SCIENTIFIC ARTICLE

A Cadaveric Study for the Improvement of Thread Carpal Tunnel Release

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Purpose The thread carpal tunnel release (TCTR) technique has been improved and offers more precise control in dissecting thread placement. The purpose of this cadaveric study was to test the procedure operationally and verify the modified TCTR anatomically.

Methods Eleven unembalmed cadaver wrists underwent the transverse carpal ligament (TCL) release by using the modified TCTR technique. An experienced observer dissected each specimen and assessed for completeness of release under direct visual assessment. Injury to the superficial palmar aponeurosis (SupPA), the Berrettini and common digital nerve branches were also recorded as a secondary outcome.

Results Eleven out of 11 wrists (100%) underwent the modified TCTR with complete release of the TCL. All 11 wrists were released without damage to any vital neurovascular structure including the Berrettini branch and the common digital nerves. The SupPA remained intact in all 5 wrists performed with the preservation steps.

Conclusions The modified TCTR technique demonstrated complete division of the TCL while protecting the SupPA as well as the Berrettini and common digital nerve branches.

Clinical relevance The modified TCTR has the potential to offer a clinically safe and effective minimally invasive procedure for complete carpal tunnel release. *(J Hand Surg Am. 2016;■(■):■−■. Copyright © 2016 The Authors. Published by Elsevier Inc. on behalf of the American Society for Surgery of the Hand. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).)*

Key words Carpal tunnel release, carpal tunnel syndrome, ultrasound-guided procedure, thread carpal tunnel release, ultraminimally invasive procedure.

A PREVIOUS STUDY ON 34 HANDS OF 20 patients showed that thread carpal tunnel release (TCTR) is safe and effective, using only 2 needle puncture sites, no incision, local anesthesia, and without need for an operating room. Patients can return to work within a few days after the procedure.[1]

Although there were no complications in the previous study, surgeons have difficulty in manipulating the routing needle to exit the skin at the designated spot in the palm because of the difficulty caused by the thick and stiff tissue mass that makes up the distal portion of the transverse carpal ligament (TCL). In addition, there is a risk of injuring the superficial palmar arterial arch (SPA) if the needle exits too distally,[2,3] and a risk of incomplete transection of the distal TCL if the needle exits too proximally. Other concerns include potential

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injury of common digital nerves or the communicating branch between the ulnar nerve and the median nerve, the so-called "Berrettini branch."[4,5]

Recently, the authors revised the TCTR technique with 3 major modifications. First, an entry-at-palm (with exit-in-wrist) technique for the routing needles is used instead of the exit-at-palm technique previously used. With this modification, the needle easily exits at the wrist with the help of wrist extension. This modification provides improved accuracy for needle control in the palm, minimizing the chances of damage to important anatomical structures in this area. Second, a fine needle (27 g) is used as an initial needle prior to passing the first routing larger-bore (18 g) needle. This 27-g needle is used to accurately create the path toward proximal and allows for hydrodissection at the entry point. The importance of this modification is that the SPA and other vital structures can be displaced away from the cutting path. Third, the superficial palmar aponeurosis (SupPA) in the palm is excluded from the cutting loop so that it is preserved.

The purpose of this cadaveric study was to assess and validate these modifications to the TCTR technique.

MATERIALS AND METHODS

General

The study was done on 11 available unembalmed cadaveric wrists, 7 in a cadaver laboratory in Baltimore, Maryland, and 4 in a laboratory in Minneapolis, Minnesota. All specimens were free from signs of trauma, without previous wrist surgery, and maintained a normal TCL.

The ultrasound systems used were the M-Turbo Model from Fujifilm Sonosite Company (Bothell, WA) and the Logic S8 R3 system from General Electric (Boston, MA). Other necessary equipment included skin-marking pens; 1.5-inch 27-g needles; 3.5-inch 18-g spinal needles; 0.9% normal saline; and a length of surgical dissecting thread (Loop&Shear, 0.009 inch in diameter; Ridge & Crest Company, Monterey Park, CA).

The distal edge of the division of the TCL was sonographically determined at the "duck's beak." The duck's beak is a sonographic concept introduced by Rojo-Manaute et al[6] to describe the appearance of the distal edge of the TCL. In a sonographic longitudinal view, the convergence of the distal portion of the TCL and the SupPA is shaped like a duck's beak (Fig. 1).

The proximal edge of the TCL was determined by selecting a needle exit site at a point 2 cm proximal to the distal wrist crease.

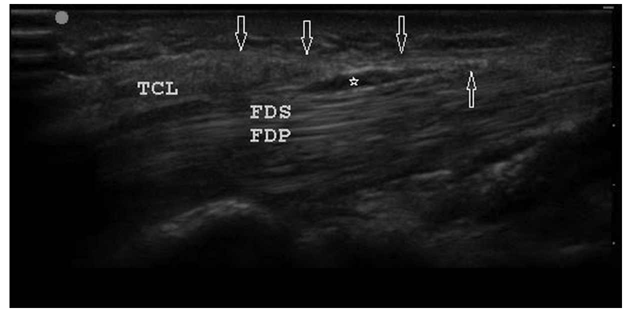

FIGURE 1: Duck's beak. The TCL blends with the SupPA to show a hyperechoic area shaped like a duck's beak. The down arrows point to the SupPA that helps form the superficial border of the TCL. The up arrow is at the distal tip of the duck's beak. The duck's beak overlies the palmar fat pad, seen as a hypoechoic area (star) between the Duck's beak and the flexor tendons. FDP, flexor digitorum superficialis tendons; FDS, flexor digitorum profundus tendons.

FIGURE 2: The routing needle travels between the entry and the exit points within the safe zone.

The routing needles travel distal to proximal between the entry point on the palm and the exit point at the wrist and are kept within the "safe zone" between the median nerve and the ulnar artery (Fig. 2). The thread placement routing process is completed in 2 18-g needle passes. The route of the first needle is along the dorsal (deep) surface of the TCL, proximally through the carpal tunnel, and the route of the second pass is on the palmar (superficial) surface of the TCL. The path of the cutting thread is illustrated in Figure 3. The whole routing process is done using real-time visualization via ultrasound and with the simultaneous use of hydrodissection. The details of the routing process are as follows:

First, a 27-g needle is inserted into the skin on the palm of the hand, at a point about 5 mm distal to the SPA, which is visualized using ultrasound. This needle is advanced proximally using hydrodissection with saline, and is passed superficial to the arterial arch. The needle is then directed to penetrate the SupPA and enter the carpal tunnel by penetrating the