Safety of carpal tunnel release with a short incision
A cadaver study

Khalil ALIZADEH, Farivar LAHIJI, Mani PHALSAPHY

From Shahid Beheshti Medical University, Taleghani Hospital, Tehran, Iran

The standard long incision technique for carpal tunnel release causes inevitable damage to skin sensation, the inter-thenar plexus and especially the distal branches of the palmar cutaneous branch of the median nerve (PCM), and may cause long-term disabling pain and scar tenderness. There are many variations in the distal branches of the median nerve at the wrist. Anatomic studies of this region also have important clinical implications to prevent injury to important anatomic structures. The purpose of this study was to evaluate the short-incision carpal tunnel release in cadavers. Several important anatomic structures, with possible anatomic variations, pass through the carpal tunnel, and blind percutaneous transection of the transverse ligament seems to be a high risk procedure. Sixty hands from 40 fresh cadavers were evaluated. Both the transverse ligament and the distal third of the deep forearm fascia were released using a Smillie knife. At the end of each procedure, the hand was explored for injury to tendinous and neurovascular structures of the wrist. In all cases the release of the carpal tunnel and the distal third of the forearm fascia was found to be complete. The superficial palmar arterial arch, flexor tendons, ulnar nerve and vessels, digital nerves, median nerve and its recurrent accessory branches, the flexor tendons, and even the subcutaneous tissue over the transverse ligament were damaged in no instance. Guyon's canal was entered in 6 (10%) hands without damage to its components. The distal branches from the ulnar side of the palmar cutaneous branch of the median nerve (PCM) were injured in 8 (13.6%) hands, an injury that is almost unavoidable with the classic open technique.

INTRODUCTION

The most common complications of classic open carpal tunnel release with a long incision are palmar pain over the thenar and hypothenar regions and scar tenderness (*8, 10, 19*). Patients who suffer from this complication cannot return to their normal activities for weeks or months. It is assumed that most of the postoperative complications are caused by injury to the sensory dermal plexus and the distal branches of the palmar cutaneous branch of the median nerve (PCM) (*3, 10, 19*). Longer incisions can lead to more injuries to the neural structures, more postoperative complications and a

■ Khalil Alizadeh, MD, Associate Professor of Orthopaedics and Hand Surgery.
■ Farivar lahiji, MD, Associate Professor of Orthopaedics and Hand Surgery.
■ Mani Phalsaphy, MD, Orthopaedic Surgeon.
Department of Orthopaedics, Shahid Beheshti Medical University, Taleghani Hospital, Tehran, Iran.
Correspondence : Khalil Alizadeh, Department of Orthopaedics, Shahid Beheshti Medical University, Taleghani Hospital, Tehran, Iran. E-mail : Alizadeh_khalil@yahoo.com.

Fig. 1. — Tangential view of the palm

Fig. 2. — Incision and probe passed through the canal on the ulnar side of the palmaris longus.

Fig. 3. — Smillie's knife passed through the probe canal to dissect the transverse ligament.

Fig. 4. — Exploration of the hand and distal third of the forearm to assess possible injury to the forearm and palmar structures.

poorer outcome (*1-4, 7, 8, 10, 12, 17*). Although all these facts show the necessity of using short-incision procedures, many surgeons continue to prefer the classic technique. On the other hand, blind percutaneous dissection of the transverse ligament, as in endoscopic carpal tunnel release, may be viewed as a high-risk procedure because of the normal variations of the important anatomic elements traversing the canal. So a thorough and detailed knowledge of the anatomy and the normal variations of all anatomic structures at the wrist, especially the median nerve, seems necessary (*14*). This anatomic study was designed to assess the median nerve variations in human cadavers and the safety of a short-incision percutaneous release of the transverse carpal ligament.

MATERIALS AND METHODS

Sixty hands from 40 Iranian cadavers (mean age 31 years, 51 male and 9 female) were included in this study at the Forensic Medical Center. The mean time elapsed from death to the time of dissection was 52 hours (range, 10 to 76). Cadavers with frost tissue damage, traumatic injury, or gross congenital deformities of the upper limb were excluded. Twenty hands were not dissected because of the presence of lacerations at the procedure site.

A one-centimeter longitudinal incision was made along the line which connects the inter-thenar depression to the third interphalangeal web (figs 1 & 2). The

midpoint of the incision was at the crossing with Kaplan's line. In the absence of an inter-thenar line, the deepest point of the inter-thenar region on a tangential view of the palm (fig 3) was accepted as the landmark for the line.

Blunt dissection with a mosquito forceps separated the palmar aponeurosis from the subcutaneous fat, and exposed the wrist transverse ligament. A cannulated probe was passed under the transverse carpal ligament into the carpal tunnel and directed along the ulnar side of the palmaris longus tendon in the direction of the transverse crease of the wrist (fig 4). A Smillie knife was passed through the probe canal to cut the transverse ligament and the distal third of the deep forearm fascia percutaneously (fig 5).

After completion of the procedure, the hand was explored from the distal third of the forearm to the distal palmar crease (fig 6) to assess any injury to the forearm and palmar structures especially the median nerve and its distal branches. All of the distal and terminal branches were examined with a 3× magnifying loupe and the observed variations were compared to the findings of other anatomic reports, using statistical Z-test.

RESULTS

Exploration after carpal tunnel release confirmed that none of the important structures including the superficial arterial arch, the flexor tendons, the ulnar neurovascular bundle, the median nerve, the digital nerves, the recurrent nerve and the accessory branches, were injured (table I).

The average distance between the superficial palmar arterial arch and the distal wrist crease was 46 ± 4.6 mm, and the average distance between the arterial arch and the distal part of the incision was 7 ± 2.8 mm.

Median nerve variations were found in 78% of the cases (46 hands). In 5 cases (4 left and 1 right) the nerve was bifurcated (8.3%).

The recurrent branch ran an extra-ligamentous course in 28 (47%) cases, sub-ligamentous in 17 (28%), trans-ligamentous in 7 (12%) and trans-fascial in 8 (13%) cases (table I). In 7 cases (12%) the recurrent branch originated from the ulnar side of the median nerve and was closer to the incision line. The recurrent nerve had an accessory branch in 19 (31.7%) of the explored hands. The origin

Table I. — Normal anatomic variations of the median nerve

Recurrent branch types		
Type of the variation	Frequency	percent
Extra ligamentous	28	46.7
Trans ligamentous	7	11.7
Trans fascial	8	13.3
Sub ligamentous	17	28.3
Origin from ulnar side of median nerve	7	11.7
Presence of accessory branch	19	31.7
PCM types		
variation	Frequency	percent
Type 1	37	61.7
Type 2	13	21.7
Type 3	10	16.7

was proximal in 8 (13.3%), distal in 8 (13.3%) and in 3 (5.1%) cases the origin was both from distal and proximal. The average distance between the recurrent branch and the incision line was 6.71 ± 3.36 mm. The knife entered Guyon's canal in 6 cases (10%), but no injury was observed to its components.

The palmar cutaneous branch of the median nerve was not injured along its course from the origin to its entry into the flexor carpi radialis tendon sheath. The distal ulnar branches of the PCM were injured distal to the transverse ligament in 8 (13.3%) cases. The average distance between the origin of the PCM to the distal wrist crease was 50.54 ± 23.78 mm.

The transverse ligament and the distal third of the forearm fascia were found to be completely released in all operated hands. The average carpal ligament width was 29.14 ± 5.05 mm and the mean distance from Kaplan's line was 3.5 ± 1.59 mm distally. The mean distance between the proximal part of the transverse ligament and the more proximal distal wrist crease was 4.94 ± 2.99 mm.

DISCUSSION

The results of our dissection compared well with those from other studies (table II) (6, 9, 11, 13).

Table II. — Median nerve variations in the literature

Studies Number of hands	Our study 60	Lanz 246	Steinberg 46	Olave 60	Kozin 101	Stancic 65
Median N. bifurcation	8.3%	2.8%	–	–	–	–
Recurrent branch of the median N.						
Extraligamentous	46.7%	46%	–	48.3%	19%	47.7%
Transligamentous	11.7%	23%	28.3%	15%	7%	18.5%
Transfascial	13.3%	–	–	–	74%	–
Subligamentous	28.3%	31%	–	18.3%	–	20%
From ulnar side	11.7%	–	16.7%	16.7%	0%	4.6%
Accessory branch	31.7%	–	–	38.3%	4%	–
Proximal	13.3%	1.6%	–	–	–	–
Distal	13.3%	7.2%	–	–	–	20%
Both	5%	–	–	–	–	–

The findings of Kozin differed significantly as to the extraligamentous subtype of the recurrent branch (46.7 versus 19%), the transfascial subtype (13.3% versus 74%), the ulnar origin of the recurrent nerve (11.7% versus 0%) and the accessory branch of the recurrent nerve (31.7% versus 4%) (*5*). The transligamentous subtype in our study was significant less frequent (11.7%) than reported by Lanz (23%) and Steinberg *et al* (28.3%) (*6, 15*).

Bifurcation of the median nerve is a rare presentation in other studies, but we found it in 8.3% of our dissected hands. This difference may be due to ethnic variations.

Palmar pain and scar tenderness are the most commonly encountered complications in carpal tunnel release and it seems that they are directly related to the length of the surgical incision (*3, 10, 19*). There are different opinions about the cause of these symptoms. The most likely mechanism is injury to the sensory branches of the PCM and the ulnar palmar sensory branches (*3, 10, 19*). These injuries may occur with the classic technique during dissection of the skin and subcutaneous tissues and release of the transverse ligament (*18*).

Postoperative grip strength following the classic technique has been reported to be lower than following a short-incision operation (*8, 18*). Furthermore, short-incision release techniques have shorter operation time and are less costly (*10, 19*).

The only worrisome complication in short-incision carpal tunnel release is the risk to injure important structures passing through the canal because of the blind percutaneous use of a knife. Our study shows that, despite their vicinity and all their possible anatomic variations, the risk of structural damage to components such as ulnar and digital nerves, palmar cutaneous and recurrent branches of the median nerve, median nerve, flexor tendons and palmar arterial arch is very low in short-incision carpal tunnel release (table II). The use of a cannulated probe as a guide for the knife protects the subligamentous structures. The overlying subcutaneous tissue containing the terminal branches of the PCM also will slide over the blunt edges of the knife.

The distal branches of the PCM were injured in only 13.3% of cases and this is much lower in comparison to the rate seen with the classic technique (100%). Further clinical trials are necessary to confirm these findings.

REFERENCES

1. **Avci S, Sayli U.** Carpal tunnel release using a short palmar incision and a new knife. *J Hand Surg* 2000 ; 25-B : 357-360.
2. **Benquet B, Fabre T, Durandeau A.** Neurolysis of the median nerve in the carpal canal using a mini-invasive

approach. Prospective study of 138 cases. *Chir Main* 2000 ; 19 : 86-93.

3. **Biyani A, Downes EM.** An open twin incision technique of carpal tunnel decompression with reduced incidence of scar tenderness. *J Hand Surg* 1993 ; 18-B : 331-334.

4. **Jugovac I, Burgic N, Golubovic V, Stancic MF.** Carpal tunnel release by limited palmar incision vs traditional open technique : randomized controlled trial. *Croat Med J* 2002 ; 43 : 33-36.

5. **Kozin SH.** The anatomy of the recurrent branch of the median nerve. *J Hand Surg* 1998 ; 23-A : 852-858.

6. **Lanz U.** Anatomical variations of the median nerve in the carpal tunnel. *J Hand Surg* 1977 ; 2 : 44-53.

7. **Lee H, Jackson TA.** Carpal tunnel release through a limited skin incision under direct visualization using a new instrument, the carposcope. *Plast Reconstr Surg* 1996 ; 98 : 313-319.

8. **Lee WP, Strickland JW.** Safe carpal tunnel release via a limited palmar incision. *Plast Reconstr Surg* 1998 ; 101 : 418-426.

9. **Matloub HS, Yan JG, Mink Van Der Molen AB, Zhang LL, Sanger JR.** The detailed anatomy of the palmar cutaneous nerves and its clinical implications. *J Hand Surg* 1998 ; 23-B : 373-379.

10. **Micovic V, Radolovic-Prenc L, Uravic M, Serra JM, Benito JR, Monner J.** Carpal tunnel release with short incision. *Plast Reconstr Surg* 1997 ; 99 : 129-135.

11. **Olave E, Prates JC, Gabrielli C, Pardi P.** Morphometric studies of the muscular branch of the median nerve. *J Anat* 1996 ; 189 : 445-449.

12. **Richter VM, Bruser P.** Surgical treatment of carpal tunnel syndrome : a comparison between long and short incision and endoscopic release. *Handchir Mikrochir Plast Chir* 1996 ; 28 : 160-166.

13. **Stancic MF, Eskinja N, Stosic A.** Anatomical variations of the median nerve in the carpal tunnel. *Int Orthop* 1995 ; 19 : 30-34.

14. **Stark B, Engkvist-Lofmark C.** Endoscopic operation or conventional open surgical technique in carpal tunnel syndrome : a prospective comparative study. *Handchir Mikrochir Plast Chir* 1996 ; 28 : 128-132.

15. **Steinberg EL, Luger E, Taitz C, Arensburg B.** Anatomic variant of the median nerve in the carpal tunnel. *Clin Orthop* 1998 ; 352 : 128-130.

16. **Thurston A, Lam N.** Results of open carpal tunnel release : a comprehensive, retrospective study of 188 hands. *Aust N Z J Surg* 1997 May ; 67 : 283-288.

17. **Trumble TE, Diao E, Abrams RA, Gilbert-Anderson MM.** Single-portal endoscopic carpal tunnel release compared with open release : a prospective, randomized trial. *J Bone Joint Surg* 2002 ; 84-A : 1107-1115.

18. **Viegas SF, Pollard A, Kaminksi K.** Carpal arch alteration and related clinical status after endoscopic carpal tunnel release. *J Hand Surg* 1992 ; 17-A : 1012-1016.

19. **Wilson KM.** Double incision open technique for carpal tunnel release : an alternative to endoscopic release. *J Hand Surg* 1994 ; 19-A : 907-912.