

Original article

Endoscopic tarsal tunnel syndrome surgery using the Universal Subcutaneous Endoscope system

Aya Yoshida^{a,b,*}, Ichiro Okutsu^a, Ikki Hamanaka^a

^a Okutsu Minimally Invasive Orthopaedic Clinic, Minato-ku, Tokyo, Japan

^b Department of Orthopaedic Surgery, Toride-Kitasouma Medical Association Hospital, Ibaraki, Japan

Received 6 December 2014; revised 4 August 2015; accepted 10 September 2015

Available online 2 November 2015

Abstract

Background/objective: Tarsal tunnel syndrome is a relatively rare entrapment neuropathy with the lateral and medial plantar nerves entrapped inside of the tarsal tunnel. When conservative treatment fails, standard open decompression of the nerve can be achieved by releasing the flexor retinaculum of the foot through a several-centimetre-long skin incision made along the tarsal tunnel. By contrast, we made a 1-cm portal incision at the proximal part of the medial ankle, and endoscopic tarsal tunnel release of the flexor retinaculum of the foot and part of the abductor hallucis muscle was achieved using the Universal Subcutaneous Endoscope (USE) system.

Methods: Our procedure was performed under local anaesthesia without a pneumatic tourniquet on an outpatient basis. The USE system was inserted into the tarsal tunnel at the proximal part of the medial ankle; the nerves, vessels, flexor retinaculum, tendons of the foot, and the abductor hallucis muscle were then endoscopically identified. Decompression of the lateral and medial plantar nerves entrapped inside of the tarsal tunnel was then achieved by releasing the flexor retinaculum of the foot and part of the abductor hallucis muscle with a push knife under complete endoscopic observation.

Results: Results from eight feet of five patients were compiled and analyzed. All showed improved clinical signs compared with their pre-operative condition.

Conclusion: Our less invasive endoscopic management for tarsal tunnel syndrome using the USE system produces sufficient results.

Copyright © 2016, Asia Pacific Knee, Arthroscopy and Sports Medicine Society. Published by Elsevier (Singapore) Pte Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Keywords: endoscopic neurolysis; endoscopic surgery; entrapment neuropathy; peripheral nerve; tarsal tunnel syndrome

Background

Tarsal tunnel syndrome is a relatively rare entrapment neuropathy. When the lateral and medial plantar nerves are entrapped inside of the tarsal tunnel, pain, paraesthesia, and/or sensory loss in the medial and/or the lateral branch area of the plantar aspect occurs. In some cases weakness or atrophy of the abductor hallucis muscle, and/or other foot intrinsic

muscles also controlled by the tibial nerve occurs. Clinical signs worsen at night and/or during the day due to overuse of the foot. There is positive percussion test (Tinel-like sign) at the tarsal tunnel. Electrophysiological examinations show decreased conduction velocity at the tarsal tunnel.

When conservative treatment fails, surgery is considered. The standard open procedure requires a several-centimetre-long skin incision along the tarsal tunnel. The wide skin incision and subsequent exploration enables the surgeon to directly observe nerves, vessels, and identify possible entrapment points. Healthy tissues, however, are coincidentally damaged during this open procedure.

* Corresponding author. Okutsu Minimally Invasive Orthopaedic Clinic, 3rd floor, Daini-Sano Building, 5-10-24, Minami-Azabu, Minato-ku, Tokyo 106-0047, Japan.

E-mail address: ayayoshida@msj.biglobe.jp (A. Yoshida).

To minimise surgical invasion of healthy tissue in the treatment of tarsal tunnel syndrome, we applied an endoscopic procedure using the Universal Subcutaneous Endoscope (USE) system (Tact Medical Inc., Tokyo, Japan). The USE system consists of a standard 30° 4-mm oblique viewing arthroscope and a tapered 6–8-mm diameter transparent closed sheath (USE sheath). It has been developed and used in subcutaneous surgical treatments such as carpal tunnel syndrome, cubital tunnel syndrome, shoulder impingement syndrome, and benign bone tumours since 1986.^{1–7}

We compiled and analysed the clinical results of our endoscopic surgeries to verify the efficacy of this less invasive procedure for the treatment of tarsal tunnel syndrome.

Methods

We have retrospectively compiled, examined, and analysed the results from all of our patients who underwent endoscopic neurolysis using the USE system for tarsal tunnel syndrome since 2004.

Diagnosis was performed using clinical signs, such as tingling and touch sensation evaluated using 2g von Frey hair at the tibial nerve distribution area and manual muscle testing of the abductor hallucis muscle, Tinel-like sign at the tarsal tunnel, and electrophysiological test results (decreased motor nerve conduction velocity between the entrance and exit of the tarsal tunnel). Surgery was performed on patients who failed to show any signs of recovery following > 2 months of conservative treatment, e.g., the taking of nonsteroidal anti-inflammatory drugs and/or steroid injections directly into the tarsal tunnel. Indications for our endoscopic procedure also include idiopathic, haemodialysis-related tarsal tunnel syndrome. Space occupying lesions such as lipoma, ganglion, aneurysm, or anomalies do not serve as indications for our endoscopic procedure.

Eight feet of five cases (3 men and 2 women) were included in this study. One case had no apparent cause (2 feet) and four were haemodialysis-related (6 feet). The mean age at the time of operation (standard deviation; SD) was 62.4 (12.1) years old (range, 44–75 years) and mean follow up period (SD) was 14.4 (10.9) months (range, 3.6–32 months).

Surgeries were performed under local anaesthesia (5 ml of 2% lidocaine containing epinephrine is applied to the skin incision area and 10 ml of 1% lidocaine containing epinephrine is injected into the tarsal tunnel) on an out-patient basis. If the patients complained of referred pain to the foot and/or if blood returned into the syringe during administration of local anaesthetic agent, we stopped the injection and changed the injection area to avoid nerve and vessel injuries. A pneumatic tourniquet is not used so that we can identify blood circulation of the artery and vein during surgery thus avoiding vascular injury. A 1-cm portal skin incision was made at the proximal part of the flexor retinaculum of the foot. The USE system was inserted into the tarsal tunnel through the portal (Figure 1). Correct positioning of the foot is crucial when placing the tip of the USE system because correct positioning of the foot allows us to advance from the portal to the proximal part of

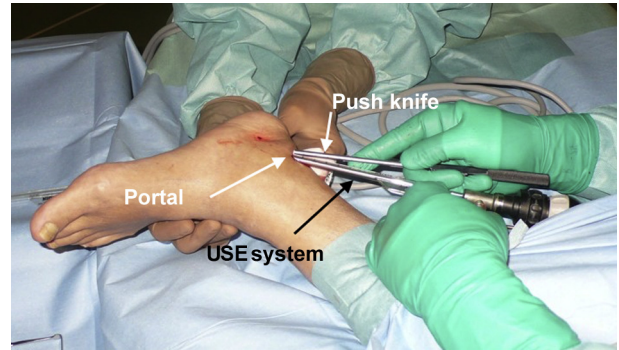


Figure 1. The Universal Subcutaneous Endoscope system and a push knife are inserted into the tarsal tunnel. The photograph shows the correct operative position of the foot. USE system = Universal Subcutaneous Endoscope system.

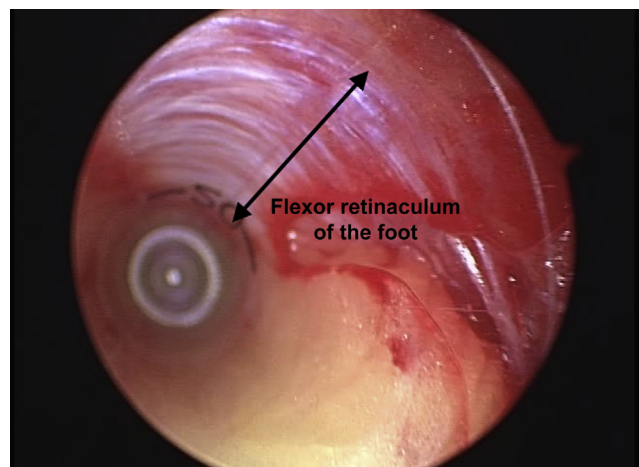


Figure 2. Endoscopic internal view of the flexor retinaculum of the foot.

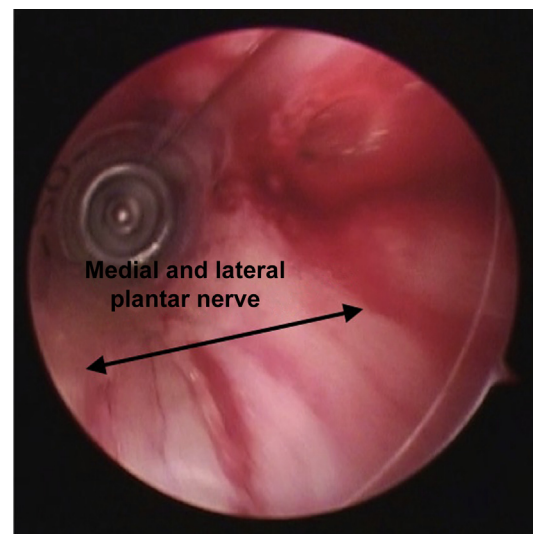


Figure 3. Endoscopic view of the medial and lateral plantar nerve.

the abductor hallucis muscle, i.e., the proximal part (entrance) of the abductor canal. The flexor retinaculum of the foot (Figure 2), nerves (Figure 3), and vessels were endoscopically identified in order to avoid injury to nerves and vessels due to

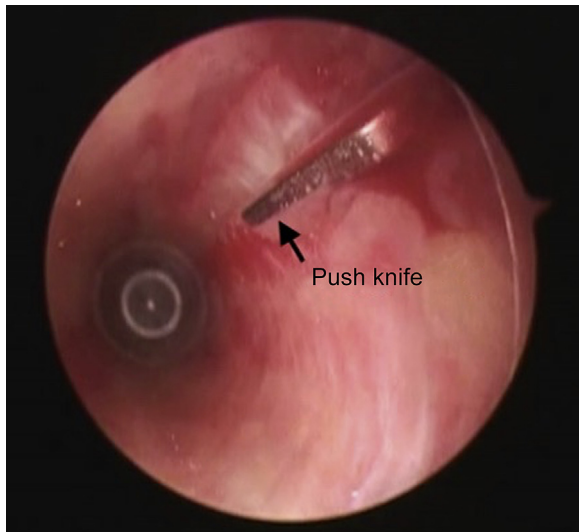


Figure 4. Endoscopic view of releasing the flexor retinaculum of the foot using a push knife.

their anatomical configuration. A push knife was inserted next to the USE sheath through the portal, and the flexor retinaculum of the foot and a part of the abductor hallucis muscle were then released from proximal to distal (Figure 4). If a patient complained of pain during surgery, we administered sufficient local anaesthetic under complete endoscopic observation. Endoscopic observation of the blood reperfusion of the nerves served to verify sufficient decompression of the nerve. We endoscopically confirmed that there was no arterial bleeding; however, if there is bleeding, endoscopically haemostasis can be done using a ligation technique from the surface skin to the injured vessels, manual compression, and/or a bipolar coagulator can also be used. A blunt obturator was used to confirm complete release of the tarsal tunnel (Figure 5). The skin incision was not sutured to allow for blood drainage and patients were recommended to avoid weight-bearing activity for 1 postoperative week.

Written informed consent was obtained from all participating patients in this treatment. This study was performed in accordance with the World Medical Association Declaration of Helsinki.



Figure 5. Complete release confirmation of the tarsal tunnel using an obturator.

Results

Preoperatively, all patients complained of tingling in the affected foot, positive Tinel-like signs, and sensory disturbance. Abnormal motor nerve conduction velocity existed in all feet and three feet showed muscle weakness (Table 1).

In foot five and foot six (same patient), the os tibiale externum that had remained following childhood surgery was excised via another small skin incision made after completion of the endoscopic tarsal tunnel release procedure.

Postoperatively, all eight feet showed improved rating scores (Table 2).⁸ Mean recovery times (SD) were 2.9 (3.1) months (range, 0.1–8.2 months) for tingling sensation; 2.9 (2.8) months (range, 0.1–8.2 months) for sensory disturbance; and 2.9 (4.6) months (range, 0.1–8.2 months) for muscle weakness. Motor nerve conduction velocity improved in 11.8 (3.7) months (range, 8.1–16.4 months) in 80% of results detectable feet.

Foot number one showed manual muscle testing level 2 muscle weakness of the abductor hallucis muscle at 13 postoperative months. Foot number four and six exhibited tingling until 10 postoperative weeks. Foot number six also showed hypaesthesia and hypalgesia at 9.6 postoperative months.

Postoperative complications were one haematoma formation and two feet with postoperative tingling in the calcaneal branch area; however, no further surgical treatments were required. Haematoma formation was spontaneously absorbed and postoperative tingling was treated with Vitamin B12 taken orally. There was no recurrence in this series during follow-up periods.

Discussion

The purpose of surgical treatment of tarsal tunnel syndrome is decompression of the tibial nerve inside of the tarsal tunnel. Although some satisfactory postoperative results have been reported, Pfeiffer and Cracchiolo⁹ reported less satisfactory postoperative results following standard exploration and decompression with only 44% having “good” or “excellent” results. They reported the existence of varicosities, tighter retinaculum, and rheumatoid arthritis in the “poor” postoperative-result patients. Barker et al¹⁰ reported 44 feet undergoing revision tarsal tunnel surgery that needed neurolysis, resection of intertunnel septum, neuroma resection (as indicated), and listed poor prognosis risk factors as coexisting lumbosacral disc disease and/or neuropathy. Every patient in our series, except patients with feet five and six, had possible histories of peripheral nerve disease as entrapment neuropathies of the upper-extremities. Patients of foot one, four, seven, and eight had been receiving haemodialysis for > 20 years and had previously undergone surgery for bilateral carpal tunnel syndrome. In foot six patient we had to insert the USE sheath while simultaneously cutting the flexor retinaculum from proximal with a push knife because of “the tight tarsal tunnel” or “tight retinaculum” described by Pfeiffer and Cracchiolo.⁹ These clinical backgrounds may have affected postoperative recovery in these cases; however, clinical and

Table 1
Profiles of the patients.

Foot no.	Age/sex/laterality	Medical history	Duration of symptoms (wk)	Abductor hallucis muscle weakness	Preoperative motor nerve conduction velocity (m/s)	Previous treatment
1	70/F/L	HD 27 y DSA (CS/LS) Lt. Baker's cyst Herpes zoster; Bil. CTS	192	+	17.6	Steroid injection
2 ^a	62/M/L	HD 2 y Cervical spondylosis DM Bil. CTS	12	–	13	
3 ^a	62/M/R	HD 2 y Cervical spondylosis DM Bil. CTS	19	–	7.6	
4	62/M/L	HD 22 y Lumber disc herniation Bil. CTS	40	–	28	
5 ^a	44/M/R	Os tibiale externum	208	+	38	Steroid injection
6 ^a	45/M/L	Os tibiale externum	208	+	49	
7 ^a	75/F/R	HD 41 y DSA (CS/LS) Parkinsonism Bil. CTS	104	–	31	Steroid injection
8 ^a	75/F/L	HD 41 y DSA (CS/LS) Parkinsonism Bil. CTS	104	–	41	

CS = cervical spine; CTS = carpal tunnel syndrome; DM = diabetes mellitus; DSA = destructive spondyloarthropathy; F = female; HD = haemodialysis; L = left; LS = lumbar spine; M = male; R = right.

^a Same patient: feet two and three; feet five and six; feet seven and eight.

Table 2
Pre- and postoperative clinical symptoms.

Foot no.	Preop. rating score ^a	Postop.						
		Pain	Tingling	Tinel-like sign	Sensory disturbance	Muscle weakness	MCV (m/s)	Rating score ^a
1	0	–	+	+	–	+	(–)	4
2	2	–	–	–	–	–	32	10
3	2	–	–	–	–	–	43	10
4	2	–	+	–	–	–	42	8
5	0	–	–	–	–	–	37	10
6	0	–	+	–	+	–	51	6
7	2	–	–	–	–	–	(–)	10
8	2	–	–	–	–	–	(–)	10

MCV = motor nerve conduction velocity; Postop. = postoperative; Preop. = preoperative.

^a Rating score according to Takakura et al⁸ (1991).

electrophysiological recovery test results do indicate an improved perineural environment following our procedure.

Other authors have previously reported endoscopic procedures for tarsal tunnel syndrome. Krishnan et al¹¹ reported an endoscopically assisted procedure that used a retractor to create observation space in the tarsal tunnel, following observation, and release of the tarsal tunnel from a several-centimetre-wide skin incision under direct vision. They reported five “excellent” and three “good” postoperative results

in eight feet. Day and Naple¹² reported a two-portal procedure using a slotted cannula with an 89% success rate. All of these procedures release from the flexor retinaculum to a part of the abductor canal as Franson¹³ stressed the importance of releasing the flexor retinaculum and the nerve distally, through the abductor canal. However, there are some significant differences between these procedures and ours. Our characteristic closed transparent sheath, used without a pneumatic tourniquet, enables us to observe the nerve and vessels without blood

obscuring the magnified field of vision. From the 1-cm endoscopic portal, the 10-cm USE sheath allows us to confirm sufficient length of tibial nerve decompression from the proximal part of the flexor retinaculum to the abductor hallucis muscle. The USE system allows us to observe restored intraneural blood circulation during the operation and verify complete decompression of the nerve. Because insufficient release and perineural scar formation lead to poor postoperative results, it is important to have a clear field of vision, avoiding interference bleeding during the endoscopic procedure and to prevent postoperative perineural adhesion after the endoscopic procedure.

As a limitation of this procedure, ganglion and bony spur formation cases (such as tarsal coalition), the most frequent cause for tarsal tunnel syndrome,^{8,14,15} are not indicated for our procedure because it does not achieve complete decompression when they exist. Although some surgeons may fear damaging nerves with insertion of the USE sheath, we have shown that no nerve damage occurs during the average 3-minute insertion of the USE sheath as proven in our carpal tunnel syndrome surgeries.¹⁶ Our postoperative clinical recovery results from tarsal tunnel syndrome reveal the effectiveness of this procedure.

Conclusion

Endoscopic treatment using the USE system is an appropriate less invasive procedure for the treatment of tarsal tunnel syndrome. Decompression of the tibial nerve is achieved without nerve and/or vessel damage during release of the flexor retinaculum of the foot and a part of the abductor hallucis muscle.

Conflicts of interest

The authors declare that there are no conflicts of interest in this study.

Funding/support

No financial or material support of any kind was received for the work described in this article.

References

1. Okutsu I, Ninomiya S, Natsuyama M, et al. Subcutaneous operation and examination under Universal Endoscope. *Nihon Seikeigeka Gakkai Zasshi (J Jpn Orthop Assoc)*. 1987;61:491–498.
2. Okutsu I, Ninomiya S, Takatori Y, Ugawa Y. Endoscopic management of carpal tunnel syndrome. *Arthroscopy*. 1989;5:11–18.
3. Okutsu I, Ninomiya S, Takatori Y, Hamanaka I, Schonholtz GJ. Coracoacromial ligament release for shoulder impingement syndrome using the Universal Subcutaneous Endoscope system. *Arthroscopy*. 1992;8:2–9.
4. Okutsu I, Ninomiya S, Hamanaka I, Tanabe T, Watanabe K. Endoscopic management of benign bone tumors. *Min Invas Ther Allied Technol*. 1998;7:407–414.
5. Okutsu I, Hamanaka I, Chiyokura Y, et al. Endoscopic treatment of cubital tunnel syndrome using the USE system in long-term haemodialysis patients. *Kansetsukyo*. 2000;25:137–141.
6. Yoshida A, Okutsu I, Hamanaka I. Endoscopic anatomical nerve observation and minimally invasive management of cubital tunnel syndrome. *J Hand Surg Eur Vol*. 2009;34:115–120.
7. Yoshida A, Okutsu I, Hamanaka I. Minimally invasive endoscopic ulnar nerve assessment and surgery for cubital tunnel syndrome patients – relation between endoscopic nerve findings and clinical symptoms. *AP-SMART*. 2014;1:96–101.
8. Takakura Y, Kitada C, Sugimoto K, Tanaka Y, Tamai S. Tarsal tunnel syndrome. Causes and results of operative treatment. *J Bone Joint Surg Br*. 1991;73:125–128.
9. Pfeiffer WH, Cracchiolo A. Clinical results after tarsal tunnel decompression. *J Bone Joint Surg Am*. 1994;76:1222–1230.
10. Barker AR, Rosson GD, Dellon AL. Outcome of neurolysis for failed tarsal tunnel surgery. *J Reconstr Microsurg*. 2008;24:111–118.
11. Krishnan KG, Pinzer T, Schackert G. A novel endoscopic technique in treating single nerve entrapment syndromes with special attention to ulnar nerve transposition and tarsal tunnel release: clinical application. *Neurosurgery*. 2006;59:ONS89–100.
12. Day FN, Naple JJ. Tarsal tunnel syndrome: an endoscopic approach with 4- to 28-month follow-up. *J Foot Ankle Surg*. 1994;33:244–248.
13. Franson J. Tarsal tunnel syndrome: a compression neuropathy involving four distinct tunnels. *Clin Podiatr Med Surg*. 2006;23:597–609.
14. Nagaoka M, Satou K. Tarsal tunnel syndrome caused by ganglia. *J Bone Joint Surg Br*. 1999;81:607–610.
15. Hirotsu H. *Entrapment Neuropathies in Practice*. 1st ed. Tokyo, Japan: Kanehara & Co. Ltd.; 1997:139–143.
16. Hamanaka I, Okutsu I, Chiyokura Y, et al. Carpal canal pressure measurements during endoscopic carpal canal decompression surgery. *Nihon Tenokeka Gakkai Zasshi (J Jpn Soc Surg Hand)*. 1999;16:568–571.