Pain Physician 2013; 16:E191-E198 • ISSN 2150-1149

Observational Report

Anatomical Basis of Ulnar Approach in Carpal Tunnel Injection

Dong Hwee Kim, MD, PhD, Ji Eun Jang, MD, and Byung Kyu Park, MD, PhD

From: Department of Physical Medicine & Rehabiliation, Korea University College of Medicine

Address Correspondence:
Dr. Dong Hwee Kim, MD, PhD
Dept. of Physical Medicine and Rehabilitation
Korea University College of Medicine, Ansan Hospital
516 Gojan-dong, Danwon-gu
Ansan-si, Gyeonggi Province
E-mail: rmkdh@korea.ac.kr

Disclaimer: There was no external funding in the preparation of this manuscript. Conflict of interest: None.

Manuscript received: 01-02-2013
Revised manuscript received: 02-22-2013
Accepted for publication: 03-11-2013

Free full manuscript: www.painphysicianjournal.com

Background: Local steroid injection may be an effective conservative treatment for carpal tunnel syndrome; however, the use of a blind injection technique can increase the chance of median nerve or ulnar artery injury due to median nerve swelling or the close proximity of the median nerve and ulnar artery around the distal wrist crease.

Objectives: The purpose of this study is to investigate the relative location of the median nerve and ulnar artery to the palmaris longus (PL) tendon around the wrist in carpal tunnel syndrome.

Study Design: An observational study.

Setting: A university outpatient interventional pain management practice in the Republic of Korea.

Methods: Thirty hands of 15 patients with carpal tunnel syndrome and 30 hands of 15 healthy subjects were studied. Ultrasonography was performed to determine the relative relationship of the ulnar artery and median nerve to the PL tendon around the wrist.

Results: There were statistically significant differences both in the distance from the medial margin of the PL to the medial end of the median nerve and the distance from the medial end of the median nerve to the lateral end of the ulnar artery at all levels of scanning between the 2 groups.

Limitations: Limitations include the inclusion of a small number of patients with carpal tunnel syndrome.

Conclusion: It is important to recognize the risk of blind local steroid injection for carpal tunnel syndrome, which is most likely a result of swelling and/or flattening of the median nerve around the distal wrist crease. A real time, ultrasound-guided local steroid injection is preferred as a safe and accurate technique in carpal tunnel syndrome treatment.

Key Words: Carpal tunnel syndrome, median nerve, ulnar artery, injection, steroid, injury, ultrasonography, risk, cross-sectional area

Pain Physician 2013; 16:E191-E198

Carpal tunnel syndrome is the most common compressive mononeuropathy of the limbs. Although surgical intervention such as open or endoscopic carpal tunnel release is known to be an effective treatment for carpal tunnel syndrome (1), non-surgical treatment, including local steroid injection and wrist splinting, might be an effective conservative treatment for carpal tunnel syndrome (2-5). Yet, a blind injection technique can increase the chance of median nerve or ulnar artery injury due to median nerve swelling or the close proximity of the median nerve and ulnar artery around the distal wrist crease

(6-9). Safe and reliable techniques for carpal tunnel injection using cadavers or humans have been reported (10-15). Among them, an ulnar approach injection to the palmaris longus (PL) tendon was often performed with a blind technique; however, concerns about the risk to the median nerve or ulnar artery in an ulnar approach injection have been raised in several studies (10,12,13,16). The purpose of this study was to evaluate the risk of an ulnar approach technique for carpal tunnel syndrome by measuring the relative distance of the median nerve and ulnar artery to the PL tendon around the distal wrist crease using ultrasonography.

Methods

Case Information

Two groups of subjects were studied: patients with carpal tunnel syndrome, which was confirmed with electrodiagostic examination, and healthy subjects who did not have hand tingling sensations or any diseases affecting the peripheral nervous system. Thirty hands of 15 patients with bilateral carpal tunnel syndrome who were diagnosed with clinical and electrodiagnostic findings of carpal tunnel syndrome (3 men and 12 women; mean age, 53 years), and 30 hands of 15 healthy subjects (4 men and 11 women; mean age, 56 years) were studied. Each subject underwent ultrasonography by one blinded ultrasonographer (Kim) who has 10 years of experience with the ultrasound technique. The Local Ethics Committee of Korea University Ansan Hospital, Republic of Korea, approved this study, and it was funded by the research fund of the Korea University College of Medicine. The Institutional Review Board approved the research protocol (AS11103), and all subjects were informed about the nature of the study with adherence to all confidentiality and Health Insurance Portability and Accountability Act requirements.

Technique

The hand was placed on a wood plate for ultrasonographic evaluation of carpal tunnel syndrome and positioned with 30-degree wrist extension. The medial border of the PL tendon was marked with a pen. For the landmark of ultrasonographic evaluation, a long needle (23 g x 60 mm) with the needle-tip broken off was applied to the medial border of the PL tendon and bent along the contour of the wrist. Ultrasonographic scanning was done at 4 sites: the distal wrist crease, 1 cm proximal to the distal wrist crease (DWC + 1), 0.5 cm proximal to the distal wrist crease (DWC + 0.5), and 1 cm distal to the distal wrist crease (DWC - 1) (Fig. 1A). The relative distances of the ulnar artery and median nerve to the PL tendon were measured using the Accuvix V20 Prestige Ultrasound System (Samsung Medison®, Republic of Korea).

Assessment Parameters

At each level of scanning, ultrasonographic parameters of the median nerve, including cross-sectional area (CSA), short diameter (SD), long diameter (LD), and flattening ratio (SD/LD of median nerve, FR), were measured. The distance from the medial border of the PL tendon to the medial end of the median nerve (PL_MN), the distance from the medial margin of the PL tendon to the lateral end of the ulnar artery (PL_UA), and the distance from the medial end of the median nerve to the lateral end of the ulnar artery (MN_UA) were also measured (Fig. 1B & 1C). If the medial end of the median nerve was located lateral to the medial border of the PL tendon, the PL_MN was recorded as a negative value (-) and was classified into the radial group. If the medial end of the median nerve was medial to the medial border of the PL tendon, the PL_MN was recorded as a positive value (+) and was classified into the ulnar group.

Statistical Analysis

The statistical analysis was performed with SPSS version 14.0 (SPSS Inc., Chicago, IL, USA). Data are presented as mean ± standard deviation. Comparisons between healthy subjects and patients with carpal tunnel syndrome were examined using the independent t-test. Pearson's chi-squared test was used to compare the frequency of the radial and ulnar groups in healthy subjects and patients with carpal tunnel syndrome. Pearson's correlation test was performed to evaluate the correlation between PL_MN and ultrasonographic parameters of the median nerve.

Results

All ultrasonographic parameters of the median nerve except FR were significantly increased in patients with carpal tunnel syndrome compared to healthy subjects at all scanning levels (Table 1). The FR of the median nerve was significantly decreased only at the level of DWC + 1.

Data on the relative distances between the median nerve, ulnar artery, and PL tendon are presented in Table 2. There were statistically significant differences in PL_MN and MN_UA at all scanning levels between

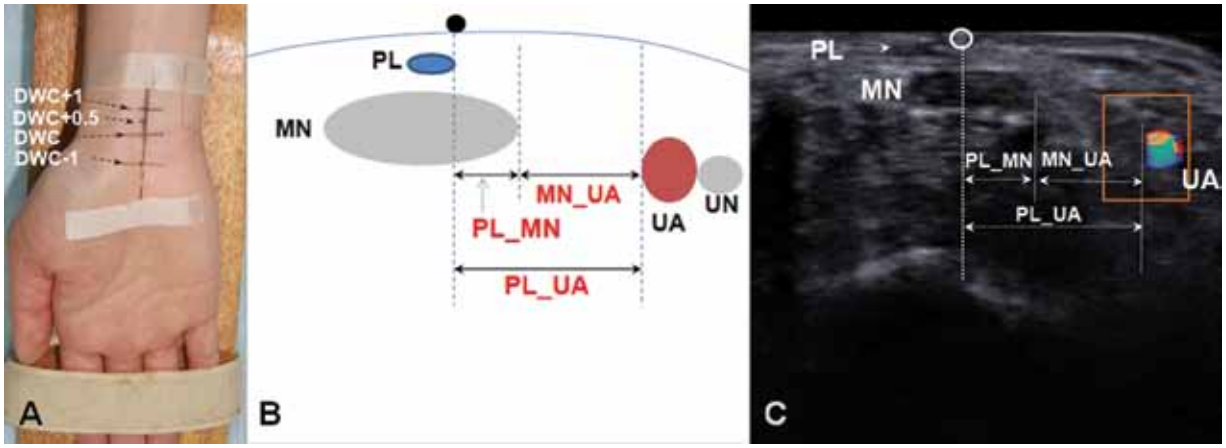

Fig. 1. *(A) The levels of sonographic scanning around the wrist. (B) Schematic drawing of relationship between the medial border (black dot) of the palmaris longus tendon (PL) and the medial margin of the median nerve (MN) or the lateral margin of the ulnar artery (UA). (C) Cross-sectional sonogram demonstrated distances of the MN and UA to the medial border of the PL tendon (white circle).*
DWC, distal wrist crease; DWC + 1, 1 cm proximal to DWC; DWC + 0.5, 0.5 cm proximal to DWC; DWC - 1, 1 cm distal to DWC; PL_MN, distance between palmaris longus tendon and median nerve; PL_UA, distance between palmaris longus tendon and ulnar artery; MN_UA, distance between median nerve and ulnar artery; UN, ulnar nerve

Table 1. *Ultrasonographic parameters of the median nerve in healthy subjects (healthy) and patients with carpal tunnel syndrome (CTS).*

Levels	CSA		SD		LD		Flattening ratio	
	Healthy	CTS	Healthy	CTS	Healthy	CTS	Healthy	CTS
DWC + 1	10.6 ± 1.6	17.7 ± 7.6*	2.4 ± 0.4	2.6 ± 0.4*	5.3 ± 0.9	7.8 ± 2.5*	0.47 ± 0.15	0.36 ± 0.11*
DWC + 0.5	10.1 ± 1.5	18.4 ± 6.3*	2.3 ± 0.4	2.9 ± 1.3*	5.2 ± 1.0	7.8 ± 2.4*	0.48 ± 0.19	0.48 ± 0.67
DWC	10.0 ± 1.8	17.4 ± 5.9*	2.2 ± 0.3	2.6 ± 0.4*	5.4 ± 0.9	8.0 ± 2.1*	0.38 ± 0.14	0.34 ± 0.10
DWC – 1	9.0 ± 2.7	15.2 ± 5.4*	2.1 ± 0.4	2.5 ± 0.6*	5.4 ± 0.9	7.6 ± 1.9*	0.40 ± 0.10	0.37 ± 0.31

DWC, distal wrist crease; DWC + 1, 1 cm proximal to DWC; DWC + 0.5, 0.5 cm proximal to DWC; DWC - 1, 1 cm distal to DWC; CSA, cross-sectional area of median nerve; SD, short diameter of median nerve; LD, long diameter of median nerve
Values are mean ± standard deviation.
* *P*-value < 0.05.

Table 2. *Distances between median nerve, ulnar artery, and palmaris longus tendon according to scanning sites in healthy subjects (healthy) and patients with carpal tunnel syndrome (CTS).*

Levels	PL_MN		PL_UA		MN_UA	
	Healthy	CTS	Healthy	CTS	Healthy	CTS
DWC + 1	-2.6 ± 2.6	-0.1 ± 3.0*	8.6 ± 2.3	8.7 ± 2.0	11.2 ± 2.5	8.8 ± 3.1*
DWC + 0.5	-1.5 ± 1.9	1.0 ± 2.5*	7.9 ± 2.1	7.8 ± 2.0	9.4 ± 1.5	6.8 ± 2.2*
DWC	-0.6 ± 1.7	1.6 ± 2.5*	7.5 ± 2.1	7.5 ± 1.5	8.1 ± 2.1	5.9 ± 2.1*
DWC – 1	-0.1 ± 1.9	0.9 ± 2.8*	8.3 ± 2.2	7.5 ± 2.1	8.4 ± 1.9	6.6 ± 1.9*

DWC, distal wrist crease; DWC + 1, 1 cm proximal to DWC; DWC + 0.5, 0.5 cm proximal to DWC; DWC - 1, 1 cm distal to DWC; PL_MN, distance between palmaris longus tendon and median nerve; PL_UA, distance between palmaris longus tendon and ulnar artery; MN_UA, distance between median nerve and ulnar artery If the medial end of the median nerve was lateral to the medial edge of the PL tendon, the PL_MN was recorded as a negative value (-). If the medial end of the median nerve was medial to the medial edge of the PL tendon, the PL_MN was recorded as a positive value (+).
*Values are mean ± standard deviation. * P-value < 0.05.*

healthy subjects and patients with carpal tunnel syndrome. In patients with carpal tunnel syndrome, the mean value of PL_MN was positive in most scanning sites. There was no significant difference in PL_UA between the 2 groups.

In patients with carpal tunnel syndrome, classification into the ulnar group (positive PL_MN value) was significantly more frequent at the levels of DWC + 1 (13, 43.3%), DWC + 0.5 (19, 63.3%), and DWC (19, 63.3%) (Fig. 2). In patients with carpal tunnel syndrome, there were significant increases in CSA and the long diameter of the median nerve at all levels except DWC between the radial and ulnar groups (Table 3); however, significant differences in SD and FR were only seen at one level (DWC) between the 2 groups.

There were moderate positive correlations between PL_MN and CSA and PL_MN and LD of the median nerve. There were moderate negative correlations between PL_MN and MN_UA at all scanning levels (Table 4).

Discussion

Carpal tunnel steroid injection can be performed for mild to moderate carpal tunnel syndrome with other conservative treatments such as rest, splinting, physical therapy, or oral medications (3,17-19). Although ultrasound-guided carpal tunnel injection techniques have been introduced (20,21), blind techniques are frequently used in clinical practice.

The main issues of previous studies about carpal tunnel injection were the routes of injection (10-13) and types of injectates (22,23). Many injection sites have been recommended (2,5,10,13,15,16,24-27), but there is no consensus about the safest site for carpal tunnel injection. Although cadaver studies demonstrated that a radial approach through the flexor carpi radialis tendon would be safer than an ulnar approach (10,13), an ulnar approach between the PL and flexor carpi radialis tendons or just medial

Table 3. *Comparison between radial and ulnar groups of the median nerve to the palmaris longus tendon in patients with carpal tunnel syndrome.*

	Cases		CSA (mm2)		SD (mm)		LD (mm)		FR	
	R	U	R	U	R	U	R	U	R	U
DWC + 1	17	13	13.7 ± 4.2	22.9 ± 7.9*	2.5 ± 0.4	2.7 ± 0.4*	6.5 ± 1.3	9.5 ± 2.7*	0.39 ± 0.10	0.31 ± 0.10*
DWC + 0.5	11	19	15.3 ± 5.8	20.2 ± 6.1*	2.7 ± 0.4	3.1 ± 0.1.6	6.5 ± 1.5	8.5 ± 2.5*	0.43 ± 0.08	0.52 ± 0.84
DWC	11	19	15.0 ± 5.0	18.8 ± 6.0	2.5 ± 0.4	2.6 ± 0.4	7.2 ± 1.9	8.5 ± 2.2	0.37 ± 0.09	0.33 ± 0.10
DWC – 1	12	18	12.3 ± 4.8	17.2 ± 5.0*	2.5 ± 0.9	2.4 ± 0.4	6.1 ± 1.7	8.5 ± 1.4*	0.50 ± 0.47	0.29 ± 0.06

DWC, distal wrist crease; DWC + 1, 1 cm proximal to DWC; DWC + 0.5, 0.5 cm proximal to DWC; DWC - 1, 1 cm distal to DWC; R, group in which the medial margin of the median nerve was located on the radial side to the medial border of the palmaris longus tendon; U, group in which the medial margin of the median nerve was located on the ulnar side to the medial border of the palmaris longus tendon
Values are mean ± standard deviation.
* P-value < 0.05.

Table 4. *Pearson's correlation coefficients between ultrasonographic parameters of the median nerve and the distance between the median nerve and palmaris longus tendon.*

	CSA		SD		LD		FR		MN_UA	
	r	*P*-value	r	*P*-value	r	*P*-value	r	*P*-value	r	*P*-value
PL_MN1	0.585	0.001	0.137	0.470	0.606	0.000	-0.504	0.005	-0.796	0.000
PL_MN2	0.474	0.008	-0.017	0.929	0.605	0.000	-0.086	0.651	-0.635	0.000
PL_MN3	0.543	0.002	0.150	0.429	0.549	0.002	-0.388	0.034	-0.815	0.000
PL_MN4	0.468	0.009	-0.049	0.798	0.503	0.005	-0.247	0.189	-0.678	0.000

PL_MN1, the distance between the medial edge of the palmaris longus tendon and the medial end of the median nerve (PL_MN) at the level of 1 cm proximal to the distal wrist crease (DWC); PL_MN2, PL_MN at the level of 0.5 cm proximal to the DWC; PL_MN3, PL_MN at the level of DWC; PL_MN4, PL_MN at the level of 1 cm distal to the DWC; CSA, cross-sectional area of median nerve; SD, short diameter of median nerve; LD, long diameter of median nerve; FR, flattening ratio of median nerve
Values are mean ± standard deviation.
* P-value < 0.05.

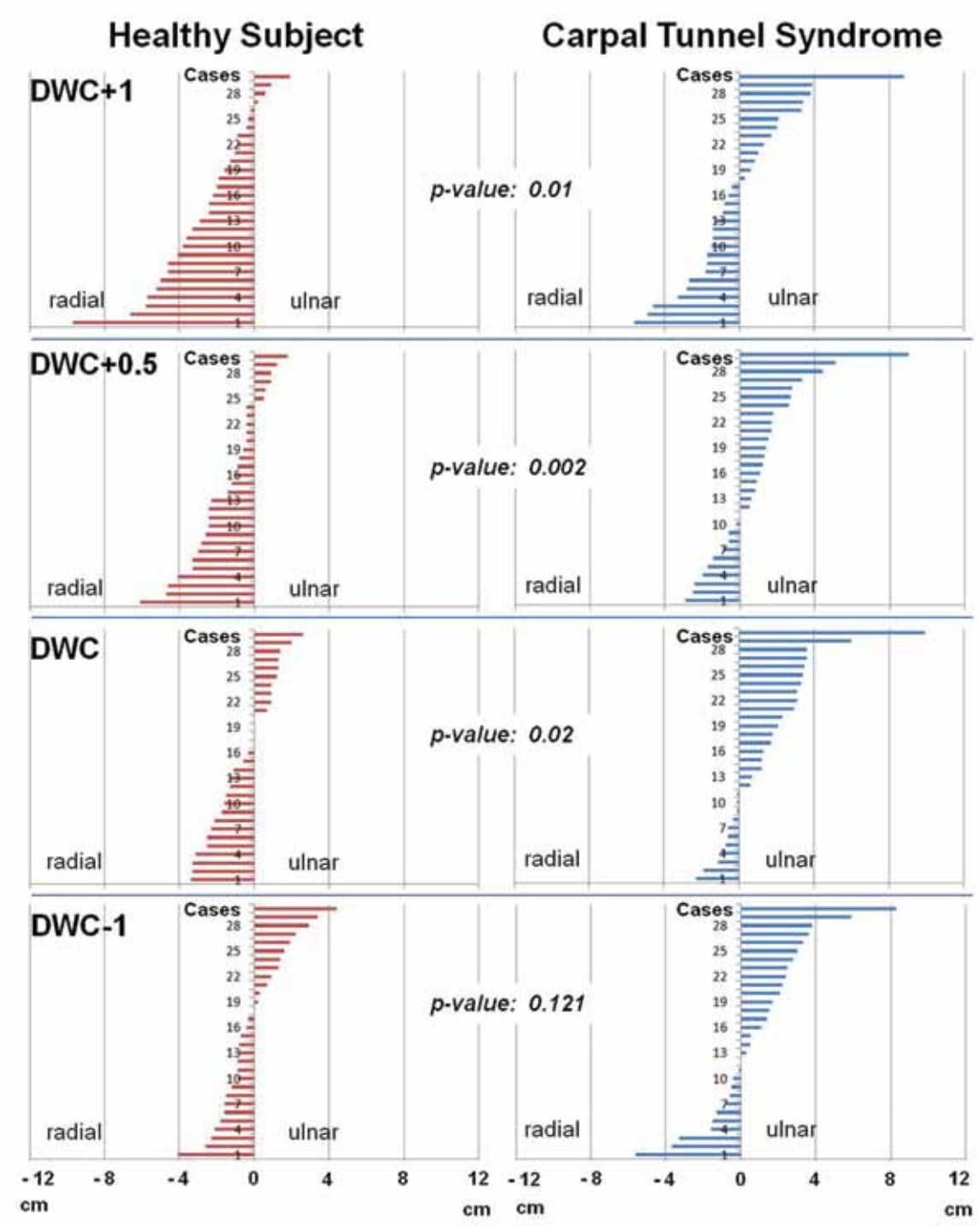

Fig. 2. *Median nerve location to palmaris longus tendon and its degree between healthy subjects and patients with carpal tunnel syndrome.*

to the PL tendon have been commonly performed (2,15,16,24,25).

Considering median nerve swelling around the inlet of the carpal tunnel in patients with carpal tunnel syndrome, the median nerve might be injured during carpal tunnel injection. Although the incidence of complications related to carpal tunnel injection is not known, it might have been underestimated. Racassan and Dubert (28) reported their clinical experience of a painful electrical sensation during injection in 12 out of 32 patients and a permanent sensory deficit in 3 of those 12. Several cases with median nerve or ulnar artery injury have been reported after carpal tunnel injection. Although some patients did not provide information about the carpal tunnel injection approach, complications of the median nerve or ulnar artery following carpal tunnel injection were caused by a blind ulnar approach (6-8,16,29) Our study could provide evidence about the causes of these complications after carpal tunnel injection. There was a statistically significant difference in the PL tendon and median nerve between healthy subjects and patients with carpal tunnel syndrome. The median nerve was swollen medially beyond the PL tendon around the wrist (43.3 – 63.3%) in the carpal tunnel syndrome patient group, which indicated that the median nerve or ulnar artery could be injured by a blind ulnar approach of carpal tunnel injection. In addition, the distance between the median nerve and ulnar artery was significantly decreased in the carpal tunnel syndrome group compared to healthy subjects. These findings suggest that an ulnar approach for injection to the PL tendon might be dangerous to the median nerve or ulnar artery in patients with carpal tunnel syndrome. In particular, a blind ulnar approach of carpal tunnel injection could be especially risky in patients with carpal tunnel syndrome who have a swollen median nerve around the wrist. Our study can also provide some information as to why endoscopic carpal tunnel release using the portal site between the PL and flexor carpi ulnaris tendons requires caution. Although recent studies about endoscopic carpal tunnel release demonstrated a low complication rate (30-32), major complications, including median nerve or ulnar artery injuries, could be developed during this procedure because of median nerve swelling (33-35).

Instead of a blind ulnar approach for carpal tunnel injection, other approaches were recommended to reduce the risk of carpal tunnel steroid injection (6,10,13,21). Among them, recent studies demonstrated that a technique through the flexor carpi radialis tendon was more accurate and safer than other approaches (6,10,13). However, it might be painful and increase the risk of tendon tear or rupture as steroid is injected through tendon. Ultrasonography-guided steroid injection could be considered to be a new and efficient treatment for entrapment peripheral neuropathies (21,36-38), and accurate injection placement. However, as it is not easy to learn the ultrasonography-guided injection technique, it should be performed after having knowledge about the ultrasound technology and injection technique, and enough experience. The ultrasonography-guided ulnar approach which was recently developed for carpal tunnel injection may be useful even in patients with severe swelling or flattening of median nerve (21). Transverse sonogram of the median nerve using a short-axis in-plane technique demonstrated an expanding collection of hypoechoic fluid around the median nerve in a patient with carpal tunnel syndrome (Fig. 3), which was a good indication of steroid and lidocaine mixture spread (donut sign) (Fig. 3B & C).

Conclusion

In conclusion, it is important to recognize the risk of blind local steroid injection for carpal tunnel syndrome most likely due to swelling and/or flattening of the median nerve around the distal wrist crease. As blind techniques for carpal tunnel injection may injure the neurovascular structures around wrist, a real time ultrasonography-guided local steroid injection is preferred as a safe and accurate technique for carpal tunnel syndrome.

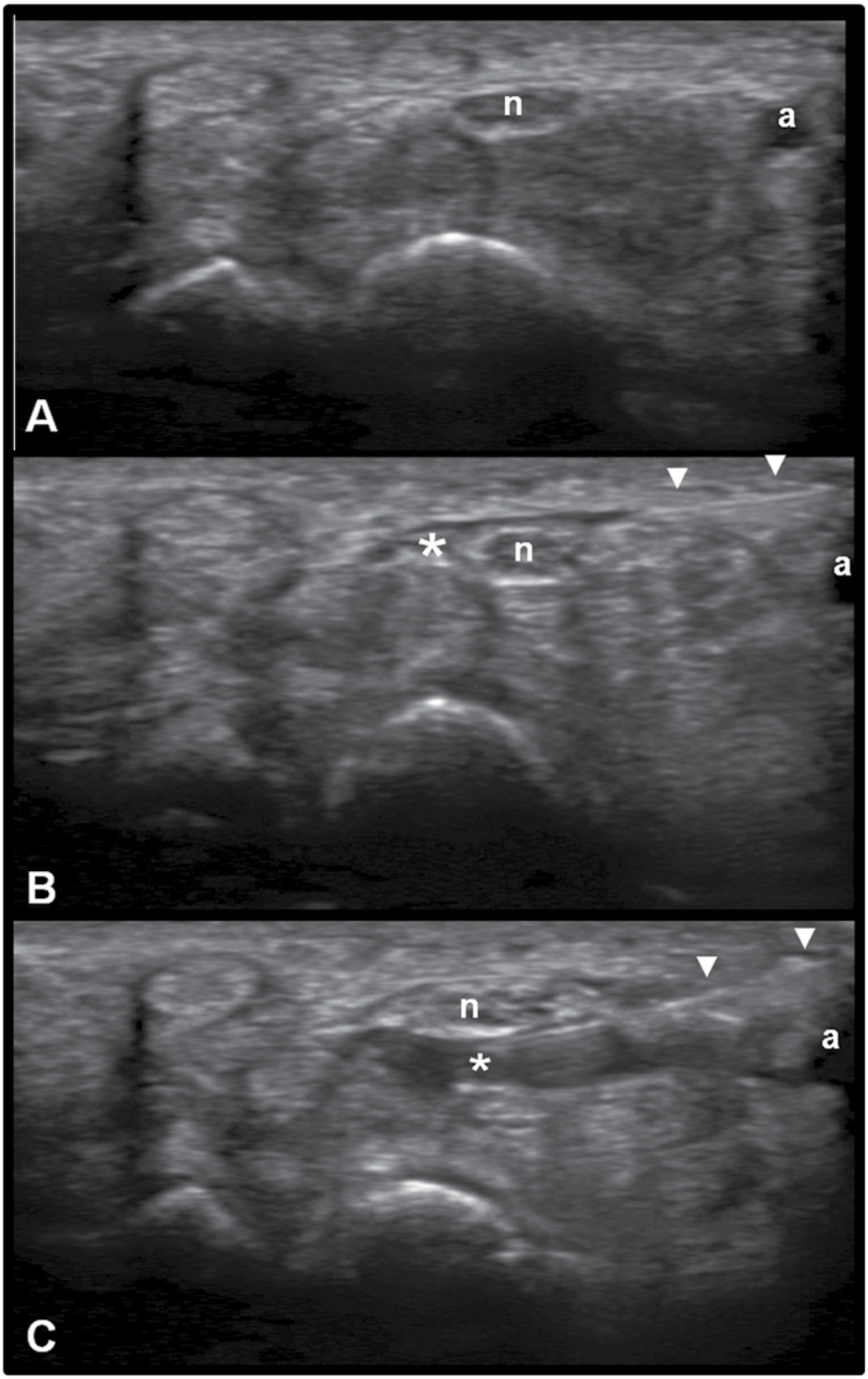

Fig. 3. Transverse sonogram demonstrated close relationship between the median nerve (n) and ulnar artery (a) (A). Needle (arrows) positioned on the upper margin of the median nerve and injectate (asterisk) was spread (B). Injectate (asterisk) was spread along the lower margin of the nerve (C).

References

1. Marshall S, Tardif G, Ashworth N. Local corticosteroid injection for carpal tunnel syndrome. *Cochrane Database Syst Rev* 2007; 2:CD001554.
2. Weiss AP, Sachar K, Gendreau M. Conservative management of carpal tunnel syndrome: A reexamination of steroid injection and splinting. *J Hand Surg Am* 1994; 19:410-415.
3. Visser LH, Ngo Q, Groeneweg SJ, Brekelmans G. Long term effect of local corticosteroid injection for carpal tunnel syndrome: A relation with electrodiagnostic severity. *Clin Neurophysiol* 2012; 123:838-841.
4. Peters-Veluthamaningal C, Winters JC, Groenier KH, Meyboom-de Jong B. Randomised controlled trial of local corticosteroid injections for carpal tunnel syndrome in general practice. *BMC Fam Pract* 2010; 11:54.
5. Graham RG, Hudson DA, Solomons M, Singer M. A prospective study to assess the outcome of steroid injections and wrist splinting for the treatment of carpal tunnel syndrome. *Plast Reconstr Surg* 2004; 113:550-556.
6. McConnell JR, Bush DC. Intraneural steroid injection as a complication in the management of carpal-tunnel syndrome - a report of 3 cases. *Clin Orthop Relat Res* 1990; 250:181-184.
7. Linskey ME, Segal R. Median nerve injury from local steroid injection in carpal tunnel syndrome. *Neurosurgery* 1990; 26:512-515.
8. Hussain SS, Taylor C, Van Rooyen R. Ulnar artery ischaemia following corticosteroid injection for carpal tunnel syndrome. *N Z Med J* 2011; 124:80-83.
9. Park GY, Kim SK, Park JH. Median nerve injury after carpal tunnel injection serially followed by ultrasonographic, sonoelastographic, and electrodiagnostic studies. *Am J Phys Med Rehabil* 2011; 90:336-341.
10. Dubert T, Racasan O. A reliable technique for avoiding the median nerve during carpal tunnel injections. *Joint Bone Spine* 2006; 73:77-79.
11. Kay NR, Marshall PD. A safe, reliable method of carpal tunnel injection. *J Hand Surg Am* 1992; 17:1160-1161.
12. MacLennan A, Schimizzi A, Meier KM, Barron OA, Catalano L, Glickel S. Comparison of needle position proximity to the median nerve in 2 carpal tunnel injection methods: A cadaveric study. *J Hand Surg Am* 2009; 34:875-879.
13. Ozturk K, Esenyel CZ, Sonmez M, Esenyel M, Kahraman S, Senel B. Comparison of carpal tunnel injection techniques: A cadaver study. *Scand J Plast Reconstr Surg Hand Surg* 2008; 42:300-304.
14. Wood MR. Hydrocortisone injections for carpal tunnel syndrome. *Hand* 1980; 12:62-64.
15. Green DP. Diagnostic and therapeutic value of carpal tunnel injection. *J Hand Surg Am* 1984; 9:850-854.
16. Frederick HA, Carter PR, Littler JW. Injection injuries to the median and ulnar nerves at the wrist. *J Hand Surg Am* 1992; 17:645-647.
17. Piazzini DB, Aprile I, Ferrara PE, Bertolini C, Tonali P, Maggi L, Rabini A, Piantelli S, Padua L. A systematic review of conservative treatment of carpal tunnel syndrome. *Clin Rehabil* 2007; 21:299-314.
18. Bland JD. Treatment of carpal tunnel syndrome. *Muscle Nerve* 2007; 36:167-171.
19. Carlson H, Colbert A, Frydl J, Arnall E, Elliot M, Carlson N. Current options for nonsurgical management of carpal tunnel syndrome. *Int J Clin Rheumtol* 2010; 5:129-142.
20. Grassi W, Farina A, Filippucci E, Cervini C. Intralesional therapy in carpal tunnel syndrome: A sonographic-guided approach. *Clin Exp Rheumatol* 2002; 20:73-76.
21. Smith J, Wisniewski SJ, Finnoff JT, Payne JM. Sonographically guided carpal tunnel injections: The ulnar approach. *J Ultrasound Med* 2008; 27:1485-1490.
22. Karadas O, Tok F, Ulas UH, Odabasi Z. The effectiveness of triamcinolone acetonide vs. procaine hydrochloride injection in the management of carpal tunnel syndrome: A double-blind randomized clinical trial. *Am J Phys Med Rehabil* 2011; 90:287-292.
23. Karadas O, Tok F, Akarsu S, Tekin L, Balaban B. Triamcinolone acetonide vs procaine hydrochloride injection in the management of carpal tunnel syndrome: Randomized placebo-controlled study. *J Rehabil Med* 2012; 44:601-604.
24. Burke FD, Ellis J, McKenna H, Bradley MJ. Primary care management of carpal tunnel syndrome. *Postgrad Med J* 2003; 79:433-437.
25. Gelberman RH, Rydevik BL, Pess GM, Szabo RM, Lundborg G. Carpal tunnel syndrome. A scientific basis for clinical care. *Orthop Clin North Am* 1988; 19:115-124.
26. Dammers JW, Roos Y, Veering MM, Vermeulen M. Injection with methylprednisolone in patients with the carpal tunnel syndrome: A randomised double blind trial testing three different doses. *J Neurol* 2006; 253:574-577.
27. Helwig AL. Treating carpal tunnel syndrome. *J Fam Pract* 2000; 49:79-80.
28. Racasan O, Dubert T. The safest location for steroid injection in the treatment of carpal tunnel syndrome. *J Hand Surg Br* 2005; 30:412-414.
29. Tavares SP, Giddins GE. Nerve injury following steroid injection for carpal tunnel syndrome. A report of two cases. *J Hand Surg Br* 1996; 21:208-209.
30. Benson LS, Bare AA, Nagle DJ, Harder VS, Williams CS, Visotsky JL. Complications of endoscopic and open carpal tunnel release. *Arthroscopy* 2006; 22:919-924, 924, e911-912.
31. Schmelzer RE, Della Rocca GJ, Caplin DA. Endoscopic carpal tunnel release: A review of 753 cases in 486 patients. *Plast Reconstr Surg* 2006; 117:177-185.
32. McDowell D, Garwood M, Barnes D, Minott M. Endoscopic carpal tunnel release in Jamaica--seven years experience. *West Indian Med J* 2012; 61:158-162.
33. Ryu SJ, Kim IS. Pseudoaneurysm of ulnar artery after endoscopic carpal tunnel release. *J Korean Neurosurg Soc* 2010; 48:380-382.
34. Didailler P, Ragois P, Morales P. Pseudoaneurysm of the superficial palmar arch, following endoscopic carpal tunnel release. A case report. *Chir Main* 2011; 30:73-75.
35. Dheansa BS, Belcher HJ. Median nerve contusion during endoscopic carpal tunnel release. *J Hand Surg Br* 1998; 23:110-111.
36. Alblas CL, van Kasteel V, Jellema K. Injection with corticosteroids (ultrasound guided) in patients with an ulnar neuropathy at the elbow, feasibility study. *Eur J Neurol* 2012; 19:1582-1584.
37. Rampen AJ, Wirtz PW, Tavy DL. Ultrasound-guided steroid injection to treat mild ulnar neuropathy at the elbow. *Muscle Nerve* 2011; 44:128-130.
38. Tagliafico A, Serafini G, Lacelli F, Perrone N, Valsania V, Martinoli C. Ultrasound-guided treatment of meralgia paresthetica (lateral femoral cutaneous neuropathy): Technical description and results of treatment in 20 consecutive patients. *J Ultrasound Med* 2011; 30:1341-1346.