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Ganglia-Induced Tarsal Tunnel Syndrome

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Background: Tarsal tunnel syndrome (TTS) is a common entrapment neuropathy that is sometimes elicited by ganglia in the tarsal tunnel.

Methods: Between August 2020 and July 2022, we operated on 117 sides with TTS. This retrospective study examined data from 8 consecutive patients (8 sides: 5 men, 3 women; average age 67.8 years) with an extraneural ganglion in the tarsal tunnel. We investigated the clinical characteristics and surgical outcomes for these patients.

Results: The mass was palpable through the skin in 1 patient, detected intraoperatively in 1 patient, and visualized on MRI scanning in the other 6 patients. Symptoms involved the medial plantar nerve area (n = 5), lateral plantar nerve area (n = 1), and medial and lateral plantar nerve areas (n = 2). The interval between symptom onset and surgery ranged from 4 to 168 months. Adhesion between large (≥ 20 mm) ganglia and surrounding tissue and nerves was observed intraoperatively in 4 patients. Of the 8 patients, 7 underwent total ganglion resection. There were no surgery-related complications. On their last postoperative visit, 3 patients with a duration of symptoms not exceeding 10 months reported favorable outcomes.

Conclusions: Because ganglia eliciting TTS are often undetectable by skin palpation, imaging studies may be necessary. Early surgical intervention appears to yield favorable outcomes.

(J Nippon Med Sch 2024; 91: 114–118)

Key words: ganglion, outcome, plantar nerve, surgery, tarsal tunnel syndrome

Introduction

Tarsal tunnel syndrome (TTS) is an entrapment neuropathy of the posterior tibial nerve at the tarsal tunnel. Plantar symptoms, e.g., numbness, pain, foreign-body sensation, and coldness, can impair quality of life of TTS patients[1–5]. Space-occupying lesions in the tarsal tunnel, e.g., ganglia or rare schwannomas, can elicit TTS[2,6,7].

Ganglia are cystic lesions that contain gelatinous fluid. They can develop at stress sites of the joint or tendon sheath, and trauma has also been implicated[6,8–11]. Most ganglia develop around the hands and wrists; 11% were present in the foot and ankle[12]. Associated neuropathies tend to affect the peroneal nerve; in 4% of patients the posterior tibial nerve was involved[8].

In up to 8% of TTS patients, a ganglion is implicated[2,6,9,13]. Nagaoka and Satou[13] studied 30 feet with TTS due to ganglia and reported that the site of origin was the talocalcaneal joint in 14. The present study examined the pathological characteristics, clinical course, surgical findings, and outcomes in 8 patients with TTS attributable to a ganglion.

Patients and Methods

This retrospective study was approved by the ethics committee of Nippon Medical School (No. M-2022-078). The requirement for written informed consent for inclusion in the study was waived because an opt-out option was provided on our hospital's homepage.

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https://doi.org/10.1272/jnms.JNMS.2024_91-203
Journal Website (https://www.nms.ac.jp/sh/jnms/)

Table 1 Characteristics of patients with TTS due to a ganglion

Case	Age/ gender	Site	Symptom duration (months)	Tinel sign	Palpable through the skin	Affected nerve	Aggravated by walking or standing	Size (mm)	Extent of removal	F/U periods (months)	Symptom (NRS)		Surgical satisfaction (NRS)
											before	after	
1	54/M	Lt	4	+	–	MPN	+	20×13×8	total	16	6	1	8
2	45/M	Lt	7	+	–	MPN	+	20×12×8	total	15	8	1	10
3	60/F	Lt	5	+	+	LPN	+	37×17×13	total	10	8	0	10
4	59/M	Rt	24	–	–	MPN+LPN	+	24×12×11	Partial	10	7	3	7
5	81/F	Lt	60	+	–	MPN+LPN	+	8×5×4	total	7	7	2	8
6	85/F	Lt	168	+	–	MPN	–	4×4×3	total	6	5	4	4
7	79/M	Lt	48	+	–	MPN	+	not measured	total	14	4	4	3
8	79/M	Lt	120	+	–	MPN	+	8×7×6	total	18	8	2	7

M: male, F: female, Lt: left, Rt: right, MPN: medial plantar nerve, LPN: lateral plantar nerve, before: before the surgery, after: after the surgery

NRS: numerical rating scale: TTS, tarsal tunnel syndrome

Between August 2020 and July 2022, we operated on 117 sides with TTS. The current study analyzed data from 8 consecutive patients (8 sides, 6.8%) with an extraneural ganglion in the tarsal tunnel. They underwent surgery because the effects of treatment with drugs such as mirogabalin, pregabalin, and nonsteroidal anti-inflammatory drugs were unsatisfactory. We inspected their medical charts and surgical videos and collected data on their clinical characteristics and surgical outcomes. Electrophysiological studies were used to measure sensory nerve conduction velocity at the tarsal tunnel. The result was classified as positive when the terminal latency of the abductor hallucis muscle exceeded 5.8 ms and the difference in side-to-side amplitude was more than 50%[14–16]. The site of the ganglion was identified by reviewing preoperative radiological and intraoperative findings.

To evaluate surgical outcome at the final visit, we compared patients' preoperative and postoperative symptom severity by using a numerical rating scale (NRS) where 0 indicated no pain and 10 indicated severe pain. The NRS was also used to evaluate patients' degree of satisfaction with their surgical treatment (0 = not satisfied; 10 = greatly satisfied). Statistical analysis was performed using IBM SPSS for Windows ver. 25.0 (IBM Corp., Armonk, NY, USA). For comparison studies we performed the Wilcoxon signed-rank test. A P value of <0.05 was considered to indicate statistical significance. All values are expressed as mean ± SD.

Results

Patient Characteristics

As shown in the **Table 1**, the study population comprised 5 men and 3 women (average age 67.8 ± 14.0 years, range 45-85 years). In all 8 patients, TTS was unilateral (right in 1, left in 7) and idiopathic. All patients experienced numbness, pain, coldness, or foreign-body sensation; none reported trauma to the affected area. The ganglion developed suddenly in 4 patients (cases 1-4), and ganglion size in these patients exceeded 20 mm. The Tinel sign at the tarsal tunnel was negative only in case 4, and the mass was palpable through the skin only in case 3. In case 7—a patient who did not undergo preoperative MRI—the mass was detected intraoperatively; in the other 6 patients it was visualized on MRI scans of the tarsal tunnel. In all but patient 6, symptoms were aggravated by prolonged standing and walking. Five patients had medial plantar nerve involvement, 1 had lateral plantar nerve involvement, and 2 had both. The mean NRS value for preoperative symptoms was 6.6 ± 1.4 (range 4-8). The interval between symptom onset to surgery ranged from 4 to 168 months (median = 36 months; upper/lower interquartile = 84).

Examination Results

Preoperative MRI scans of the tarsal tunnel, acquired in 7 patients, visualized the ganglia, which were slightly hypointense on T1-weighted images (5 cases) and hyperintense on T2-weighted images (7 cases). On T2* fat-suppression images, the signal was hyperintense (**Fig. 1**). All ganglia were located at the bottom of the tarsal tunnel and compressed nerves. Mean ganglia diameter was 17.3 ± 10.7 mm (range 4-37 mm).

Electrophysiological studies were performed in 7 patients: 4 had a positive result, 1 had a negative result, and 2 showed no evocation.

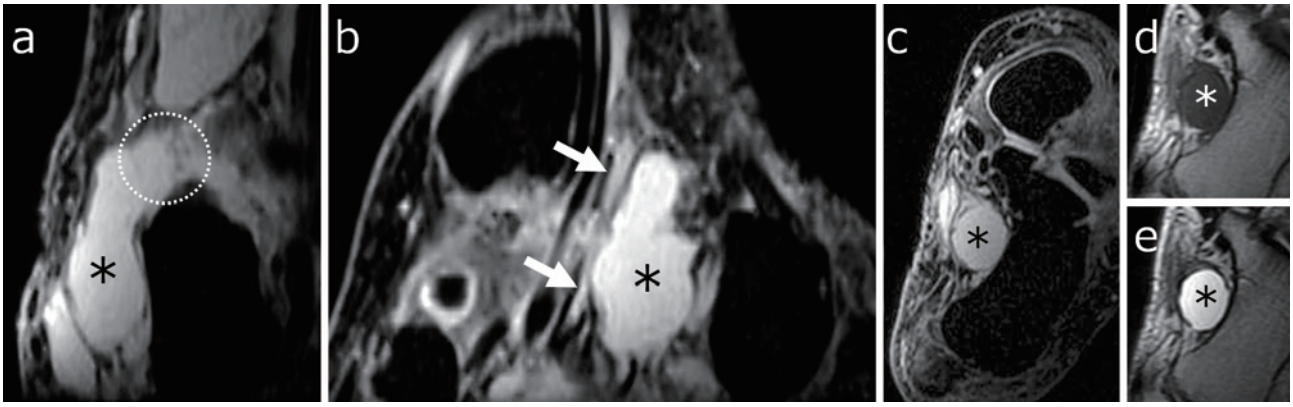

Fig. 1
a-c T2 fat-suppression MR images of case 3: (a) coronal, (b) sagittal, and (c) axial images.
d, e Axial T1-weighted (d) and T2-weighted images (e).
The ganglion (*) is present on the ventral side of the nerve in the tarsal tunnel. The compressed lateral plantar nerve is not visible. The dotted circle shows the attachment between the ganglion and talocalcaneal joint; the arrows indicate the medial plantar nerve.

Treatment

Despite echo-guided ganglion puncture, patient 2 developed a recurrence the next day. The ganglia in patients 5, 7, and 8 were small and were not aspirated. Patient 3 refused ganglion puncture. We did not perform ganglion puncture for patients 1 and 4, as we assessed the procedure as anatomically risky. In patient 6 the site of the ganglion was not identified preoperatively.

Surgical procedures for idiopathic TTS usually require only local anesthesia, which was used for patients 4-8. Patients 1-3 were treated under general anesthesia because the mass was large. The operations were performed under a surgical microscope; no tourniquet was placed. A bow-like or S-shaped skin incision (20-70 mm, average 43.8 ± 14.3 mm) was made on the tarsal tunnel. Typically, exposed ganglia contained a transparent or yellowish, jelly-like fluid, and all originated at the talocalcaneal joint. In patients 1-4 we observed adhesions between the mass and surrounding tissues and nerves; the size of the ganglia in these patients was 20 mm or larger. Patient 4, treated under local anesthesia, reported pain during the operation, so a portion of the ganglionic capsule adhering to the nerve was left *in situ*, and partial ganglion removal was performed. Thus, treatment of the joint attachments was insufficient. In the other 7 patients the entire ganglion was detached at its pedicle, and the excision site was coagulated or closed with sutures at its transition to the joint. Ganglia smaller than 10 mm were closed with sutures. Postoperatively, all 8 patients were allowed to walk without external fixation. No surgery-related complications were noted.

Surgical Outcomes

As shown in **Table 1**, 6 patients reported marked improvement of symptoms at the final post-treatment follow-up visit (12.0 ± 4.1 months postoperatively, range 6-18 months). However, patients 6 and 7 experienced limited improvement. The average NRS value for treatment satisfaction was 7.1 ± 2.4 (range 3-10). The most favorable outcomes were reported by patients with a symptom duration of 10 months or less.

Discussion

TTS is usually idiopathic, although space-occupying lesions may be implicated. Palpation can help identify ganglionic sites near the skin surface; however, when the mass is located deep in the tarsal tunnel, it cannot be detected by palpation[6,9,17]. Ultrasound and MRI studies of the tarsal tunnel may be helpful in diagnosing TTS[7,13,18]. Diagnostic palpation was useful for identifying the ganglionic site in only 1 of the present 8 patients; the other 7 ganglia were identified on preoperative MRI or intraoperatively. An MRI of the tarsal tunnel yields useful information on the status of tissue surrounding the ganglion and lesion characteristics and pathophysiology and is useful for surgical planning[6,15]. Preoperative MRI helps to understand the anatomical relationship between the ganglion and adjacent structures, including the tibial neurovascular bundle[6,8,17,19–21]. Ganglia tend to be hypointense on T1-weighted MRI scans and hyperintense on T2-weighted MRI scans[8,20], as was the case in 7 of the present patients. We recently reported the usefulness of the 3D T 2* fat-suppression sequence for identifying the anatomy of the tarsal tunnel[15]. In all 8 patients the ganglia were

hyperintense on T2* fat-suppression images, which made these images diagnostically valuable. Diagnostic ultrasonography is minimally invasive and inexpensive and can be used to identify factors that contribute to development of TTS[1,7,13,19].

TTS symptoms tend to be exacerbated by prolonged walking and standing[2,3,14], as was the case in 7 of our 8 patients. Nagaoka and Satou[13] reported that among 30 of their patients with TTS due to a ganglion, 19 had symptoms involving the medial plantar nerve area, which was the case for 6 of our 8 patients.

Among our 8 patients with TTS attributable to ganglia, 4 were older adults (79+ years) and the cause of TTS was unclear. The symptoms and symptom exacerbation in our 8 patients were similar to those of patients with idiopathic TTS, and the mass was palpable through the skin only in patient 3. Consequently, differentiation of idiopathic TTS from TTS due to ganglia can be difficult. Interestingly, in patients with a ganglion size exceeding 20 mm, symptoms developed suddenly.

The talocalcaneal joint was reported as the most common origin site for ganglia eliciting TTS[13,22]; this was the case in all 8 of our patients. Takakura et al.[23] examined CT scans of 85 patients with talocalcaneal coalition affecting 136 feet. They diagnosed TTS in 24.7% of these patients (34 feet), and a ganglion was involved in 7 patients (33.3%). The talocalcaneal coalition was not solid and bony. Rather, it was fibrous and cartilaginous and possibly the precursor of the observed ganglia. In another study[17], only 2 of 11 TTS patients (18.2%) presented with talocalcaneal joint involvement.

Ganglia that elicit TTS are often located on the ventral side of nerves and vessels. While aspiration of the ganglionic fluid may be useful[24], puncture risks iatrogenic nerve injury because nerve branches may be present on the ganglionic surface[8,13]. We performed ultrasound-guided aspiration in patient 2; it was not curative and a recurrent ganglion was subsequently removed.

Outcomes were better for TTS patients undergoing surgery to address space-occupying lesions confirmed on imaging studies than for patients with idiopathic TTS[2,13,17,22]. At present there is no gold standard for the diagnosis and treatment of idiopathic TTS[19,25,26], and the treatment outcome may not meet patient expectations[6,7,22,24,27]. Because some ganglia in the tarsal tunnel strongly adhere to nerves, patients scheduled for cyst removal must be made aware of the possibility of iatrogenic nerve injury[6,22,27]. In patients 1-4, adhesion to the large ganglion was strong. Patient 4 underwent only partial removal, and his postoperative NRS value was 7.

Patient selection, symptom duration and severity, electrophysiological findings, Tinel-sign positivity, fibrosis around the nerve, and surgical technique are important factors in the outcome for patients undergoing surgery for ganglion-induced TTS[1,17,22,25,28,29]. Treatment outcome was better when symptom duration did not exceed 12 months[17,22,29]. Prolonged symptom duration had a negative impact on the results of surgical intervention in patients with TTS due to the presence of a ganglion[7,8]. Among our 8 patients, 3 with a symptom duration not longer than 10 months experienced a favorable treatment outcome. Nagaoka and Satou[13] advocated early surgical intervention because only 1 of their 30 TTS patients with an intratarsal tunnel ganglion presented with spontaneous ganglionic resolution.

The reported recurrence rate after surgical ganglion removal ranges from 5% to 30%[6,8,12,30]. Ahn et al.[6] surgically treated ganglia of the foot and ankle and reported a recurrence rate of 5.7%; all masses originated in the tendon sheath and there was no recurrence in the tarsal tunnel. Nagaoka and Satou[13] reported that surgical intervention for tarsal tunnel ganglia yielded satisfactory outcomes and that ganglionic recurrence may be asymptomatic. Cione et al.[20] studied 29 patients who had undergone tarsal tunnel surgery to treat a tarsal ganglion. One of their patients developed recurrence; the recurrent ganglion was removed and there was no further ganglionic recurrence. To avoid recurrence due to inadequate ganglionic excision, pedicle resection is advisable[6,8,13,20,27].

Ahn et al.[6] recommended that to avoid incomplete ganglionic excision due to bleeding, the surgical procedure should be performed with the patient under general anesthesia to obtain adequate hemostasis. One of our patients (case 4) who had a large ganglion (24 mm) was operated under local anesthesia. Severe intraoperative pain prevented complete ganglionic removal in this case. In the other 7 patients we isolated the ganglionic pedicle at the base and performed coagulation or suturing to close the connection to the joint. None of these patients developed a recurrence of symptoms during 6-18 months of postoperative follow-up.

Study Limitations

Our study sample was very small and the duration of follow-up was relatively short. In addition, we did not use CT scanning to investigate the role of talocalcaneal coalition in the development of ganglia in our TTS patients.

Conclusion

Patients with TTS due to ganglia at the talocalcaneal joint tend to experience symptoms in the medial plantar nerve area. Because the ganglionic site may not be identifiable by skin palpation in patients with ganglion-induced TTS, we recommend diagnostic imaging studies. It may be advisable to remove large ganglia with the patient under general anesthesia. Early surgery to remove TTS-eliciting ganglia may yield good treatment outcomes.

Conflict of Interest: The authors declare no conflicts of interest and no commercial relationships or financial support from pharmaceutical or other companies.

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(Received, June 27, 2023)

(Accepted, October 4, 2023)