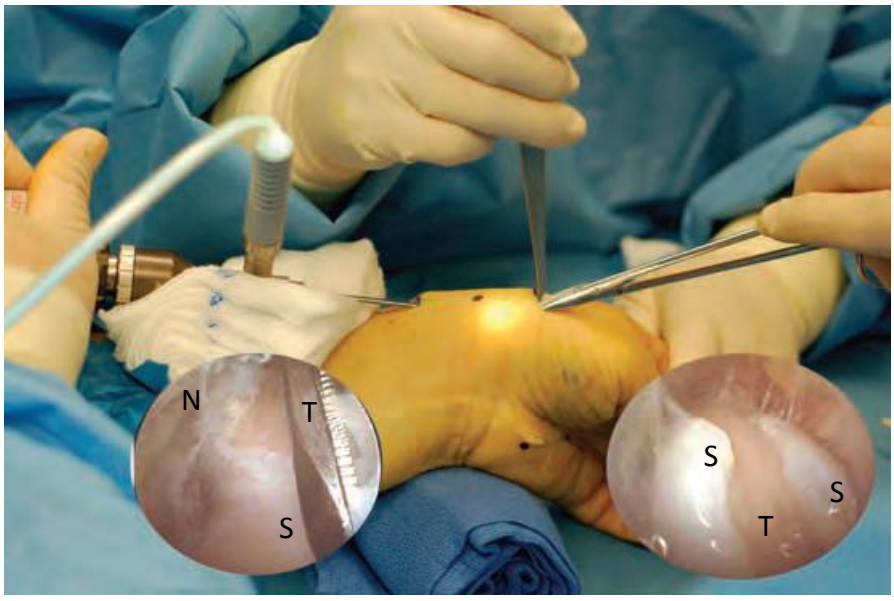


FIGURE 66. Endoscopic release of the sheath. Endoscopic image on the left shows beginning of the fascial sheath release of the first dorsal compartment, underlying tendons, and superficial radial nerve. Endoscopic image on the right showing complete release of first dorsal compartment sheath with underlying tendons. Abbreviations: N, nerve; S, sheath; T, tendons.

The tendon slips of the APL and extensor pollicisbrevis (EPB) are identified under direct visualization. To ensure release of both the EPB and APL, stabilize the first metacarpal and manually flex and extend the metacarpophalangeal joint. Through the endoscope, the EPB tendon can be visualized gliding proximally and distally while the APL tendons remain stationary. If all tendons are either stationary or gliding, then search for a separate compartment. Postoperatively patients are placed in a volar splint. The technique achieves two goals by addressing two possible sources of pain, mechanical and neuropathic. The first goal is to decrease the friction, which results in a restriction of tendon gliding. This is accomplished by release of the unyielding fascial compartment overlying the thumb extensor tendons. This release allows for a gradual reduction in tendon irritation. Over time, swelling decreases and the tissues recover.

The second goal is to perform a neurectomy of the small SRN branches to the first dorsal extensor compartment. Lin et al. demonstrated that the dorsal wrist capsule has an extensive array of sensory nerve endings (126).

Berger and Weinstein have shown that ablation of the terminal portions of the anterior and posterior interosseousnerves, which supply proprioceptive fibers to the wrist capsule, can be an effective treatment for a variety of chronicunreconstructable pathologies (127,128). Additional support for the neurectomy is found inthe pattern of referred pain from the APL. It has been shown to resemble the C6, 7, and 8 dermatomes. This parallels the superficial radial sensory nerve distribution, and is very similar to the radiation of pain that is experienced in De Quervain’s tenosynovitis (129).

2. Review of the Literature

2.1 Review methodology

The literature review employed the Pub Med and Google scholar database up to 2014 and applied the words " Mirza Technique" , "Chow Technique" , "Indiana Tome", "Security Clip", "Agee Technique", Percutaneous Trigger Finger Release", "Endoscopic De Quervain's Release" , "Carpal tunnel", "Trigger Finger", De Quervain's" in various combinations. The review included all the relevant publications in the English literature. Potentially relevant abstracts identified and screened were n=77 excluded n=47 for the following reasons : 1. Non English (n=2) and 2. Not relevant (n=45). The final studies, with usable information, included were 30.

3. Discussion

Published results of Carpal Tunnel Release (CTR) utilizing a limited incision technique have demonstrated good relief of symptoms with minimal risk of nerve injury . Proposed advantages of using a limited incision are decreased pillar tenderness and earlier return to work or a vocational activities . Hallock found similar results when comparing the mini-open technique to the endoscopic CTR (140).

Vasiliadis et al have shown that Endoscopic Carpal Tunnel Release (ECTR) appears to be associated with fewer minor complications compared to Open Carpal Tunnel Release (OCTR), but we found no difference in the rates of major complications. Return to work is faster after endoscopic release, by eight days on average. Conclusions from this review are limited by the high risk of bias, statistical imprecision and inconsistency in the included studies. Twenty-eight studies (2586 hands) were included. Twenty-three studies compared ECTR to standard open carpal tunnel release (OCTR), five studies compared ECTR with OCTR using a modified incision, and two studies used a three-arm design to compare ECTR, standard OCTR and modified OCTR. (141)

At short-term follow-up (three months or less), only one study provided data for overall improvement. They found no differences on the Symptom Severity Scale (SSS) (scale zero to five) (five studies, standardised mean difference (SMD) -0.13, 95% CI -0.47 to 0.21) or on the

Functional Status Scale (FSS) (scale zero to five) (five studies, SMD -0.23, 95% CI -0.60 to 0.14) within three months postoperatively between ECTR and OCTR. Pain scores favoured ECTR over conventional OCTR (two studies, SMD -0.41, 95% CI -0.65 to -0.18). No difference was found between ECTR and OCTR (standard and modified) when pain was assessed on noncontinuous dichotomous scales (five studies, RR 0.69, 95% CI 0.33 to 1.45). Also, no difference was found in numbness (five studies, RR 1.14; 95% CI 0.76 to 1.71). Grip strength was increased after ECTR when compared with OCTR (six studies, SMD 0.36, 95% CI 0.09 to 0.63). This corresponds to a mean difference (MD) of 4 kg (95% CI 1 to 6.9 kg) when compared with OCTR, which is probably not clinically significant. (141)

In the long term (more than three months postoperatively) there was no significant difference in overall improvement between ECTR and OCTR (four studies, RR 1.04, 95% CI 0.95 to 1.14). SSS and FSS were also similar in both treatment groups (two studies, MD 0.02, 95% CI -0.18 to 0.22 for SSS and MD 0.01, 95% CI -0.14 to 0.16 for FSS). ECTR and OCTR did not differ in the long term in pain (six studies, RR 0.88, 95% CI 0.57 to 1.38) or in numbness (four studies, RR 0.64, 95% CI 0.31 to 1.35). Results from grip strength testing favoured ECTR (two studies, SMD 1.13, 95% CI 0.56 to 1.71), corresponding to an MD of 11 kg (95% CI 6.2 to 18.81). Participants treated with ECTR returned to work or daily activities eight days earlier than participants treated with OCTR (four studies, MD -8.10 days, 95% CI -14.28 to -1.92 days).

Both treatments were equally safe with only a few reports of major complications (mainly with complex regional pain syndrome) (15 studies, RR 1.00, 95% CI 0.38 to 2.64).

ECTR resulted in a significantly lower rate of minor complications (18 studies, RR 0.55, 95% CI 0.38 to 0.81), corresponding to a 45% relative drop in the probability of complications (95% CI 62% to 19%). ECTR more frequently resulted in transient nerve problems (i.e., neuropraxia, numbness, and paresthesias), while OCTR had more wound problems (i.e., infection, hypertrophic scarring, and scar tenderness). ECTR was safer than OCTR when the total number of complications were assessed (20 studies, RR 0.60, 95% CI 0.40 to 90) representing a relative drop in the probability by 40% (95% CI 60% to 10%).

Rates of recurrence of symptoms and the need for repeated surgery were comparable between ECTR and OCTR groups.

The overall risk of bias in studies that contribute data to these results is rather high; fewer than 25%of the included studies had adequate allocation concealment, generation of allocation sequence or blinding of the outcome assessor **(Table 1).**

Endoscopic versus open or mini-open carpal tunnel release for carpal tunnel syndrome

Patient or population: participants with carpal tunnel syndrome

Intervention: endoscopic versus open or mini-open carpal tunnel release

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Open or mini-open carpal tunnel release (OCTR)	Endoscopic carpal tunnel release (ECTR)				
Symptom Severity Scale (Levine) at 3 months or less Participants' self assessment questionnaire. Scale from: 1 to 5.		The mean symptom severity score at 3 months or less in the ECTR groups was **0.13 standard deviations lower** (0.47 lower to 0.21 higher)[1]		551 (5 studies)	⊕⊕⊖⊖ **low**[2,3]	SMD -0.13 (95% CI -0.47 to 0.21)
Functional Status Scale (Levine) at 3 months or less		The mean functional status score at 3 months or less in the ECTR groups was **0.23 standard**		551 (5 studies)	⊕⊕⊖⊖ **low**[2,3]	SMD -0.23 (95% CI -0.60 to 0.14)

Participants' self assessment questionnaire. Scale from: 1 to 5.		**deviations lower** (0.6 lower to 0.14 higher)[1]				
Grip strength at 3 months or less Dynamometer		The mean grip strength at 3 months or less in the ECTR groups was **0.36 standard deviations higher** (0.09 to 0.63 higher)[1]		560 (6 studies)	⨁⨁⨁⊖ **moderate**[2]	SMD 0.36 (95% CI 0.09 to 0.63)
Overall improvement at more than 3 months Participants' subjective evaluation	**781 per 1000**	**812 per 1000** (742 to 891)	**RR 1.04** (0.95 to 1.14)	317 (4 studies)	⨁⨁⊖⊖ **low**[2,4]	
Symptom Severity Scale (Levine) at more than 3 months Participants' self assessment questionnaire. Scale from: 1 to 5.	The mean symptom severity scale in more than 3 months ranged across control groups from **1.42 to 1.8 points**	The mean symptom severity score at more than 3 months in the ECTR groups was **0.02 higher** (0.18 lower to 0.22 higher)		273 (2 studies)	⨁⨁⊖⊖ **low**[2,4]	

Function Status Scale (Levine) at more than 3 months Participants' self assessment questionnaire. Scale from: 1 to 5.	The mean Function Status Scale in more than 3 months ranged across control groups from **0.5 to 0.9 points**	The mean Function Status Score at more than 3 months in the ECTR groups was **0.01 higher** (0.14 lower to 0.16 higher)		273 (2 studies)	⨁⨁⊖⊖ **low**[2,4]	
Grip strength at more than 3 months Dynamometer. Scale from: 0 to 50.		The mean grip strength at more than 3 months in the ECTR groups was **1.13 standard deviations higher** (0.56 to 1.71 higher)[5]		56 (2 studies)	⨁⨁⊖⊖ **low**[2,4]	SMD 1.13 (0.56 to 1.71)
Time to return to work (in days)	The mean time to return to work ranged across control groups from **19 to 76 days**	The mean time to return to work in the ECTR groups was **8.1 days shorter** (14.28 to 1.92 lower)		274 (4 studies)	⨁⊖⊖⊖ **very low**[2,3,4]	
Major complications (events)	**Study population** **10 per 1000**	**10 per 1000** (4 to 26)	**RR 1** (0.38 to 2.64)	1508 (15 studies)	⨁⨁⊖⊖ **low**[2,6]	
	Moderate					

		5 per 1000			
	5 per 1000	(2 to 13)			
	Study population				
		57 per 1000			
	103 per 1000	(39 to 83)			
	Low				
		6 per 1000			
	10 per 1000	(4 to 8)			
Minor complications	**Moderate**		**RR**		
events with minor complications		**17 per 1000**	**0.55** (0.38 to 0.81)	1786 (18 studies)	⊕⊕⊖⊖ **low**[2,6]
	30 per 1000	(11 to 24)			

*The basis for the **assumed risk** (eg the median control group risk across studies) is provided in footnotes.

The **corresponding risk** (and its 95% CI) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: confidence interval; **ECTR**: endoscopic carpal tunnel release; **RR:** risk ratio; **SMD**: standardised mean difference

Table 1

There was a significant improvement in pre to post operative symptom severity score (SSS) and functional status score (FSS) in a postoperative study from Maliyappa CC et al **(Table 2)**.(142)

Type of scoring	Evaluation			Significance		
	Preoperative	6 months	Follow-up	Preoperative to 6 months	Preoperative to final follow-up	6 months final follow-up
SSS	3.16±0.36	1.77±0.29	0.46±0.26	d=1.38 *P*=<0.001**	d=2.70 *P*=<0.001**	d=1.31 *P*=<0.001**
FSS	2.92±0.39	1.34±0.29	0.54±0.21	d=1.58 *P*=<0.001**	d=2.38 *P*=<0.001**	d=0.79 *P*=<0.001**

*Moderately significant (*P*: 0.01<*P* ≤ 0.05), **Strongly significant (*P*: *P* ≤0.01), *Suggestive significance (*P*: 0.05<*P*<0.10). SSS: Symptom severity score, FSS: Functional status score, d = Difference

Table 2

There were 22 patients (27 hands) who underwent limited open carpal tunnel release from January 2009 to August 2012. In patients with bilateral pathology, each hand was considered separately. All 22 patients (21 female and 1 male) completed the study. The right wrist was involved in 16 cases and left in 11. The mean age of patients was 44.9 years (standard deviation [SD] ± 12.91) with mean duration of follow-up was 16.2 months (SD ± 9.86). The average duration of symptoms before surgery was 8.64 months (SD ± 5.15).The mean operative time was 32.78 min (SD ± 9.34).While average surgical wound length was 2.7 cm. The median time to return to work was 14 days (range: 7-31 days). The preoperative SSS was 3.16 (SD ± 0.36). The score improved to 0.46 (SD ± 0.26) at average final follow-up. Similarly, the FSS also improved from 2.92 (SD ± 0.39) preoperative to 0.54 (SD ± 0.21) postoperative. The details of the statistical calculation are shown in (**Table 2)**.

Tiffany N. et al found that there was no statistically significant difference between the single- and two-incision CTR groups with respect to pre- and post-operative DASH scores, BWCTQ scores, grip strength, pinch strength, scar tenderness, or pillar pain. The only statistically significant difference was improved sensation by Semmes–Weinstein in the single-incision group in the second finger at 6 weeks post-operatively and in the third finger at 6 months post-operatively (143). From 2008 to 2009, patients with isolated carpal tunnel syndrome were randomized to undergo either single-incision or two-incision CTR by a single surgeon at a university medical center. Pre-operatively, participants completed a Disabilities of the Arm, Shoulder, and Hand (DASH) Questionnaire, Brigham and Women's Carpal Tunnel Questionnaire (BWCTQ), as well as grip and pinch strength and Semmes–Weinstein monofilament sensation testing. At 2 weeks, 6 weeks and at least 6 months post-operatively, these measurements were repeated along with assessment of scar tenderness and pillar pain. Data

were analyzed using SPSS version 20 software to perform non-parametric tests and Pearson's correlations. Significance was set at $p = 0.05$.

Dongqing Zuo et al have done a meta analysis of the literature about the safety and efficacy of endoscopic carpal tunnel release (ECTR) and open carpal tunnel release (OCTR) for idiopathic carpal tunnel syndrome (CTS). A comprehensive literature search of the electronic databases MEDLINE, EMBASE, Google Scholar, and the Cochrane Controlled Trial Register was undertaken for randomized studies reporting carpal tunnel syndrome treated with ECTR or OCTR **(Table 3)** .

Study	Study design	Publication year	Country	Number (hands)	Gender (F/M)	Age (year)	Treatment	Study visits (week postoperative)	Efficacy variables	Complication
Agee 1992	Randomized Ten-center study	1992	US	ECTR: 65 OCTR: 82 147 hands in 122 patients	UN	UN	Agee's one-portal procedure Regional block or general anesthesia	1, 2, 3, 6, 9, 13, 26	Grip strength, pinch strength, SemmesWeinstein monofilament sensory mapping, Phalen's wrist flexion test, Tinel's test, manual motor testing, time return to work	ECTR: 4/65 (2 partial transection, 2 transient ulnar neurapraxia) OCTR: 4/82 (1 deep motor branch of the ulnar nerve, 1 bowstringing of the digital flexor tendons, 2 wound dehiscence)
Brown 1993	Prospective, multicenter, randomized study	1993	US	ECTR: 84 OCTR: 85 169 hands in 151	31/53 23/62	57 55	Two-portal technique	3, 6, 12	Strength, pinch strength, satisfaction, pain	ECTR: 4/84 (1 partial transection, 2 nerve injury, 1 wound hematoma) OCTR: 0/85
Sennwald and Benedetti 1995	Prospective randomized study	1995	Switzerland	ECTR: 25 OCTR: 22	19/6 18/4	48.6 57	One-portal procedure Regional anesthesia	4, 8, 12	Pain, grip, key-pinch strength, and ability to return to work Operative time	ECTR: 1/25 (1 neurapraxia) OCTR: 2/22 (1 RSD, 1 hypotrophic scar)
Dumontier 1995	Prospective randomized study	1995	France	ECTR:56 OCTR:40	49/7 36/4	53.4 50.7	Two-portal technique	2, 4, 12	Numbness, pain, return to work, pinch and grip strength	ECTR: 2/56 OCTR:2/40 (2 reflex sympathetic dystrophy for both groups
Jacobsen 1996	Prospective randomized study	1996	Sweden	ECTR: 16 OCTR: 16 29 patients	11/5 12/4	UN	Two-portal technique	2, 6, 24	Return to work, patient satisfaction	ECTR: 3/16 (3 transient numbness) OCTR: 0/16

MacDermid 2003	Prospective randomized study	2003	Canada	ECTR: 91 OCTR: 32	62/29 22/10	45 53	Two-portal Chow's procedure	1, 6, 12	Symptom severity, pain, pinch, grip strength, satisfaction	ECTR: 0/91 OCTR: 0/32
Ferdinand 2002	Prospective randomized blinded study	2002	Scotland	ECTR: 25 OCTR: 25	20/5 20/5	54.88	Two-portal	6, 12, 26, 52	Return to work, day off ADL score, satisfaction, operative time	ECTR: 1/25 (wound pain) OCTR: 3/25 (2 persisting pain, 1 nerve injury)
Trumble 2002	Prospective multicenter randomized study	2002	US	ECTR: 97 OCTR: 95	48/27 47/25	56 56	One-portal	2, 4, 8, 12, 26, 52	Symptom severity score, function score, operative time, satisfaction score, median time return to work, cost	ECTR: 0/97 OCTR: 2/95 (2 reflex sympathetic dystrophy)
Wong 2003	Prospective randomized study	2003	HK	ECTR: 30 OCTR: 30	28/2 28/2	47 47	Two-portal Intravenous regional block	2, 4, 8, 12, 16, 24, 48	Wound and pillar pain, pinch and grip strength, two-point discrimination power, operative time	ECTR: 0/30 OCTR: 0/30
Atroshi 2006	Prospective randomized study	2006	Sweden	ECTR: 63 OCTR: 65	44/19 52/13	44 44	Two-portal technique	3, 6, 12, 48	Pain in scar, median postoperative workabsence, severity of symptom, functional score, QOL, hand sensation, operative time	ECTR: 2/63 (2 recurrenceof symptoms, 1 for OCTR) OCTR: 1/65
Soichi Ejiri 2012	Prospective randomized controlled study	2012	Japan	ECTR: 51 OCTR: 50	48/3 43/7	59 58	Okutsu's one-portal technique Local anesthesia	4, 12	Change in subjective symptom, impairment in daily activity, APB-DL, sensation, muscle strength	ECTR: 3/51 (3 exacerbation of symptoms) OCTR: 0/50

Larsen 2013	Prospective Single-blind randomized controlled study	2013	Denmark	ECTR: 30 OCTR: 30	22/8 48/12	54 45	One-portal technique	1, 2, 3, 6, 12, 24	Pain VAS score, paresthesia, grip strength, range of motion, pillar pain, duration of sick leave	ECTR: 2/302 (neurapraxia) OCTR: 2/60 (2 infection)
Ho Jung Kang 2013	Prospective randomized controlled study	2013	South Korea	ECTR: 52 OCTR: 52	48/4 48/4	55 55	One-portal technique General anesthesia	12	BCTQ-S, BCTQ-F, DASH, intraoperative tourniquet time, pain, scar or pillar pain	UN

UN unknown, BCTQ-S Boston Carpal Tunnel Questionnaire score, DASH Disabilities of the Arm, Shoulder and Hand, APB-DL abductor pollicis brevis-distal latency, ADL activity of daily living 7**(Table3)**

Danielle Cross et al refers thirteen male and four female patients (average age of 50.5) underwent dual endoscopic cubital and carpal tunnel release. Two patients were lost to follow-up and eliminated from data analysis. Pre- and postoperative comparisons were completed for median DASH scores, grip strength, chuck pinch strength, and key pinch strength at their preoperative visit and at 12 weeks. DASH scores improved significantly from a median of 67.5 to 16 ($p = 0.002$), grip strengths improved from 42 to 55.0 lbs ($p = 0.30$), chuck pinch strengths improved significantly from 11 to 15.5 lbs ($p = 0.02$), and key pinch strengths increased significantly from 13 to 18 lbs ($p = 0.003$). Average static two-point discrimination decreased from 5.9 to 4.8 mm. In terms of pain, 82 % of patients had complete resolution of pain, and the remaining 18 % experienced pain only with strenuous activity. In terms of numbness/tingling, 100 % of patients had complete resolution of median nerve symptoms; 88 % of patients had substantial improvement of numbness and tingling symptoms, and 12 % had residual ulnar nerve symptoms. In terms of muscle strength, 92 % of patients had improvement to 5/5 APB strength, while 100 % of patients had improvement to 5/5 intrinsic and FDP strengths. Two minor complications occurred, including one superficial hematoma and one superficial cellulitis. (144)

48 Patients with CTS were enrolled in Hamidreza Aslani et al prospective trial. Participants were classified in 2 groups: 24 patients underwent open surgery technique and 24 underwent endoscopic carpal tunnel decompression. Carpal canal shape and volume, configuration and position of contents, were analyzed by using imaging techniques. Preoperative carpal canal volume in endoscopic patient group averaged 5.7 ± 1.4 cc and 7.3 ± 2.9 cc at 6 weeks postoperatively ($28\% \pm 7\%$, $p = 0.018$). In contrast preoperative carpal canal volume in open carpal tunnel release group averaged 4.9 ± 1.1 cc (and increased to 6.2 ± 1.7 cc at 6-week follow up investigation ($36\% \pm 5\%$, $p = 0.002$).

Preoperative carpal arch width calculation in endoscopic carpal tunnel release group averaged 21.7 ± 1.1 mm and 21.5 ± 1.9 mm in open carpal tunnel release patients ($p = 0.6575$). Postoperative carpal arch width measurements in endoscopic carpal tunnel decompression group averaged 22.6 ± 4.1 mm and 22.1 ± 2.9 mm in open carpal tunnel release patient population at 6-week follow-up investigation ($p = 0.628$).(160)

On the other hand, percutaneous trigger thumb release has been extensively used in adults, the technique is not widespread in children. One study from Masquijo, Julio J. MD et al ,was to evaluate the efficacy and safety of percutaneous trigger thumb release in the pediatric age

group.(161) Twenty consecutive thumbs of 15 patients scheduled for surgical release of the A1 pulley were included in this cohort. Each patient received first the percutaneous release (PR) followed by an open release (OR) and served as self-controls. Thumb extension was assessed immediately before PR, after PR, and finally after OR, using a goniometer. Extent of the A1 pulley release, iatrogenic injury to the digital nerve and vessels, and flexor tendon laceration was assessed after PR. The distance between the PR and the digital nerve was measured in millimeters. Comparison between thumb extension after PR and OR was made using a paired test. Preoperative range of motion averaged −45.2±21.7 degrees loss of extension (range, −80 to −10 degrees), decreased to −4±8 degrees loss of extension (range, −25 to 0 degrees) after PR, and to 0 degrees after OR. Clinically, release was complete in 14 cases (70%) and partial in 6 cases (30%). Once the thumb was approached, we confirmed that A1 pulley was completely cut in 4 cases (20%), to >75% in 2 cases (10%), and between 50% and 75% in the remaining 14 cases (70%). There were no neurovascular iatrogenic injuries. Mean distance between the needle and the digital nerve was 2.45±0.9 mm (range, 1 to 4 mm). Lacerations to the flexor tendons were observed in 80% of the cases. (161)

Gulabi, D., et al. present the clinical results and ultrasonographic findings of 61 trigger digits treated with percutaneous A1 pulley release. An endoscopic carpal tunnel knife was used for the release in the outpatient department. The mean follow-up period was 3.5 months. A total of 55 digits (90%) had complete relief of their triggering postoperatively. Six digits (10%) had Grade 2 triggering clinically in the early postoperative period. The complications included six cases of insufficient release (10%), scar sensitivity in one patient, short-term hypoaesthesia in three digits (5%), and flexor tendon laceration noted on postoperative ultrasonography in eight digits (13%). No neurovascular damage was noted on the postoperative ultrasonography. Ultrasonography provides information about tendon laceration and changes in thickness of the pulleys and confirm A1 pulley release after surgery, but it does not alter clinical decision-making. He believes that pre- and postoperative ultrasonography does not need to be included as a routine examination.(162)

4. Conclusion

CTS remains one of the most well-known and frequent form of median nerve entrapment, and accounts for 90% of all entrapment neuropathies. This review of the recent literature has provided an overview of this common condition, with an emphasis on the various methods of minimally invasive surgery and its complications .

Both open and endoscopic techniques are widely used. Increased carpal tunnel volume has been observed independently of the technique used for sectioning the flexor retinaculum. After open surgery, an increase in volume of 24.2 ± 11.6% was observed, with palmar displacement of the content of 3.5 ± 1.9 mm(145). After endoscopic surgery, the increase in the sectioned area was estimated as 33 ± 15%(146). Safety, efficacy, morbidity, cost and time taken to return to preoperative activities have been compared. The learning curve is longer for endoscopic surgery. One study found that, one year after the operation, there was no difference between the two techniques(147). On the other hand, some studies have demonstrated that endoscopic surgery enables earlier functional recovery, especially over the first three months(148). Pain at the site of the surgery has been less observed after Atroshi's endoscopy(151, 152). Eight studies out of 14 showed that there was a faster return to work after endoscopy, with a difference of between six and 25 days(153). However, this continues to be a matter of controversy, such that there are studies showing that each of the techniques was superior to the other one(154). Few studies have compared endoscopy with the mini-open technique, and the results have either been identical or have favored endoscopic surgery regarding postoperative pain(153). According to Wong et al. (155) the technique of Lee and Strickland (156) seemed to lead to less postoperative pain than did Chow's endoscopic technique. In comparing conventional surgery with the mini-open technique, the results are inconclusive, with some short-term advantages for the mini-open procedure(153). On the other hand, the risk of incomplete sectioning of the flexor retinaculum is higher with the mini-open technique(157). The choice between open, mini-open or endoscopic surgery depends on the surgeon's preferences and habits (158), the information available to the patient, the type of CTS, its etiology and the availability of equipment.

A number of authors demonstrated that the percutaneous A1 pulley release for trigger digits is equally effective and safe as an open technique, and it avoids the time, expense, and complications related with surgical procedure. It can be performed easily, quickly, and safely in

an outpatient or office setting. The procedure itself is well tolerated by most patients, and the discomfort associated with it compares favorably with that associated with steroid injection.

The endoscopic approach for De Quervain's Syndrome allows to keep incisions outside of the hyper sensitized zone of injury. Additionally, an arthroscopic approach allows for an extensive neurectomy of the tiny branches of the superficial radial nerve (SRN), which may innervate the first dorsal compartment. Therefore, the minimally invasive approach along with this neurectomy may result in faster and more complete pain relief, with less risk for painful scar development. Finally, with the proper training, endoscopic approach can be a safe technique. At this point, the neurectomy component of the procedure is strictly a working hypothesis and not yet substantiated by substantial basic science and clinical research.

5. Abstract

Surgical treatment of Carpal Tunnel Syndrome (CTS) consists of the division of the transverse carpal ligament which reduces the pressure on the median nerve by increasing the space in the carpal tunnel (130). Surgery is recommended for most patients with moderate to severe CTS. There are two different categories of methods used for surgical treatment of CTS: open release and endoscopic release. Open carpal tunnel release consists of the standard method of open release, as well as several modified methods. Modifications to the standard open carpal tunnel release (OCTR) include new incision techniques, such as the mini-open release, and addition of other procedures such as epineurotomy (131,132). The standard open carpal tunnel release consists of a longitudinal incision at the base of the hand and in line with this incision, the incision of the subcutaneous tissue, the superficial palmar fascia and the muscle of the palmaris brevis (132) . The mini-open carpal tunnel release is a relatively new technique that consists of a longitudinal incision that varies from 1.5-3.0 cm, placed in line with the radial border of the ring finger(132) . Different tools have been used for the mini-open carpal tunnel release, such as the Indiana Tome (132) . Endoscopic carpal tunnel release (ECTR) is another new technique that was developed by Okutsu and colleagues since 1986 (134) . The two most commonly used methods of endoscopic carpal tunnel release are the single-portal and dual-portal technique; techniques that differ based on the number of ports used to access the carpal tunnel (135) . The

single portal technique consists of the release of the transverse carpal ligament by using a single incision at the wrist. The double-portal technique consists of two incisions, one at the wrist and one at the palm of the hand. Several studies have tried to compare the efficiency and outcomes of the techniques involving carpal tunnel release procedures. Open carpal tunnel release and endoscopic carpal tunnel release have been shown to have no significant differences in outcomes within 12 week of surgery (136) and within 1 and up to 5 years of surgery (132) . Mini-open carpal tunnel release and standard open carpal tunnel release have shown no significant differences within 4 months of surgery (137) and within 6 months of surgery (139) ; however, mini-open carpal tunnel release has been shown to have better outcomes in earlier stages after surgery (138). ECTR release is sometimes favored over OCTR as dividing the skin from below preserves the muscle and overlying skin, thus facilitating return to work; however, it has an increased risk of nerve or artery injury because of limitations in visualization (132) . ECTR has been shown to have better outcomes in muscle strength within 12 wk of surgery (132) and better outcomes compared to both standard open and mini-open release within 4 week of surgery (137)

The Agee ECTR technique represents a single-portal, minimally invasive procedure to treat patients with median nerve compression at the wrist who meet the criteria for surgery. General advantages of this technique over open CTR include:

- less scar tenderness
- decreased pillar pain
- faster recovery of pinch and grip strength, and
- earlier return to work and daily activities.

Moreover, the Agee technique has the advantage of being a single incision technique that utilizes a blade system that readily attaches to the standard endoscopic equipment that is widely available in most medical centers. However, as in any surgical and especially endoscopic procedure, safety and success are dependent upon patient selection, thorough knowledge of the surface and surgical anatomy, adequate training, and familiarity with the use and capabilities of the instrumentation. Surgeons who are not familiarized with endoscopic equipment and technique may give rise to major iatrogenic complications.

Open A1 pulley release is a standard surgical procedure for treatment of trigger finger. The disadvantages of the open technique include injury to the soft tissue, developing a painful palmar scar and patients requiring an extended recovery time since the procedure is more complex.

Another technique used for treatment of trigger finger is percutaneous release. This technique offers the benefits of smaller incision, faster recovery time and an easier procedure compared to the open technique. The A-Knife is a new specially designed invention for percutaneous trigger finger release.(163)

Therefore, percutaneous trigger finger release is believed to be the indicated treatment of choice for:

- cases that failed conservative treatment,
- cases when the symptoms last for more than four months,
- Grade 3 (locking but passively correctable), and
- Grade 4 (a locked digit) triggering is present.

The advantages of the procedure are short operative time, safety and ease as an office procedure. The patient will have a rapid recovery period and less post-operative pain.

DeQuervain's tenosynovitis is a common problem that often requires surgical treatment. The classic open approach for release of the first dorsal compartment is not without complications and results are not uniformly excellent. Controversies that exist include location and orientation of the incision and the amount of retinaculum removed. Endoscopic treatment of this tendinopathy may be helpful in minimizing these problems.

6. Περίληψη

Η χειρουργική θεραπεία του Συνδρόμου Καρπιαίου Σωλήνα συνιστάται στη διάνοιξη του καρπιαίου συνδέσμου , μειώνοντας έτσι την πίεση του νεύρου και αυξάνοντας τον χώρο του καρπιαίου σωλήνα. Υπάρχουν δυο διαφορετικές χειρουργικές μέθοδοι : η ανοικτή διάνοιξη του καρπιαίου συνδέσμου και η ενδοσκοπική. Η πάγια τεχνική είναι η ανοικτή διάνοιξή. Όμως η ενδοσκοπική θεραπεία χαρακτηρίζεται από μικρότερο μήκος της τομής (1.5-3.0 cm). Όσον αφορά την ενδοσκοπική μέθοδο υπάρχουν ειδικά εργαλεία που να εξυπηρετούν αυτό το σκοπό όπως το Indiana tome.

Ανακαλύφθηκε από τον Okutsu και τους συνεργάτες του το 1986 και διακρίνεται σε τεχνική του ενός ή των δύο "port". Η διαφορά τους έγκειται στο ότι του ενός port χρησιμοποιεί ένα σημείο εισόδου στον καρπό, ενώ των δύο port και ένα σημείο εισόδου στον καρπό. Σε σύγκριση με την ανοικτή τεχνική δεν παρουσιάζεται κανένα διαφορετικό αποτέλεσμα μετά το πέρας 12

εβδομάδων. Η ανάμεσα στην ανοικτή και στην ενδοσκοπική τεχνική περιορίζεται στον άμεσο μετεγχειρητικό χρόνο και αφορά την γρήγορη επιστροφή στην εργασία, τον λιγότερο πόνο μετεγχειρητικά και την ταχύτερη επαναφορά της μυϊκής ισχύος του χεριού. Ωστόσο λόγω της μειωμένης ορατότητας με την ενδοσκοπική τεχνική , υπάρχει ο κίνδυνος της κάκωσης αγγείων και νεύρων. Από της mini τεχνικές διάνοιξης του καρπιαίου σωλήνα φαίνεται πως η τεχνική Agee συγκεντρώνει τα περισσότερα πλεονεκτήματα που προαναφέρθηκαν. Παρόλα αυτά η μη εξοικείωση με τις τεχνικές ελαχίστης επεμβατικότητας είναι δυνατόν να προκαλέσει πολλαπλές επιπλοκές στον ασθενή.

Η διάνοιξη του A1 pulley είναι ο κανόνας στην αποκατάσταση του εκτινασσόμενου δακτύλου. Και εδώ υπάρχει η ανοικτή και η ενδοσκοπική τεχνική, με τη δεύτερη να υπερτερεί στον χρόνο αποθεραπείας, στον χρόνο αποχής από την εργασία, στο μετεγχειρητικό άλγος και στο μέγεθος της χειρουργικής τομής. Ωστόσο υπάρχουν ενδείξεις για ενδοσκοπική αποκατάσταση , όπως η χρονιότητα της πάθησης, η αποτυχία των συντηρητικών θεραπειών και η νόσος σταδίου 3 και 4.

Η θεραπεία του συνδρόμου DeQuervain's συνίσταται κατά βάση σε ανοικτού τύπου χειρουργική αποκατάσταση, με πολλαπλά όμως μετεγχειρητικά προβλήματα, που αφορούν το σημείο εισόδου και τους χειρισμούς στην περιοχή. Η ενδοσκοπική θεραπεία δύναται ελαττώσει τις επιπλοκές της ανοικτής αποκατάστασης.

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