Mustafa Ürgüden · Hakan Bilbaşar · Hakan Özdemir
Yetkin Söyüncü · Semih Gür · Ahmet Turan Aydın

Tarsal tunnel syndrome – the effect of the associated features on outcome of surgery

Accepted: 18 February 2002 / Published online: 25 April 2002
© Springer-Verlag 2002

Abstract Between 1989 and 2000, 16 patients underwent surgery for tarsal tunnel syndrome; 12 patients (13 feet) were available for follow-up at a mean of 83 (12–143) months. The symptoms had resolved in six feet, were improved in four, were unchanged in two and recurred after five years in one. Better results are obtained in patients who have space occupying lesions than in those in whom the aetiology is idiopathic or post-traumatic or those with foot deformities.

Résumé Entre 1989 et 2000 nous avons traité chirurgicalement 16 malades présentant un syndrome du tunnel tarsien. Chez 12 malades (13 pieds) les résultats ont été évalués après une moyenne de 83 (12–143) mois. Pour six pieds les symptômes avaient complètement disparus, pour quatre pieds les symptômes ont été améliorés, deux pieds ont été inchangés et dans un cas les symptômes sont revenus après 60 mois. Le résultat du traitement chirurgical est meilleur chez les patients avec des lésions l'espace occupante.

Introduction

Tarsal tunnel syndrome (TTS) is an entrapment neuropathy of the posterior tibial nerve and its branches within the tunnel formed by the flexor retinaculum. It was first described by Kopell and Thompson [11] in 1960. The term “Tarsal Tunnel Syndrome” was first used independently by Keck [10] and Lam [12] in 1962. The syndrome may be idiopathic or secondary to direct pressure from space-occupying lesions, adhesions following trauma, inflammatory causes or deformities of the foot [1, 2, 21, 24, 26, 28, 30].

M. Ürgüden (✉) · H. Bilbaşar · H. Özdemir · Y. Söyüncü · S. Gür
A.T. Aydın

Akdeniz University, Faculty of Medicine,
Department of Orthopedics and Traumatology, Tıp Fakültesi,
Ortopedi ve Travmatoloji Anabilim Dalı,
07070 Antalya / Türkiye
e-mail: urguden@hipokrat.med.akdeniz.edu.tr
Tel.: +90-242-3346731, Fax: +90-242-2274329

Onset of symptoms is usually insidious. Patients usually complain of burning pain and numbness, especially on the medial plantar aspect of the foot, in the area served by the affected nerve [18, 30]. Tinel's sign is usually positive [3, 20, 27]. There may be night pain and cramps in the longitudinal arch. Symptoms are related to exercise and maximal at the end of the day [14, 21, 30]. Diagnosis is made from the history, physical examination and nerve conduction studies. Normal nerve conduction studies, however, may not exclude an entrapment neuropathy [5, 7, 9, 19, 22]. In this study, we aimed to assess the factors that affect the outcomes of surgically treated TTS patients, such as different aetiologies, duration of symptoms etc..

Patients and methods

Of 16 patients with TTS who underwent surgery, 12, (13 feet) were available for review at a mean follow-up of 83 (12–143) months. There were nine women and three men, with a mean age of 39.5 (25–57) years and a mean duration of symptoms of 31.9 (2–240) months. In six patients the right foot was involved, five the left and both in one. Tinel's sign was positive pre-operatively in 12 feet and doubtful in one. All pre-operative EMGs, except for one, were consistent with a diagnosis of TTS. The findings were positive for the medial plantar nerve in four feet and for both plantar nerves in eight. There were significant foot deformities in five cases, three of which had pes planus, one splayfoot and one calcaneal fracture. Atrophy and weakness of the plantar muscles was found in one case, whose symptoms were chronic (20 years). The symptoms were related to exercise in eight patients. Those who did not have a space-occupying lesion received conservative treatment initially and surgery was undertaken in those who did not respond. The demographic data of the patients are shown in Table 1.

Although there was no pre-operative assessment, all patients were assessed at the final follow-up using the rating system of Takakura et al. [27] (Table 2). According to this system patients with 10 points were considered excellent, 8–9 good, 6–7 fair and 5 or less poor.

Results

Aetiology of the TTS was idiopathic in three feet, due to hindfoot pathology in three, a ganglion in three, a vari-

Table 1 Data on the patients

Patient no.	Age	Gen-der	Date of operation	Foot deformity	Duration of symptoms	Side	EMG	Tinel's sign	Aetiological factor	Trauma	Pain by movement	Night pain	Concomitant sickness	Previous treatment
1	25	M	19.12.91	-	1.5 years	Right	+, medial	+	Neurilemmoma	-	-	+	-	Prolapsed disc treatment
2	39	F	28.4.94	Fracture of calcaneus	2 years	Right	+	+	Varicose vein	+	+	-	Cervical arthrosis	Prolapsed disc treatment
3	32	F	7.7.99	-	4 months	Right	-	-	Ganglion	-	-	+	Prolapsed discdouble crush	-
4	50	F	4.4.94	Pes planus	20 years	Left	+, medial	+	Ganglion	-	+	-	-	Plantar fasciitis
5	39	M	13.6.94	-	3 years previously operated, recurrence	Right	+	+	Ganglion	-	-	-	-	-
6	37	F	21.6.93	-	2 years	Left	+	+	-	-	+	+	Bilateral CTS	Treatment for tendinitis
7		F	21.6.93	-	6 months	Right	+	+	-	-	+	-	-	Treatment for tendinitis
8	27	F	31.1.89	-	2 months	Left	+, medial	+	Ganglion	-	+	-	-	Treatment for tendinitis
9	39	F	29.3.89	-	3 months	Left	+, medial	+	-	-	-	+	Bilateral CTS + cubital tunnel	-
10	50	M	5.7.90	-	3 months	Right	+	+	Neurilemmoma	-	-	-	-	-
11	40	F	3.1.99	Pes planus	7 months	Left	+	+	-	-	+	+	-	Arc support
12	57	F	8.9.94	Splayfoot	1 year	Left	+	+	-	+	+	-	-	Arc support
13	40	F	24.3.97	Pes planus	3 years	Right	+	+	-	-	+	+	-	-

Fig. 1 MRI view of the ganglion at the entrance of the tarsal tunnel (Black arrow indicates ganglion whose origin is unclear)**Table 2** Takakura's rating scale

	Absent	Some	Definite
Pain, spontaneous or on movement	2	1	0
Burning pain	2	1	0
Tinel's sign	2	1	0
Sensory disturbance	2	1	0
Muscle atrophy and weakness	2	1	0

cose vein in one, a neurilemmoma of the medial plantar nerve in two and a combination of a ganglion and hind-foot pathology in one. In four cases there was a ganglion in the tarsal tunnel; one arose from flexor digitorum communis, one from tibialis posterior and the origin could not be identified in two (Fig. 1). Symptoms resolved completely in six feet, improved in four, were unchanged in two and recurred after 5 years in one.

According to the rating system of Takakura et al. [27], there were excellent results in three feet, good results in six, fair results in two and poor results in two. Of six cases, with a mean pre-operative duration of symptoms of 52.3 months, two were being treated with a diagnosis of a prolapsed intervertebral disc, three tendonitis and one plantar fasciitis. After decompression there were excellent results in two cases and good results in four. In the five cases with significant foot deformities (three pes planus, one splayfoot and one calcaneal fracture), there were good results in three, fair in one and a recurrence in one.

There were associated symptoms in four cases; one carpal tunnel syndrome (CTS), one combined carpal and

Table 3 Follow-up evaluation of the patients

Patient no.	Follow-up (months)	Clinical results	Clinical points
1	108	Excellent	10
2	80	Good	8
3	15	Poor	5
4	80	Good, atrophy in the foot	8
5	78	Good	9
6	90	Good	9
7	90	Excellent	10
8	143	Good	9
9	141	Fair	7
10	125	Excellent	10
11	12	Good	8
12	73	Recurrence poor	5
13	45	Same complaint fair	6

cubital tunnel syndrome, one cervical spondylosis and one lumbar radiculopathy. There were good results in two cases with CTS and cervical spondylosis, a fair result in the case with combined carpal and cubital tunnel syndrome and a poor result in the case with lumbar radiculopathy. The ratings at follow-up are shown in Table 3.

Discussion

Tarsal tunnel syndrome is an entrapment neuropathy of the posterior tibial nerve and its branches in the tunnel formed by the flexor retinaculum. Symptoms include pain, numbness and weakness of the toes. Night pain has been reported and different aetiologies proposed [1, 4, 15, 17, 23, 29]. It is thought that night pain occurs in cases with hindfoot deformities, as altered foot posture causes tethering of the nerve [15, 29]. Others have proposed that night pain is caused by either venous congestion or "double crush" [4, 23]. No relationship between night pain and the presence of a space-occupying lesion has been reported. Peiffer [20] reported that although night pain was frequently found there was no association between a particular pathology and night pain. However, in 17 of his 30 cases there were space-occupying lesions such as varicose veins, ganglia and synovitis. Menon [17] reported night pain in a case caused by a neurilemmoma. In our study six cases reported night pain. Among these the aetiology in two was hindfoot valgus due to pes planus, space-occupying lesions in two and idiopathic in two. Although the number of cases in our series was limited the association between night pain and particular aetiologies of TTS suggests that night pain is not related to foot posture.

The volume of the tarsal tunnel changes with differing deformities of the hindfoot and hypermobility of the hindfoot may induce the syndrome because of local tethering of the nerve [1, 6, 13, 24, 29]. Heel varus and pronation of the forefoot are also aetiological factors [21]. Radin [21] reported that varus and inversion of the heel can cause TTS. Albrektsson [1] reported that eversion

causes TTS. Trepman et al. [29] have shown in a cadaver study that the pressure within the tarsal tunnel increases with inversion or eversion of the foot and reported that both can cause posterior tibial nerve entrapment. They also noted that recovery may be expected with immobilisation in the neutral position, as in this position there is no increase in pressure within the tunnel. Lau [13] has shown that tethering of the nerve in cases with pes planus is an aetiological factor in TTS, and also that, in cadaver studies, stabilisation procedures such as triple arthrodesis and distraction calcaneocuboid arthrodesis are superior to decompression. Trepman [29] has shown that most cases of TTS formerly classified as idiopathic had tethering of the nerve due to the position of the hindfoot. In our series among the cases with structural problems of the hindfoot, three of which were pes planus (one also with a ganglion) and one with splayfoot, there were good results in two, a fair result in one and a poor result (with recurrence) in one. Surgical treatment is thus less satisfactory in these cases compared to other causes of TTS. There was one excellent, one good and one poor result in three idiopathic cases.

Few patients respond to conservative treatment. The incidence of a satisfactory outcome after surgical treatment varies between 44% and 95% [9, 15, 20, 27]. The importance of seeking a precise diagnosis has been stressed, and it has been suggested that conservative measures should be continued for some time in patients without a space-occupying lesion [20, 28].

Factors that contribute to a poor prognosis are age, chronic symptomatology with motor involvement, epineural scarring of the nerve, inappropriate decompression, crush injury of the nerve and idiopathic cases [12, 20, 23, 25, 27]. Mann [16] found minimal or no recovery in 30% of cases treated surgically. Takakura et al. [27] indicated that the outcome after decompression was better where there was a space-occupying lesion and worse where the aetiology was idiopathic or post-traumatic. Nagaoka [18] reported 100% excellent and good results (21 excellent and eight good) in cases where decompression was performed for a ganglion. Sammarco et al. [24] reported that the outcome after surgery for TTS due to a muscle anomaly is not as good as in those cases where there is a space-occupying lesion.

While the results of surgical treatment are better in young patients and patients with tarsal coalition, the outcome is worse in females in the 40–50 age group [20]. In our group, with different aetiologies, the results were excellent in three feet, good in six, fair in two and poor in two. The results in post-traumatic cases are poor [3, 20, 27, 30]. Takakura et al. [27] and others have reported poorer results with increased duration of symptoms [5, 9, 27]. In chronic cases there may be axonal demyelination due to pressure or local ischaemia of the nerve. However, even in such cases surgery should be offered. Baba [3] reported poor results where symptoms had been present for more than 12 months.

Good results may be obtained where there is no trauma to the nerve or its environment. Turan et al. [30] re-

ported 61% complete relief, 22% partial relief and 17% poor relief of symptoms after surgery. They noted poor results in patients with chronic symptoms or a history of trauma. They had, however, a good result in a patient with symptoms lasting for 12 years. In our series there were seven patients in whom the symptoms lasted for 12 months or more, and in these there was one excellent, four good, one fair and one poor result. Many factors affect the outcome. There was a good outcome in the case with pes planus and symptoms for 20 years, and a recurrence in a case of symptoms lasting for only 12 months. It is reported that the symptoms resolved in a shorter period in those cases with a shorter duration of symptoms and that recovery took up to 1 year in cases with chronic symptoms [3]. In our series we had two excellent, two good, one fair and one poor (the case with "double crush") results in six feet with symptoms lasting for 12 months or less.

Treatment may start with a different diagnosis. Turan et al. [30] reported that six cases in their group had been treated with an initial diagnosis of plantar fasciitis. Iida et al. [8] reported that the nerve was trapped within the tendinous arc of soleus in a case in which there was a positive Tinel's sign. Smith [26] described a case with a diagnosis of TTS due to neurilemmoma of the tibial nerve in a patient who had previously undergone surgery for an interdigital neuroma. In our series six patients had been treated with a different diagnosis, three for tendinitis, two for a prolapsed disc and one for plantar fasciitis. There were two excellent and four good results after surgical treatment in these cases. It is reported that entrapment of the nerve elsewhere in the same extremity ("double crush") adversely affects the outcome [9]. In our series there was a poor result in a case with a ganglion and lumbar radiculopathy.

TTS is rare and may present in many different ways. Previously reported series contain many different aetiologies and it is not possible to identify prognostic factors. In our group the outcome after surgery depended on the duration of symptoms, the associated pathology, and the presence of structural foot problems or a space-occupying lesion.

References

- Albrektsson B, Rydholm A, Rydholm U (1982) The tarsal tunnel syndrome in children. *J Bone Joint Surg [Br]* 64: 215–217
- Aydin AT, Karaveli S, Tuzuner S (1991) Tarsal tunnel syndrome secondary to neurilemmoma of the medial plantar nerve. *J Foot Surg* 30: 114–116
- Baba H, Wada M, Annen S, Azuchi M, Imura S, Tomita K (1997) The tarsal tunnel syndrome: evaluation of surgical results using multivariate analysis. *Int Orthop* 21: 67–71
- Distefano V, Sack JT, Whittaker R, Nixon JE (1972) Tarsal tunnel syndrome: review of the literature and two case report. *Clin Orthop* 88: 76–79
- Edwards WG, Lincoln CR, Bassett FH III, Goldner JL (1970) The tarsal tunnel syndrome. *South Med J* 88: 76–79
- Forst L, Hryhorczuk D (1988) Occupational tarsal tunnel syndrome. *British J Indust Med* 45: 277–278
- Fullerton PM (1963) The effect of ischemia on nerve conduction in the carpal tunnel syndrome. *J Neurol Neurosurg Psychiatry* 26:385–397
- Iida T, Kobayashi M (1997) Tibial nerve entrapment at the tendinous arch of the soleus. A case report. *Clin Orthop* 334: 265–269
- Kaplan PE, Kernahan WT (1981) Tarsal tunnel syndrome. An electrodiagnostic and surgical correlation. *J Bone Joint Surg [Am]* 63: 96–99
- Keck C (1960) The tarsal tunnel Syndrome. *J Bone Joint Surg [Am]* 1962; 44: 180–182
- Kopell HP, Thompson WAL: Peripheral entrapment neuropathies of the lower extremity. *N Engl J Med* 262: 56–60
- Lam SJS (1962) A tarsal tunnel syndrome. *Lancet* 2: 1354–1355
- Lau JTC, Daniels TR (1998) Effects of tarsal tunnel release and stabilization procedures on tibial nerve tension in a surgically created pes planus foot. *Foot Ankle Int* 19: 770–777
- Lau JTC, Daniels TR (1999) Tarsal tunnel syndrome: a review of the literature. *Foot Ankle Int* 20: 201–209
- Mann RA (1974) Tarsal tunnel Syndrome. Proceeding of the American Orthopaedic Foot Society. *Orthop Clin North Am* 5: 109–115
- Mann RA (1990) Tarsal tunnel syndrome. In: McCollister EC (ed) *Surgery of the musculoskeletal system*, vol 4, 2nd edn. Churchill Livingstone, New York, pp 4059–4064
- Menon J, Dorfman HD, Renbaum J, Friedler S (1980) Tarsal tunnel syndrome secondary to neurilemmoma of the medial plantar nerve. A case report and review of the literature. *J Bone Joint Surg [Am]* 62: 301–303
- Nagaoka M, Satou K (1999) Tarsal tunnel syndrome caused by ganglion. *J Bone Joint Surg [Br]* 81-B: 607–610
- Oh SJ, Sarala PK, Kuba T, Elmore RS (1979) Tarsal tunnel syndrome: electrophysiological study. *Am Neurol* 5: 327–330
- Peiffer WH, Cracchiolo A (1994) Clinical results after tarsal tunnel decompression. *J Bone Joint Surg [Am]* 76: 1222–1230
- Radin EL (1983) Tarsal tunnel syndrome. *Clin Orthop* 181: 167–170
- Saal JA, Dillingham MF, Gamburd RS, Fanton GS (1988) The pseudoradicular syndrome. Lower extremity peripheral nerve entrapment masquerading as lumbar radiculopathy. *Spine* 13: 926–930
- Sammarco GJ, Calk DE, Feibel JH (1993) Tarsal tunnel syndrome and additional nerve lesions in the same limb. *Foot Ankle* 14: 71–77
- Sammarco GJ, Conti SF (1994) Tarsal tunnel syndrome caused by anomalous muscle. *J Bone Joint Surg [Am]* 76: 1308–1314
- Skalley TC, Schon LC, Hinton RY, Myerson MS (1994) Clinical results following revision tibial nerve release. *Foot Ankle Int* 15: 360–367
- Smith W, Amis JA (1992) Neurilemmoma of the tibial nerve. A case report. *J Bone Joint Surg [Am]* 74: 443–444
- 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
- Takakura Y, Kumai T, Takaoka T, Tamai S (1998) Tarsal tunnel syndrome caused by coalition associated with a ganglion. *J Bone Joint Surg [Br]* 80: 130–133
- Trepman E, Kadel NJ, Chisholm K, Razzano L (1999) Effect of foot and ankle position on tarsal tunnel compartment pressure. *Foot Ankle Int* 20: 721–726
- Turan I, Rivero-Melian C, Guntner P, Rolf C (1997) Tarsal tunnel syndrome. Outcome of surgery in long-standing cases. *Clin Orthop* 343: 151–156