Rethinking Tarsal Tunnel Syndrome

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Author(s):
By Paul R. Scherer, DPM

Podiatrists have been treating tarsal tunnel syndrome (TTS) conservatively for decades although there is no clinical outcome study to document the effectiveness of orthotics for this syndrome. Most podiatrists rely on the anecdotal evidence and their own experience to prescribe orthoses, which are intended to change the position of the foot and reduce the trauma and traction of the posterior tibial nerve at the flexor retinaculum.

First defined by Keck in 1962, tarsal tunnel syndrome is a relatively common problem that podiatrists see in their practice and is frequently associated with extremely pronated feet and patients with standing occupations.[1] The hallmark of the syndrome is pain in the proximal medial arch with paresthesias extending along the course of the medial and lateral plantar nerve. The thinking is the pathology is the result of traction on the tibial nerve and compression by the flexor retinaculum or occurs due to compression of the medial plantar nerve as it perforates the fascia and intrinsics at the porta pedis.

Conservative treatment is always the first step. This includes strapping and orthotics to hold the foot in a less pronated position. One may use antiinflammatory or anesthetic injections in some areas to reduce concomitant symptoms. In cases of resistant pathology, podiatrists would proceed with surgical treatment by releasing the retinaculum at the medial malleolus or decompressing the nerve at the porta pedis.

Reviewing The Anatomy Of Tarsal Tunnel Syndrome

However, before discussing the etiology, pathology and differential diagnosis of tarsal tunnel syndrome, one must have a strong grasp of the involved anatomy. After all, it is highly likely that abnormal anatomy or dysfunction due to abnormal anatomy that produces the trauma on the nerve leads to the symptoms we call tarsal tunnel syndrome.

The tarsal tunnel is actually a channel produced by the septa of the flexor retinaculum, which has a constantly changing volume dependent on the position of the foot. The flexor retinaculum blends with the plantar fascia and is affected to some degree by the tension on this structure since the flexor retinaculum and the plantar fascia are both anchored at the calcaneus and connected to each other. Tension on the plantar fascia (think pronation) may affect the tension on the retinaculum and alter the volume of the tunnel.

Four fibrous septa emerge from the interior surface of the flexor retinaculum. They each create an independent channel that allows leg structures to transition to foot structures. The third channel, counting from medial to lateral, contains the nerve with the vascular structures. The walls of the tunnel are the septa, the roof is the retinaculum and the floor is the sheath of the three flexor tendons. Swelling of the tendon sheaths from overuse, trauma or inflammation has the capability to also decrease the volume of the tunnel. It is all about the size.

Not only is the size of the tunnel vulnerable to the swelling and movement of the structures creating it, but one author believes the bifurcation of the nerve — before it enters the tunnel — increases the size of the nerve tissue going through the tunnel. Havel dissected 68 feet and discovered the bifurcation occurred within or after the tunnel in 93 percent of the feet.[2] The bifurcation occurred before the tunnel in 7 percent of the feet, producing two nerves instead of one traversing the tunnel. Could this increase in nerve tissue make the nerve more susceptible to injury from inflammation of the tendon sheaths and motion of the plantar fascia? Does tarsal tunnel syndrome occur at a 7 percent frequency in the general population to match this anatomical variant?

The bifurcated nerve now enters the foot at the abductor canal, which is traditionally referred to as the porta pedis. Edwards was one of the first authors to suggest this area of extreme constriction may be as influential in producing symptoms as the nerve jammed in the tunnel.[3] Experienced surgeons know that not inspecting this area increases the chance of recurrence.

The fascia of the abductor hallucis helps form this portal and hypertrophy of this muscle must put greater pressure on the nerve. Could the dorsiflexion of the first ray — which is common with excessive pronation — be a contributing factor to overuse hypertrophy of the abductor hallucis and constriction on the nerve?

Understanding The Potential Causes Of TTS

A helpful way to look at factors producing tarsal tunnel syndrome is to identify extrinsic factors and intrinsic factors. These categories are interrelated but the division helps with the differential diagnosis and assists in selecting a more focused treatment.

Extrinsic factors usually produce symptoms of tarsal tunnel syndrome but are not related directly to pathomechanics of the syndrome. Herniation of L4 through S3 can produce exact tarsal tunnel syndrome symptoms but is unrelated to pathology in the foot. Clearly obvious is the conclusion that changing the mechanics of the foot cannot reverse this radiculopathy or the symptoms.

Even more proximal extrinsic factors include varicosities of the tibial vena commitantes within the tunnel and ganglions, diabetic neuropathy, seropositive and seronegative arthropathies and, in one reported case, lipoma near the medial malleolus. Most of these events put direct pressure, which is ischemic in nature, on the nerve and rarely involve mechanical factors of the foot.

Intrinsic factors involve the abnormal position of the foot producing traction injury to the nerve or direct compression trauma by the flexor retinaculum and its surrounding structures. A brief visit to the most recent literature on the pathomechanics of tarsal tunnel syndrome sheds light on why orthotic therapy works and why orthotic therapy might help avoid surgical intervention (see “Why One Should Be Wary Of Surgical Intervention” below).

Why One Should Be Wary Of Surgical Intervention

Most podiatrists approach surgical intervention for tarsal tunnel syndrome cautiously because of the high incidence of postoperative complication, specifically sensory dysfunction. Recently, Gundring, et. al., published their outcome analysis of 68 tarsal tunnel releases and showed that 100 percent of the patients developed a positive Tinel’s sign postoperatively and abnormal motor nerve conduction velocity.[4] At least, we now know to chart this complication preoperatively “as expected” in our consent. The study documented that 85 percent of the patients, regardless of this complication, rated the surgery successful.

Last year, Raikin reported that operating a second time to decompress the nerve rarely improved the patient’s condition. It seems surgical intervention is a one-shot deal.[5]

What The Literature Reveals About Diagnosing TTS

During the past year, warnings have appeared in the literature about making a diagnosis and starting treatment without establishing a differential diagnosis for extrinsic factors. Fujita reported cases of intrafascicular ganglions causing tarsal tunnel syndrome symptoms and Marui reported deep-seated neurilemomas mimicking tarsal tunnel syndrome.[6,7] Both authors recommended obtaining a MRI of the areas after abnormal velocity tests but prior to surgery.

This year, Mondelli offered a new way to classify tarsal tunnel syndrome by comparing DML (distal motor latency), SCV (sensory conduction velocity) and SAP (sensory action potential).[8] If you send your patients for neurological testing, the report you receive back may use this new classification, which is also useful in determining clinical outcome. The system uses an “electrophysiological severity scale” to classify tarsal tunnel syndrome from grade one to grade five.

Further studies directed attention toward foot motion and position as clues to the biomechanical etiology of TTS. The first was a study by Labib, who followed 286 patients over a three-year period and developed a new heel pain triad that seems to be gaining popularity in the orthopedic community.[9] The HPT Syndrome includes plantar fasciitis, heel pain, posterior tibial tendinitis and tarsal tunnel syndrome. He believes from the study that a "lack of muscular support of the longitudinal arch of the foot (posterior tendon dysfunction in podiatry terms) produces the traction injury to the tibial nerve and tarsal tunnel syndrome."

A test recommended by Kinoshita helps diagnose tarsal tunnel syndrome but also sheds light on the etiology.[10] He recommends holding the foot in dorsiflexion and eversion for 15 seconds before conducting velocity studies. If paresthesias on the plantar aspect of the foot occurs, he believes it is an overwhelming positive sign of tarsal tunnel syndrome. He later operated on these individuals and confirmed the diagnosis. If pronation of the foot in this test produces symptoms, it appears a logical deduction that orthotic therapy, which prevents this position, may assist in reducing symptoms. The article confirms that a positive Kinoshita test is extremely accurate in identifying pathology.

The most convincing part of the recent literature is an elegant piece of work by Trepman, who actually measured the anatomic space pressure in the tarsal tunnel compartment with the foot in various positions.[11] He discovered an increase of pressure in the tunnel when the foot was pronated. This increase averaged 32 mmHg as compared to just over 1 mm when the foot was in neutral positions. Trepman also discovered that inversion of the foot as well as plantarflexion of the ankle reduced the tarsal compartment pressure significantly.

Can Orthotics Have An Impact On TTS?

an we use this information from these articles to produce better clinical outcomes for podiatry and orthotic therapy? Let us consider some recommendations. If the lack of longitudinal arch support causes traction injury to the tibial nerve; if pronation of the foot produces symptoms in a test; if pronation increases tunnel pressure on the nerve; and if plantarflexion and inversion decrease tunnel pressure; then an orthotic device that supports the longitudinal arch, decreases pronatory motion and plantarflexes the ankle joint will have a positive effect.[9,10,11]

Can we produce a pathology specific orthotic device that accomplishes this goal? What would it look like? A wide device of semi-rigid material is a good start. The more surface area touching the foot, the greater the effect you will have on motion control of the foot. The greater the surface area, the more effective orthotic forces.

A medial skive cast technique (Kirby Skive) is a rise on the inside of the heel cup.[12] It comes in mild (2 mm), strong (4 mm) and very strong (6 mm). Developed in 1992, this technique increases ground reactive force through the orthotic on the medial plantar side of the calcaneus, decreasing the motivation to evert and encouraging inversion of the heel. This technique requires a deep heel cup (16 mm) and a hard rearfoot post for orthotic stability.

One should add a heel lift to the device since raising the height of the proximal orthotic places the ankle joint in a plantarflexory position. Plantarflexing and inverting the foot decreases tunnel pressure.[11]

Therefore, a pathology specific orthotic for tarsal tunnel syndrome relief would be semi-rigid or rigid, have a minimum fill and a 4 mm medial skive, a wide width, a deep 16+ mm heel cup, a 0/0 rearfoot post and a 3- to 6 mm heel lift.

Remember an orthotic is only effective if the patient wears it in a shoe that has a rigid enough sole so as to not torque the forefoot to the rearfoot during gait and prevent calcaneal eversion.

The literature suggests that abnormal foot motion and an everted position of the heel contribute to the pathology related to tarsal tunnel syndrome. Logic and anecdotal information seem to suggest that a properly prescribed and constructed orthoses can prevent, limit or reverse some of the pathology and reduce the symptomatology.

Final Notes

Unfortunately, the aforementioned cited work documenting new information on tarsal tunnel syndrome in the past four years was not produced nor sponsored by the podiatry profession. However, an outcome study utilizing a pathology specific orthoses to reduce tarsal tunnel syndrome symptoms on a universal scale would greatly advance the reputation of podiatrists as experts of the foot.

Dr. Scherer is the Chairperson of the Department of Applied Biomechanics at the California School of Podiatric Medicine at Samuel Merritt College. He is also the Podiatric Medical Director at ProLab Orthotics.

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