The Impact of Tarsal Tunnel Syndrome on Cold Sensation in the Pedal Extremities

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■ OBJECTIVE: **Tarsal tunnel syndrome (TTS) is an entrapment neuropathy of the posterior tibial nerve in the tarsal tunnel. It is not known whether vascular or neuropathic factors are implicated in the cause of a cold sensation experienced by patients. Therefore, we studied the cold sensation in the pedal extremities of patients who did or did not undergo TTS surgery.**

■ METHODS: **Our study population comprised 20 patients with TTS (38 feet); 1 foot was affected in 2 patients and both feet in 18 patients. We acquired the toe-brachial pressure index to evaluate perfusion of the sole and toe perfusion under 4 conditions: the at-rest position (condition 1); the at-rest position with compression of the foot dorsal artery (condition 2); the Kinoshita foot position (condition 3); and the Kinoshita foot position with foot dorsal artery compression (condition 4). Patients who reported abatement in the cold sensation during surgery underwent intraoperative reocclusion of the tibial artery to check for the return of the cold sensation.**

■ RESULTS: **The toe-brachial pressure index for conditions 1 and 3 averaged 0.82 ± 0.09 and 0.81 ± 0.11, respectively; for conditions 2 and 4, it averaged 0.70 ± 0.11 and 0.71 ± 0.09, respectively. Among the 16 operated patients, the cold sensation in 7 feet improved intraoperatively; transient reocclusion of the tibial artery did not result in the reappearance of the cold sensation.**

■ CONCLUSIONS: **Our findings suggest that the cold sensation in the feet of our patients with TTS was associated with neuropathic rather than vascular factors.**

INTRODUCTION

Tarsal tunnel syndrome (TTS) is an entrapment neuropathy of the posterior tibial nerve and its branches in the tarsal tunnel on the medial side of the ankle.[1-3] Its symptoms are numbness and pain, sensory disturbance, and a foreign-body sensation perceived as walking on gravel in the affected area of the medial and lateral plantar nerve; approximately half of patients with TTS report having a cold sensation.[4] TTS surgery has been reported to be effective.[2, 4-11]

Postoperatively, patients reported that not only the numbness and pain but also the cold sensation in the sole and toes had improved; some experienced intraoperative improvement of symptoms.[4] During TTS surgery, not only the posterior tibial nerve but also the posterior tibial artery and vein are decompressed because the posterior tibial nerve runs with those vessels in the tarsal tunnel. We reported previously[4] that the assessment of tibial artery pulsation was useful for assessing the adequacy of decompression of the neurovascular bundle in the tarsal tunnel. It remained to be determined whether decompression of the posterior tibial nerve or of the tibial artery and vein led to abatement of the cold sensation (ie, whether vascular or other factors were involved).

METHODS

The ethics committee of Chiba Hokuso Hospital of Nippon Medical School approved the study protocol. Prior informed consent for participation in this study was obtained from all patients. Based on our diagnostic criteria, the 20 patients (38 feet) had TTS.[4] There were 11 men and 9 women, ranging in age from 64 to 88 years (average, 75.4 years) at the time of treatment. One foot was affected in 2 patients and both feet in 18 patients. Five patients had medically treated diabetes mellitus. We excluded patients with arteriosclerosis obliterans (ASO) by measuring their ankle-brachial pressure index (ABI). Patients with other

Key words
- Cold sensation
- Decompression
- Entrapment neuropathy
- Tarsal tunnel syndrome (TTS)

Abbreviations and Acronyms
ABI: Ankle-brachial pressure index
ASO: Arteriosclerosis obliterans
FDA: foot dorsal artery
TBI: Toe-brachial pressure index
TTS: Tarsal tunnel syndrome

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vasculopathic diseases diagnosed by medical examinations or determined by interview or their past history were also excluded. The mean follow-up period was 15.5 months (range, 1–36 months).

Diagnostic Criteria for TTS

Our diagnosis was primarily based on clinical symptoms.[4,12] All patients reported sensory disturbance in the sole of the affected foot without heel involvement. Their symptoms were paresthesia, a foreign-body sensation like walking on gravel, a cold sensation, and burning or tingling. All patients were positive for the Tinel sign in the tarsal tunnel. It is the most useful clinical test[4,10,12-15] and it is included in our diagnostic criteria. All patients with TTS presented with idiopathic disease; none had TTS caused by tumors or mass lesions. To avoid false-positive and false-negative results, we did not perform electrophysiologic study.[1,4,11,12,16] All patients had undergone conservative treatment lasting more than 3 months; if that failed, they underwent surgery.

Surgical Treatment for TTS

All surgical procedures were performed under local skin anesthesia with approximately 5 mL of 1% lidocaine infiltrated superficially into the incision site to avoid nerve block; no anesthetic was introduced into the inner tarsal tunnel.[4] A 4- to 5-cm bowlike skin incision was made without a tourniquet. The patients were not sedated to allow observation of symptom changes intraoperatively. Under a surgical microscope, the flexor retinaculum was dissected from the proximal to the distal end of the tarsal tunnel at the edge of the abductor pollicis muscle. For sufficient decompression of the neurovascular bundle, connective tissue surrounding the tibial nerve and vessels was dissected.[4] We addressed the distal portion of the tibial nerves on the inlet portion to the abductor pollicis muscle. Skin closure was without closure of the dissected retinaculum. After surgery, the patients were allowed to walk without cast immobilization.

Evaluation of Sole and Toe Perfusion

We recorded the patients' ABI to rule out proximal ASO. To evaluate the blood flow in the plantar artery originating from the posterior tibial artery and passing through the tarsal tunnel, the toe-brachial pressure index (TBI) was measured; it reflects the plantar digital artery blood flow from the plantar artery to the first toe. To assess factors involved in the elicitation of TTS affecting perfusion to the sole and toe, we recorded the TBI under 4 conditions. Condition 1 was the at-rest position. Sole perfusion depends on the medial and lateral plantar artery originating from the posterior tibial artery in the tarsal tunnel. The lateral is thicker than the medial plantar artery; it forms the plantar arterial arch and delivers blood to the sole. To exclude anastomosis from the foot dorsal artery (FDA), the TBI was measured under FDA compression (condition 2). Because blood flow to the sole and toe is delivered by the posterior tibial artery passing through the tarsal tunnel, the FDA is strongly compressed to stop peripheral blood flow to the FDA. In the presence of TTS, the tarsal tunnel pressure increases when the ankle is passively maximally everted and dorsiflexed while all of the metatarsophalangeal joints are maximally dorsiflexed. This is the Kinoshita foot position[13] (condition 3) (**Figure 1**). To rule out anastomosis from the FDA, the TBI was also measured in the Kinoshita foot position with FDA compression (condition 4).

We defined the abnormal range according to Hirsch et al.[17]; an ABI <0.9 and a TBI <0.6 were considered anomalous.

Tibial Artery Occlusion During Surgery

When patients reported improvement of the cold sensation intraoperatively we reoccluded the tibial artery for 3 minutes with an aneurysm clip (Sugita titanium temporary clip 07-934-52) (MIZUHO Co. Ltd., Bunkyo-ku, Tokyo, Japan) to check for the reappearance of the cold sensation.[4]

Clinical Outcomes

To evaluate our treatment results, we used the rating system of Pfeiffer and Cracchiolo.[11] The outcome was recorded as excellent when the patient reported pain disappearance, no functional limitations, and the cessation of analgesic medications. The result was recorded as good when there was marked improvement in the presence of residual minor symptoms, usually pain, and when pain was intermittent, did not interfere with function, and had not required medical attention or analgesic drugs on a regular basis. The outcome was rated as fair when there was alleviation in the intensity or frequency of pain although severe pain and functional impairment persisted and analgesics were required. Patients in this category did not regret having undergone surgery. When the degree of pain was unchanged or worse after surgery, the result was recorded as poor.

Statistical Evaluation of Our Results

We compared the ABI and the TBI recorded under each condition with the Student t test and the TBI changes before and after surgery with the Wilcoxon signed-rank test using Statmate III software (ATMS Co. Ltd., Bunkyo-ku, Tokyo, Japan). Differences of $P < 0.05$ were considered to indicate statistical significance.

RESULTS

Evaluation of the Posttreatment Results

As shown in **Table 1**, of the 20 patients, 5 patients were treated conservatively without surgery and 16 underwent surgery. At the last follow-up examination, 8 considered the treatment result as excellent, 7 as good, 3 as fair, and 2 as poor.

Rule Out ASO

The postoperative ABI exceeded 0.9 in all patients (average, 1.16 ± 0.07). None of the patients had been diagnosed preoperatively with proximal ASO.

Evaluation with the TBI

The at-rest TBI (condition 1) averaged 0.82 ± 0.09; in the Kinoshita foot position (condition 3), it averaged 0.81 ± 0.11. In all feet with a TBI exceeding 0.6, there was no statistical difference between condition 1 and 3. The TBI in the at-rest position with FDA compression (condition 2) averaged 0.70 ± 0.11; in 6