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● *Original Contribution*

A CADAVERIC AND PRELIMINARY CLINICAL STUDY OF ULTRASONOGRAPHICALLY ASSISTED PERCUTANEOUS CARPAL TUNNEL RELEASE

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Abstract—The aim of this study was to assess the effectiveness and safety profile of a new technique for ultrasonographically assisted percutaneous carpal tunnel release. Experiments were performed on 40 hands in 20 cadavers. We first performed a detailed ultrasonographic examination and correlation study that included surgical dissection of the transverse carpal ligament, the related neurovascular structures and the bony landmarks of the radiocarpal, midcarpal and carpometacarpal joints of the right hand. We then used the measurements we made for percutaneous carpal tunnel release of the transverse carpal ligament using intra-operative ultrasonography for guidance and a hook knife on the left-hand side. The completeness of the release and the potential risks of injury to the flexor tendon and neurovascular bundles were examined. Using real-time intra-operative ultrasonographic monitoring to clearly delineate these targets, we were able to percutaneously release the transverse carpal ligament completely in 18 (90%) of the 20 hands and partially release it in 2 without injuring any neurovascular bundles. We then performed the procedure on 91 consecutive cases of carpal tunnel syndrome and found that the sensory disturbances disappeared in 100% patients 12 mo post-operatively; only 2 hands were graded as unsatisfactory. There were no intra- or post-operative complications. Based on the results from the cadaveric studies and our successful preliminary clinical outcomes, we conclude that this method is tolerable and that its clinical application can be encouraged. (E-mail: Jming@mail.ncku.edu.tw) **© 2014 World Federation for Ultrasound in Medicine & Biology.**

Key Words: **Carpal tunnel syndrome, Percutaneous release, Ultrasonography.**

INTRODUCTION

Carpal tunnel syndrome is a relatively common affliction for which surgical release of the transverse carpal ligament is generally recommended if conservative treatment has failed. Traditional open carpal tunnel release is regarded as tolerable and effective (American Academy of Orthopaedic Surgeons Work Group 2008; Scholten et al. 2007). A review of several follow-up studies, however, reveals a certain rate of patient dissatisfaction with the surgical result and that significant post-operative complications, that is, hypertrophic scarring, decreased grip strength, easy hand fatigability, pillar pain, incisional pain and prolonged convalescence time, have all been described in significant numbers (Boya et al. 2008; Kluge et al. 1996). Traditional open surgery has been evolving toward more minimally invasive techniques in efforts to reduce approach-related morbidity, to improve cosmesis and to speed recovery and return to normal activity. Although there have been many controversies about potential complications caused by blind insertion of the trocar and the restricted view of the carpal tunnel (Benson et al. 2006; Boeckstyns and Sorensen 1999; Muller et al. 2000; Rowland and Kleinert 1994; Varitimidis et al. 1999), endoscopic carpal tunnel

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release has been found to be a most valuable alternative to the traditional method because it eliminates the palmar scar and minimizes the subsequent scar tenderness (Ferdinand and MacLean 2002; Scholten et al. 2007; Thoma et al. 2004; Trumble et al. 2002). Further efforts searching for other monitoring systems may result in our being able to percutaneously divide the transverse carpal ligament for such minimally invasive benefits. New techniques and technologies should be introduced, and we should continue to push for improvements in minimally invasive hand surgery. Previously, we proposed a new and efficient technique to release the A1 pulley using intra-operative ultrasonography in trigger digits (Jou and Chern 2006; Kuo et al. 2009). Advances in technology have made it possible for ultrasonography to provide higher spatial resolution and depict nerves with excellent visual quality, which has proved useful in diagnosing carpal tunnel syndrome by observing changes in the median nerve and transverse carpal ligament (Tai et al. 2012). These studies indicate that ultrasonography adequately delineates the target structures related to carpal tunnel release. With its non-invasiveness, real-time ultrasonography feedback and ability to identify the surrounding vital structures, ultrasonography has promise as an improvement on current minimally invasive carpal tunnel release (Lecoq et al. 2011; Nakamichi and Tachibana 1998; Rowe et al. 2005). In an earlier study we proposed, in concept, a new procedure for percutaneous release of the transverse carpal ligament; we found that high-resolution ultrasonography can depict the exact location and anatomy of those structures, and that further topographic measurement revealed a good correlation between the actual extent of the transverse carpal ligament and the ultrasonographically determined distance between the bony landmarks (Chern et al. 2009). Here, we report on this minimally invasive technique for percutaneous release of the transverse carpal ligament in human cadavers using a simple dilator and commercial hook knife under intra-operative ultrasonographic guidance and test the hypothesis that ultrasonography allows direct or indirect intra-operative visualization of those target structures and facilitates tolerable and effective percutaneous release of the transverse carpal ligament.

METHODS

Forty upper extremities of 12 embalmed and eight fresh cadavers (7 male, 13 female; mean age at death: 48.2 y; range: 18–78 y) were selected and used in this study. They had not been dissected and had no major wrist or hand injuries. Real-time linear-array equipment with a broadband linear probe (5–10 MHz, SonoSite, Bothell, WA, USA) was used in this study. We used a commercially available stand-off gel material (Surgilube, E. Fougera, Melville, NY, USA) to allow appropriate contact between the probe and the skin and to provide accurate visualization of the skin, subcutaneous soft tissues and underlying bones and joints.

Ultrasonographically assisted percutaneous release of transverse carpal ligament and subsequent explorative evaluation in cadaver

We began this procedure at the left hand after correlating and measuring the transverse carpal ligament and neurovascular bundles in open dissection of the right hand and landmarks using ultrasonography of the right hand. We localized the distal and proximal margins of the transverse carpal ligament using the metacarpal shaft-base junction and the midpoint of the longitudinal length of the lunate (Chern et al. 2009). These margins were the parameters in the following ultrasonographically assisted percutaneous carpal tunnel release procedure.

Ultrasonographically assisted percutaneous release of transverse carpal ligament. The procedure began with ultrasonographic location of the key structures: transverse carpal ligament, median nerve and flexor tendons; and the bone landmarks of the hamate hook and underlying third metacarpal, the capitate, the lunate and distal radius, and the joint constituted by these bones. Using a longitudinal image along the median nerve and centered at the capitate, we also localized the transverse carpal ligament. We then moved the transducer parallel approximately 5–10 mm medially to locate the hamate hook, and moved it laterally to hold it steady within the transverse safe zone, which was defined as the distance between the median nerve and the radial edge of the hamate hook by using a transverse section at the axis of the hamate hook and the scaphoid tubercle (Chern et al. 2009) (4.9 ± 0.3 mm, range: 3–7 mm) [unpublished data] (Fig. 1b, c). A 2-mm puncture wound was made with an 18-gauge needle 1.5–2 cm proximal to the wrist flexion crease along the midline of the transducer, which was held in the position described above (Fig. 1d–f). The wounds were made at this point to avoid interfering with the position of the transducer and to allow us to delineate the key structure during division and preclude a scar on the palm. The hand, held in a 15° extended position, was then kept stationary. Through these 2-mm puncture wounds, a specially designed blunt dilator, of approximately the same diameter as the hook knife, was inserted extrabursally and subcutaneously. With real-time ultrasonographic visualization and guidance, the dilator was introduced along the space just lateral to the hamate hook (within the transverse safe zone) and advanced until it was 5 mm distal to the metacarpal shaft-base junction