

## Can Orthotics Have An Impact On Tarsal Tunnel Syndrome?



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In a review of the literature and their clinical experience, these authors discuss the pathomechanics of tarsal tunnel syndrome, keys to the differential diagnosis and the role of functional foot orthotics in treating the condition.

Keck coined the phrase “tarsal tunnel syndrome” in a 1962 case report of an Army recruit who experienced numbness, a pins and needles sensation, and burning on the plantar surface of the feet.<sup>1</sup> This eventually progressed to complete anesthesia during basic training. While rest relieved the pain initially, the patient went on to have weakness and dysfunction in multiple intrinsic foot muscles. Percussion to the neurovascular bundle could reproduce symptoms. Conservative care included bed rest and whirlpool massage during a hospital admission.

When there was no improvement, the treating physician quickly entertained surgery and identified a constricted and compressed posterior tibial nerve in its compartment within the tarsal tunnel. The physician released the nerve from beneath the flexor retinaculum, relieving the symptoms.

The author made several important points in this case report.<sup>1</sup> He stated that tarsal tunnel syndrome, in most cases, was probably much more common and simply misdiagnosed and therefore mistreated. Keck added that “poor foot structure” in the general population, unlike the athletic army recruits, could be a cause of the pain. He concluded that this is likely a larger problem than perceived since the general population would stop being active to relieve the pain, which would result in under-reporting of a larger problem.

Many clinicians, including us, exhaust conservative care prior to entertaining surgery. The diagnosis and care of tarsal tunnel syndrome is no different. A recent literature search on PubMed limited to the phrase “tarsal tunnel syndrome” published in the last 10 years yielded 154 articles. Unfortunately, none of these articles document the effectiveness of functional foot orthotic devices in the care of tarsal tunnel syndrome. However, multiple articles list orthotic therapy as an option of care based on the goal of holding the foot and ankle in a more neutral position to relieve tension on the nerve and therefore decrease pain.<sup>2-4</sup>

Accordingly, we will carefully explain the reasons why we believe functional foot orthotics can have an impact on tarsal tunnel syndrome. It is important to understand the anatomy of the region of the tarsal tunnel and the mechanics of your patient’s foot, and how they relate to the symptoms before considering any treatments, including orthotic therapy.





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diffuse plantar foot pain, burning, tingling or even numbness, which may radiate proximally or distally from the posteromedial ankle. There is a positive Tinel's sign upon percussion of the nerve with possible altered sensations.<sup>6</sup> Patients may also present with weakness in the lateral plantar intrinsic muscles with an inability to spread the toes on the affected side.<sup>7,8</sup> Confirmation of sensory loss and diminished muscle function with nerve conduction studies is valuable in diagnosing these patients. One may also exacerbate the symptoms with eversion and dorsiflexion of the subtalar-ankle joint complex in a pronated position to create tension on the nerve.

In 2002, Kinoshita and colleagues performed pronatory stress tests by dorsiflexing and everting the hindfoot with a 10-second hold on 37 patients who were diagnosed with tarsal tunnel syndrome.<sup>9</sup> Researchers were able to reproduce plantar paresthesias in all patients. In order to confirm actual nerve impingement, all of these patients then had surgery to release the nerve and confirm the diagnosis, and nearly 100 percent (42 of 43 feet) had physical findings of nerve entrapment. The authors concluded that a positive "Kinoshita test" was very accurate in identifying tarsal tunnel syndrome.

### Understanding The Anatomy And Pathomechanics Of The Tarsal Tunnel

Simply stated, the tarsal tunnel is the distal aspect of the deep posterior compartment of the leg behind the medial malleolus.<sup>3</sup> The tarsal tunnel contains the tendons of the posterior tibial, flexor digitorum longus and the flexor hallucis longus muscles, each in their own compartments created by septae of the flexor retinaculum.<sup>2</sup> The tarsal tunnel also contains the posterior tibial artery, nerve and vein all together in a single compartment. This is all bordered by the flexor retinaculum superficially, the posterior side of the medial malleolus anteriorly and the medial talus and calcaneus deep and posteriorly.

It is important to appreciate that each of these compartments has constantly changing volumes due to the fact that the flexor retinaculum and the included septae run from the medial malleolus to the calcaneus where they can blend with the plantar fascia.<sup>2</sup> Therefore, tension on the fascia may create tension of the retinaculum and less volume (more pressure) on the contained structures, resulting in pain.

A 1999 article by Trepman and colleagues looked at the effect of foot position on tarsal tunnel compartment pressure.<sup>10</sup> The authors used 10 fresh, frozen cadaver distal extremities and measured compartment pressures with the foot-ankle held in subtalar joint neutral. The foot-ankle then went into full inversion and subsequently into full eversion. It is important to note that researchers held the ankle joint in approximately 20 degrees of plantarflexion throughout testing. The tarsal tunnel compartment pressure in neutral position was  $2 \pm 1$  mmHg while eversion yielded the greatest pressure of  $32 \pm 5$  mmHg and inversion yielded  $17 \pm 5$  mmHg. The authors concluded that their results might explain why neutral immobilization of the hindfoot relieves tarsal tunnel syndrome symptoms because of less pressure in the compartment and therefore less irritation to the posterior tibial nerve.

### What To Consider In The Differential Diagnosis

As the clinician works up the patient with a thorough history and physical exam, and approaches the diagnosis of tarsal tunnel syndrome, it is important to appreciate what other diagnoses can mimic tarsal tunnel syndrome in order to ensure an accurate diagnosis and effective treatment.

Differential diagnoses to consider include: radiculopathy, diabetic neuropathy, peripheral neuropathy, rheumatoid arthritis, seronegative arthropathies, vascular disease, Baxter's nerve entrapment, plantar fasciitis, scar tissue from prior injury or surgery, lower extremity edema, or a space-occupying lesion such as a ganglion, lipoma or tumor.<sup>2,3,8</sup>

Ordering nerve conduction studies and possibly magnetic resonance imaging (MRI) may assist in diagnosing the patient to allow for proper and successful treatment.

### What One Study Revealed About The Diagnosis And Treatment Of Tarsal Tunnel Syndrome

In 1998, Mondelli and coworkers performed pre- and post-treatment nerve conduction studies on patients with tarsal tunnel syndrome in order to evaluate the success, or lack thereof, in treating tarsal tunnel syndrome.<sup>11</sup> Initially, they found three things: 1) slowing sensory conduction velocity in the plantar nerve in 77 percent of feet; 2) distal motor latency was delayed in 55 percent of feet; and 3) electromyography (EMG) showed neurogenic changes in 45 percent of feet soles.



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conduction velocity and distal motor latency tests. The physical therapy patients reported good outcomes and unfortunately did not repeat nerve testing at follow-up. Finally, of the five feet with no treatment, three patients returned for nerve testing and two had improved sensory conduction velocity and distal motor latency while one worsened.

The authors concluded that surgery should be limited to patients with space-occupying lesions.<sup>11</sup> They stated that one should not operate on patients with trauma-induced or “idiopathic” tarsal tunnel syndrome because with time or conservative care, these patients can recover. The study did not fully define conservative care or physical therapy. The authors went on to say that one should always confirm the diagnosis of tarsal tunnel syndrome with “electrophysiological evidence of delay of the distal conduction of the plantar nerves.” This will allow separation of the diagnosis of tarsal tunnel syndrome from other causes of foot pain, such as plantar fasciitis, deformity and vascular disease.

### A Closer Look At Conservative Care Options

Conservative care options for tarsal tunnel syndrome may include but are not limited to many modalities.<sup>3,5,6,8</sup> The literature reports include rest; weight loss if the patient is obese; compression stockings if the patient has swelling; oral pain medication such as narcotics, anti-inflammatories or nerve pain medication; vitamin B6 injection therapy; or even local anesthesia with or without the addition of cortisone to the impingement site. Other conservative care options include avoidance of activities that irritate or trigger pain, or physical therapy geared to decrease inflammation and strengthen both the intrinsic and extrinsic muscles in the foot. Other options may include immobilization with a cast, walking boot, or ankle brace; a heel lift to attempt to decrease tension on the nerve by placing the ankle in a slightly plantarflexed position; and functional foot orthotics.

In the office, the primary author has found the best control and reduction of pain with activity modification and the use of either a walking boot or lace-up ankle brace to control hindfoot position with the addition of a heel lift. These patients tend to present not only with a positive Tinel’s sign on percussion of the nerve with burning and/or numbness but also pronation or a valgus resting calcaneal stance position and equinus. Some will also have sinus tarsi impingement and pain, but all require mechanical correction of the hindfoot and bracing helps significantly in this population in the primary author’s office. For these patients, there is subsequent progression to functional foot orthotics with the primary goal of maintaining decreased tension on the neurovascular bundle in addition to mechanically controlling the feet. This decreases pain and slowly allows patients to ease back into and increase their activities.

### Assessing The Role Of Functional Foot Orthoses

Using this information on tarsal tunnel syndrome, we can incorporate what the literature says about increased compartment pressures and increased pain in the dorsiflexed and everted (or pronated) position to determine if functional foot orthotic devices may be a viable treatment option.

Trepman found the highest tarsal tunnel compartment pressures when the foot was stressed into full eversion, which is why functional foot orthotics might be successful in reducing pain.<sup>10</sup> Kinoshita found that placing the foot into dorsiflexion-eversion, a pronated position, and applying stress for 10 seconds elicited pain reproduction in patients with tarsal tunnel syndrome nearly 100 percent of the time.<sup>9</sup>

Considering that the goal of functional foot orthotics is to hold the foot out of maximal pronation and instead in subtalar neutral, this again favors usage of these devices in treating painful tarsal tunnel syndrome. Based on this, it seems logical to assume that a custom-molded functional foot orthotic would be a successful treatment option. Functional foot orthotics are designed to hold the hindfoot in a neutral position and the literature does point out conservative care treatment options of casts, walking boots, and ankle braces all in order to hold the hindfoot neutral to control pain.<sup>5</sup>

### Keys To Writing Orthotic Prescriptions For Tarsal Tunnel Syndrome

When writing the orthotic prescription for a patient with tarsal tunnel syndrome, the goal is to position the foot out of maximal pronation and into subtalar joint neutral in order to reduce tension on the nerve and diminish pain.<sup>2</sup> This requires a wide device in order to get as much surface area as possible under the foot to effect this change. This occurs with semi-rigid polypropylene, which will not deform under load but instead offer continuous support to the foot. The polypropylene thickness should be based on the



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In addition, prescribe minimal arch fill to minimize lengthening of the longitudinal arch, which would have otherwise placed tension on the nerve. We also recommend a deep heel cup and medial heel skive in order to better control the hindfoot, or more specifically, calcaneal eversion.

Kirby developed the medial skive in order to offer an additional supinatory torque in the medial half of the heel cup portion of the orthotic.<sup>12</sup> The medial skive can range from 2 mm (mild deformity correction) to 6 mm of correction depending on the degree of calcaneal eversion. Finally, in order to stabilize this device, one would add a rearfoot post using a firm material such as polypropylene or high durometer ethylene vinyl acetate (EVA) with no motion. Additionally, in reference to a study we mentioned earlier, compartment pressures decrease with the foot not only held in subtalar joint neutral but also slightly plantarflexed through the ankle.<sup>10</sup> With this in mind, clinicians may also consider a heel lift to aid in decreasing traction on the nerve and add a top cover for comfort.

### In Conclusion

At the start of this article, we asked if orthotics can impact tarsal tunnel syndrome. After looking at the anatomy of the region, the symptoms patients present with, the mechanics of the hindfoot that can irritate or place the nerve on traction, and what the literature says about tarsal tunnel syndrome, we believe that functional foot orthotics can certainly impact tarsal tunnel syndrome.

Unfortunately, current literature only suggests the success of these devices but using logic and knowledge of foot and ankle mechanics, we believe that a properly prescribed orthotic from a properly molded foot can result in a device that will aid in pain reduction for patients with tarsal tunnel syndrome.

Perhaps a future study, following the paper by Mondelli, could first identify patients with tarsal tunnel syndrome using clinical parameters and employ pre-treatment and post-treatment nerve conduction studies to evaluate patients multiple months after use of functional foot orthotics.<sup>11</sup> This would certainly evaluate whether these devices removed tension on the nerve to rid patients of their symptoms and also potentially allow repair of the nerve.

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