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The tarsal tunnel syndrome: evaluation of surgical results using multivariate analysis

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Summary. *Thirty-four patients with the tarsal tunnel syndrome were treated by decompression of the posterior tibial nerve. The condition was bilateral in 3 cases. There were 9 men and 25 women with an average age at operation of 41 years. The average follow up was for 3.8 years. Multivariate analysis showed that the outcome is influenced, in order of importance, by fibrosis around the nerve, the preoperative severity of the condition, a history of sprained ankle, worker's compensation, a long history, and heavy work. The results were favourable when there was a short history, the presence of a ganglion, no sprains, and light work. Measurement of the terminal latency of the medial plantar nerve was valuable in assessing recovery. The precise cause of the syndrome and its effect on treatment should be considered before operation.*

Résumé. *Nous rapportons ici les résultats des décompression chirurgicales du tunnel tarsien. Trente-sept nerfs tibiaux avaient été décomprimés sur trente-quatre patients (9 hommes et 25 femmes), dont la moyenne d'âge était de 41 ans. L'intervalle moyen des examens de contrôle était de 3,8 ans. D'après les analyses des multiviariables il apparaît que les résultats sont affectés dans l'ordre: par des fibroses autour du nerf, la gravité de la maladie avant l'opération, des entorses de la cheville, des indemnités sociales, des antécédents pathologiques de longue date, et des travaux pénibles. Inversement les résultats sont favorables dans le cas d'un kyste du ganglion, d'absence de facteurs antérieurs et de travail physique peu pénible. La mesure de la latence finale du nerf plantaire médian a fait ressortir des valeurs significatives pour l'évolution du syndrome du tunnel tarsien.*

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Introduction

The tarsal tunnel syndrome is an entrapment neuropathy caused by pressure on the posterior tibial nerve as it passes posterior and inferior to the medial malleolus beneath the fibrous origin of the abductor hallucis muscle [2, 8]. Various factors contribute to the clinical presentation and symptoms. Although the syndrome is well known, the results of operation vary [3, 9, 14, 15].

We evaluated by multivariate analysis the factors affecting the outcome in a group of patients with the syndrome.

Patients and methods

The group comprised 34 patients (9 men and 25 women) with an average age of 41 years (range 14 to 73 years) at the time of operation. In 3 women the condition was bilateral. The average duration of symptoms was 0.9 years (range 1 month to 8 years). Seven patients were hypertensive (systolic pressure >150 mmHg), 3 had diabetes mellitus, and one had chronic obliterative arteriosclerosis. None had clinical evidence of lumbosacral radiculopathy. Fourteen had a history of a sprained ankle, but without major injury to the bones or ligaments.

The diagnosis was established when one or more of the following conditions were present: local pain, a positive Tinel's sign; sensory disturbances, and weakness of abductor hallucis. The clinical condition was graded:

- Grade I – no symptoms;
- Grade II – pain only;
- Grade III – pain and numbness;
- Grade IV – muscle weakness associated with grade III symptoms.

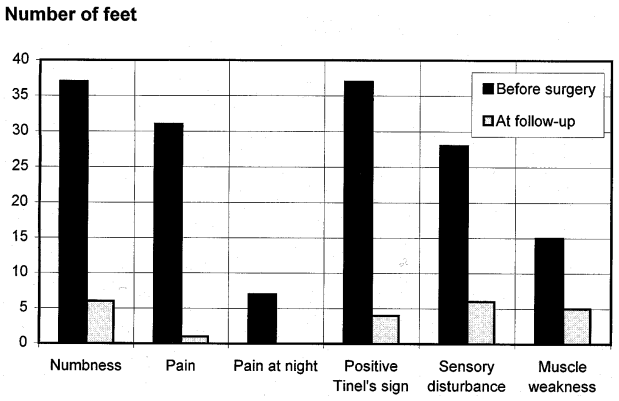


Fig. 1. The clinical findings before operation and at the last follow-up

The terminal latency of the posterior tibial nerve was measured in 27 patients (29 feet). This involved electrical stimulation at a point 1 cm distal and posterior to the medial malleolus and monitoring evoked responses from the abductor hallucis muscle 1 cm posterior and inferior to the navicular tuberosity. A Neuromatic 200 and a N1500 digital electromyography (EMG) apparatus (Dantec DISA, Scovlunde, Denmark) was used. A denervation pattern in the abductor hallucis EMG, with positive-sharp wave, was further evidence for the syndrome. CT and MRI were used in 16 cases to study abnormalities of the bones and ligaments.

Operative technique

Epidural or spinal anaesthesia was used in 22 and local anaesthesia in 12 patients. A curved incision, 3.5 cm long, was made 1 cm distal to the medial malleolus and the posterior tibial nerve was exposed proximal to the flexor retinaculum. This was divided with all constricting structures and any lump present was excised. The calcaneal branch of the posterior tibial nerve was preserved. Two plantar branches were freed beneath the fibrous origin of abductor hallucis in patients with muscle weakness or EMG evidence of denervation. The patient wore a short leg-ankle-foot support for 3 weeks and was then encouraged to resume normal activity.

Follow-up was carried out at an average of 3.8 years (range 1 to 7 years) after operation to determine improvement of numbness and sensory disturbances, relief of pain and recovery of motor strength in the big toe.

Statistical analysis

Multivariate analysis, based on the theory of Quantification Type II programme (Nakayama Books, Tokyo, Japan), was applied to the following variables namely gender, age at operation, duration of symptoms, causes of nerve compression, preoperative grading, occupation, and precipitating factors. With the definition of the postoperative clinical condition as a dependent variable, these categories were entered into multivariate analysis (Quant 2, Kyoritsu, Tokyo) in a NEC-PC9801 ns-T computer (Nihon Electric, Tokyo). The postoperative clinical state was also examined with regard to the terminal latency using Student's *t*-test (StatView™ programme, Abacus Concepts, Berkeley, CA) with $P = 0.05$ considered significant.

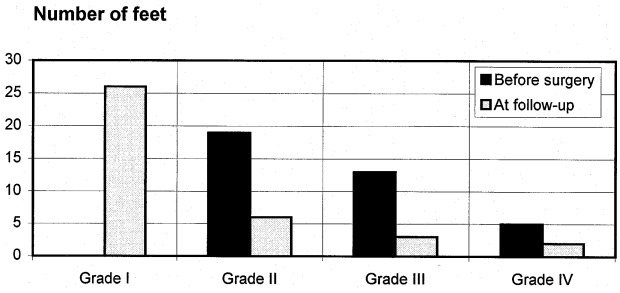


Fig. 2. The preoperative and postoperative clinical grades

Results

Before operation, 31 patients (37 feet) complained of pain on the medial side of the sole which was worse at night in 7. A positive Tinel sign was present in every case. Sensory disturbances were recorded in 28 feet with hyperaesthesia of the sole and calcaneal area in 3 feet, in the medial and calcaneal area in 17, and in the medial and lateral side of the sole in 8 feet. Weakness of the abductor hallucis was found in 15. The grading was II in 19, III in 13 and IV in 5.

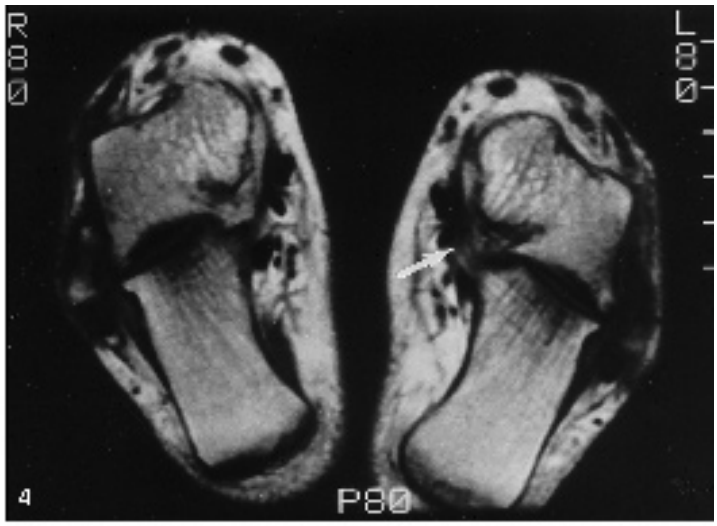
After operation, there was improvement in pain, sensory disturbances and Tinel's sign (Fig. 1). At follow-up, 26 feet were graded as I, 6 as II, 3 as III, and 2 as IV (Fig. 2). Twenty-one feet improved by one grade and 12 by two grades. Three remained in the same grade, one in grade II and 2 in grade IV.

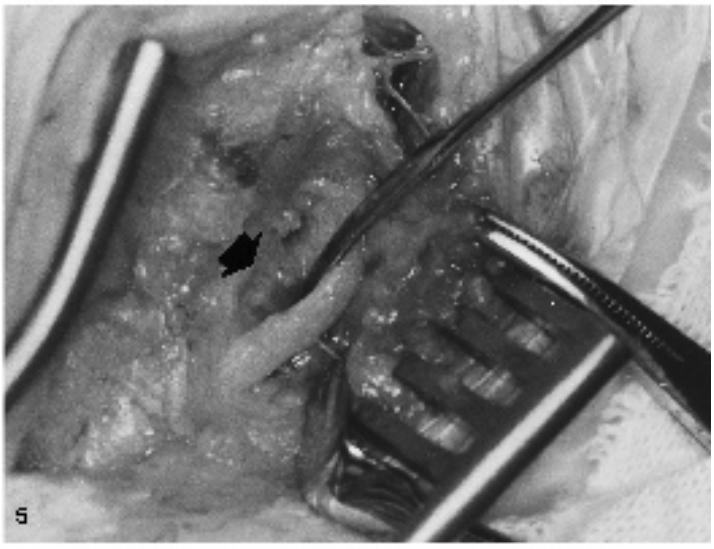
Radiographs showed a bony prominence at the medial talocalcaneal joint in 3 patients (Fig. 3), one showing abnormal growth of soft tissue as well as an osteocartilaginous protrusion around the nerve (Fig. 4). Talocalcaneal coalition was not found.

At operation a ganglion, arising from the medial part of the talocalcaneal joint, was present in 13 feet (Fig. 5). The mass impinged on the nerve as it penetrated the tibiocalcaneal ligament in 9, or at the point between the tibiocalcaneal and posterior tibio-fibular ligaments in 4. Significant fibrosis around the nerve was present just distal to the flexor retinaculum in 7, 6 of whom had a history of recurrent minor sprains of the ankle. The other finding included abnormal growth of synovium and an osteocartilaginous mass around the nerve together with habitual dislocation of the posterior tibial tendon anteriorly (Fig. 6).

Measurement of terminal latency

Latency in the feet showing one grade of improvement averaged 5.9 ± 0.5 ms (n = 14; mean $\pm$ standard error, range 4.9 to 7.8 ms). In those feet with an improvement of 2 grades the





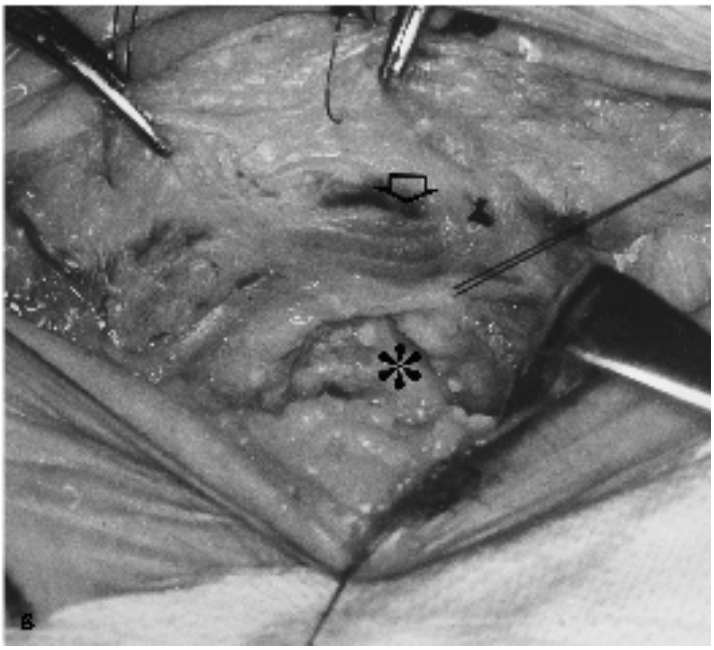


Fig. 3. Preoperative CT showing the bony prominence (*arrow*) at the talocalcaneal joint, distal to the tarsal tunnel (*asterisk*)

Fig. 4. MRI showing increased soft tissue, consistent with hypertrophied synovium, and an osteocartilaginous protrusion (*arrow*)

Fig. 5. Operative photograph showing a ganglion (*arrow*) arising from the medial talocalcaneal joint and impinging on the posterior tibial nerve

Fig. 6. Operative photograph showing a significant growth of osteocartilaginous tissue (*asterisk*) beneath the neurovascular bundle (*arrow*). This is the same patient as Fig. 4

Table 1. Demographic data showing results of multivariate analysis

Item	Category	Category score	Range (P.C.C.)[a]
Gender	G1: male	0.039	0.193 (0.392)
	G2: female	–0.078	
Age at operation	A1: <40 years	–0.109	0.238 (0.512)
	A2: 40's	0.029	
	A3: 50's	–0.099	
	A4: ≧60 years	–0.121	
Duration of disease history	T1: <6 months	0.887	0.830 (0.924)
	T2: 6–12 months	–0.183	
	T3: >12 months	–0.371	
Cause of the disease	C1: fibrosis	–0.692	0.914 (0.955)
	C2: ganglion cyst	0.733	
	C3: undetectable	–0.119	
Occupation	O1: light work	0.167	0.772 (0.851)
	O2: heavy work	–0.277	
	O3: worker's compensation	–0.457	
Preceding factors	P1: nothing remarkable	0.331	0.972 (0.938)
	P2: sprain	–0.611	
Preoperative grades	G1: grade II	0.492	1.137 (1.005)
	G2: grade III	–0.092	
	G3: grade IV	–0.633	

[a] P.C.C.: partial correlation coefficient (average, 0.893)

latency averaged 5.1 ± 0.5 ms (n = 12, range 4.0 to 6.6 ms). The difference between the 2 groups was statistically significant ($P < 0.05$). Three patients with unchanged grades after operation showed a latency > 7.0 ms.

Multivariate analysis (Table 1)

The partial correlation coefficient of the analysis averaged 0.893, showing a high statistical validity. With the exception of gender and age, duration of symptoms, cause of nerve compression, occupation, preceding factors and preoperative grades showed a significantly high score of range (partial correlation coefficient > 0.700). The surgical result was significantly influenced by the presence of symptoms for > 12 months (category score –0.371), fibrosis around the nerve (–0.692), worker's compensation (–0.457), sprain (–0.611) or grade IV before operation (–0.633).

Discussion

The tarsal tunnel syndrome is a clinical entity which may present with pain in the foot and weakness of the toes [1, 5, 10]. Entrapment of the posterior tibial nerve, or its branches, is due to intrinsic or extrinsic factors within the tunnel formed by the flexor retinaculum, behind and distal to the medial malleolus. A thorough search should be made to identify the underlying lesion, but a number of cases arise spontaneously with no obvious cause. The diagnosis is based on clinical findings and EMG studies [4], and radiography may detect the underlying abnormality. Treatment may vary depending on the lesion present.

Examination should include palpation of the posterior tibial nerve in the retromalleolar area and along each of its branches, including the interdigital nerves. Percussion over the nerve may show a positive Tinel's sign. The distal tunnel syndrome is indicated when pain on percussion is limited to the undersurface of the abductor hallucis muscle. Subtle diminution of sensation may be the first sign, especially after heavy exercise [18] or excessive movement of the foot and ankle. Injection of local anaesthetic into the tunnel may reduce pain temporarily.

Measurement of terminal latency is the standard test for disturbed motor conduction between the site of stimulation, usually proximal to the tunnel, and the abductor hallucis. Kaplan et al demonstrated that latencies measured in both the abductor hallucis and the digiti minimi muscles were significantly greater than normal in patients with the syndrome [4]. They also reported a significant decrease in amplitude and prolongation of motor evoked potentials from the same muscles in the syndrome. Abnormalities detected from the muscular response reflect involvement of funicular motor integrity with denervation potentials in the

EMG, and further loss of muscle strength. Early involvement of the neural pathway involved in sensory conduction with small funiculi of the tibial nerve would show decreased amplitude and increased latency of the sensory action potentials measured across the tunnel.

Oh and Oh et al demonstrated that the terminal latency test is sensitive in the tarsal tunnel syndrome with abnormal latency in 52.4% of patients [11, 12]. They considered that examination of sensory conduction in the medial and lateral plantar nerves was a more rewarding test for diagnosis, and abnormal conduction (either absent spike or slow conduction velocity) was present in 90.5% of their cases. Nevertheless terminal latency may be of value for evaluation of the outcome, as is shown in our cases.

Radiography may detect talocalcaneal coalition, space occupying lesions, or fibrotic soft tissue changes around the nerve. Bony prominence at the talocalcaneal joint is reported to cause symptoms in 25% of cases, and a ganglion in 35% [17]. High resolution CT scanning and MRI may detect fibrosis or scarring around the nerve and allows better choice of the surgical procedure.

Management depends on the clinical symptoms and the level of disability. Symptoms may be relieved by the temporary use of an immobiliser, injections of steroid, anti-inflammatory drugs, physiotherapy or a combination of these. Decompression is indicated for persistent pain and paraesthesia. Before operation, specific points of maximum tenderness should be noted and these areas explored. All compressive lesions must be excised and neurolysis is optional if there is scar tissue; we carry it out routinely when there is significant muscle wasting and denervation potentials are seen on the EMG.

The differential diagnosis includes entrapment of the medial plantar nerve below the talus and navicular bones, known as jogger's foot, or distal tarsal tunnel entrapment.

The reported results of surgery vary [3, 9, 14, 15], possibly because of different methods of assessment. We used multivariate analysis which showed that the results are influenced, in order of importance, by fibrosis around the nerve, the preoperative severity of the condition (grade IV), a history of sprained ankle, worker's compensation, a long history (>12 months), and heavy work. Conversely, the outcome was favourable when there was a short history, a ganglion, a preoperative grade of II, no sprains, and light work. These results are significant, and this type of evaluation provides better clinical assessment and reliably indicates the different factors which influence the outcome.

References

1. Cimino WR (1990) Tarsal tunnel syndrome: review of the literature. Foot Ankle 11: 47–52
2. DiStefano V, Sack JT, Whittaker R, Nixon JE (1972) Tarsal-tunnel syndrome. Review of the literature and two case reports. Clin Orthop 88: 76–79
3. Edwards WG, Lincoln CR, Bassett FH III, Goldner JL (1969) The tarsal tunnel syndrome: diagnosis and treatment. JAMA 207: 716–720
4. Fu R, DeLisa JA, Kraft GH (1980) Motor nerve latencies through the tarsal tunnel in normal adult subjects: standard determinations correlated for temperature and distance. Arch Phys Med Rehab 61: 243–248
5. Goodgold J, Kopell HP, Speilholz NI (1965) The tarsal tunnel syndrome. Objective diagnostic criteria. N Engl J Med 273: 742–745
6. Jackson DL, Haglund B (1991) Tarsal tunnel syndrome in athletes. Case reports and review of the literature. Am J Sports Med 19: 61–65
7. Kaplan PE, Kernohan WT Jr (1981) Tarsal tunnel syndrome. An electrodiagnostic and surgical correlation. J Bone Joint Surg [Am] 63: 96–99
8. Keck C (1962) The tarsal-tunnel syndrome. J Bone Joint Surg [Am] 44: 180–182
9. Kline DG, Hudoson AR (1995) Diagnosis and treatment: tarsal tunnel syndrome: Saunders, Philadelphia, pp 315–316
10. Lam SJS (1967) Tarsal tunnel syndrome. J Bone Joint Surg [Br] 49: 87–92
11. Oh SJ (1984) Tarsal tunnel syndrome. Clinical electromyography and nerve conduction studies. University Park Press, Baltimore, pp 408–410
12. Oh SJ, Arnold PK, Park KH, Kim DE (1991) Electrophysiological improvement following decompression surgery in tarsal tunnel syndrome. Muscle Nerve 14: 407–410
13. Pfeiffer W, Cracchiolo A III (1994) Clinical results after tarsal tunnel decompression. J Bone Joint Surg [Am] 76: 1222–1230
14. Radin EL (1983) Tarsal tunnel syndrome. Clin Orthop 181: 167–170
15. Ricciardi-Pollini PT, Moneta MR, Falez F (1985) The tarsal tunnel syndrome: a report of eight cases. Foot Ankle 6: 146–149
16. Schon LC (1994) Nerve entrapment neuropathy, and nerve dysfunction in athletes. Orthop Clin North Am 25: 47–59
17. Takakura Y, Kitada C, Sugimoto K, Tanaka Y, Tamai S (1991) Tarsal tunnel syndrome. Causes and results of operative treatment. J Bone Joint Surg [Br] 73: 125–128
18. Zeiss J, Fenton P, Ebraheim N, Cooms RJ (1991) Magnetic resonance imaging for ineffectual tarsal tunnel surgical treatment. Clin Orthop 264: 264–266