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DIAGNOSIS, BIOMECHANICS, AND ORTHOSIS TREATMENT OF SINUS TARSI SYNDROME

Sinus tarsi syndrome is a pathological condition which causes pain and tenderness within the sinus tarsi region of the subtalar joint (STJ) with increased duration and/or intensity of weightbearing activities. The patient may have a history of trauma, with the most common injury being an inversion ankle sprain. However, sinus tarsi syndrome may also be seen in patients with no history of specific traumatic event and who report their sinus tarsi pain developed gradually before the sinus tarsi pain was first noted.

Anatomically, the sinus tarsi is located just inferior and anterior to the lateral malleolus. During STJ supination motion, the lateral process of the talus glides superiorly and posteriorly along the posterior facet of the STJ, moving away from the floor of the sinus tarsi of the calcaneus, and opening up the tarsal canal. During STJ pronation, however, the lateral process of the talus glides inferiorly and anteriorly along the posterior facet until the talar lateral process contacts the floor of the sinus tarsi of the calcaneus, closing the sinus tarsi (Fig. 1). Once STJ pronation motion is stopped by the lateral calcaneal process abutting up against the floor of the sinus tarsi of the calcaneus, then, by definition, the STJ is said to have reached its maximally pronated position. Any further STJ pronation moments acting when the STJ is maximally pronated will not produce further pronation motion, but rather will increase the interosseous compression force within the sinus tarsi (Kirby KA: Rotational equilibrium across the subtalar joint axis. JAPMA, 79: 1-14, 1989).

Located deep within the STJ and sinus tarsi are the cervical ligament, interosseous talo-calcaneal ligament, and inferior extensor retinaculum which help guide the motions of the talus on the calcaneus and also help to restrict abnormal motions at the STJ. In addition, the insertion of the anterior talo-fibular ligament and origin of the extensor digitorum brevis muscle are also located within the sinus tarsi (Kelikian AS (ed): Sarrafian's Anatomy of the Foot and Ankle: Descriptive, Topographic Functional. 3rd ed. Lippincott Willaims & Wilkins, Philadelphia, 2011, pp. 196-202). These structures, if injured traumatically or by repetitive microtrauma within the sinus tarsi, may be the cause of the pain in many cases of sinus tarsi syndrome.

There are two major etiologies of sinus tarsi syndrome, post-traumatic and non-traumatic. *Post-traumatic sinus tarsi syndrome* most commonly results after injuries to the lateral ankle and STJ ligamentous structures from inversion ankle injuries. In these very common injuries, the retaining ligaments of the ankle joint and lateral STJ may become damaged resulting in painful scar tissue within the sinus tarsi. Patients with post-traumatic sinus tarsi syndrome will complain of chronic lateral ankle pain that occurred soon after they suffered a lateral ankle injury. On the other hand, patients with *non-traumatic sinus tarsi syndrome* will remember no specific traumatic event that could have started the lateral ankle pain. In both types of sinus tarsi syndrome, the patient's sinus tarsi pain will be made worse by increased duration and intensity of weightbearing activities, and will also be made worse by walking barefoot, walking in low-heeled or flat shoes and/or when walking on uneven surfaces.

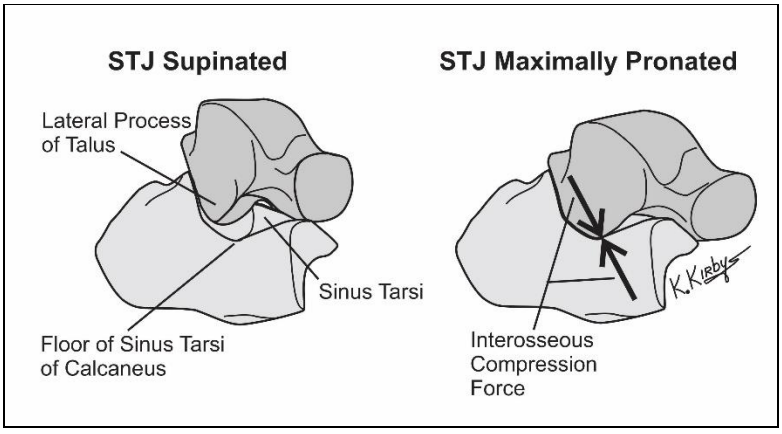


Figure 1. When the subtalar joint (STJ) supinates, the lateral process of the talus glides posteriorly and superiorly along the posterior facet of the STJ (left). However, when the STJ pronates, the lateral process of the talus glides anteriorly and inferiorly until it contacts, and compresses against, the floor of the sinus tarsi of the calcaneus (right). When the lateral process of the talus impacts against the floor of the sinus tarsi of the calcaneus, the STJ is defined as being "maximally pronated". Any further STJ pronation moments acting on the foot while the STJ is maximally pronated will increase the interosseous compression force between the lateral talar process and sinus tarsi calcaneal floor, increasing the risk of sinus tarsi syndrome developing.

Clinical examination of the foot with sinus tarsi syndrome will reveal that the patient has increased pain with forced inversion range of motion of the STJ but little to no pain with

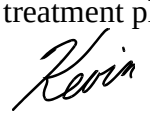
pronation motion of the STJ. Palpation within the sinus tarsi will always cause tenderness. Clinical swelling of the sinus tarsi may be present, but is not common. Even though there are no specific x-ray findings in sinus tarsi syndrome, MRI imaging may confirm the diagnosis of sinus tarsi syndrome. In a study done by Lektrakul et al., 18 of 42 patients with clinical evidence of sinus tarsi syndrome had their diagnosis confirmed by MRI. Pathologic sinus tarsi findings included tears of the interosseous and cervical ligaments in 14 patients, ganglia in 3 patients, and pigmented villonodular synovitis in one patient. Alteration of the tarsal sinus fat was seen in all 42 patients (Lektrakul N et al.: Tarsal sinus: arthrographic, MR imaging, MR arthrographic, and pathologic findings in cadavers and retrospective study data in patients with sinus tarsi syndrome. Radiology, 219(3):802-810, 2001).

Over my nearly four decades of clinical experience in treating patients with sinus tarsi syndrome, it seems biomechanically logical that most cases of non-traumatic sinus tarsi syndrome are caused by increased interosseous compression forces which occur when the lateral process of the talus forcefully strikes against the floor of the sinus tarsi of the calcaneus with each step during weightbearing activities. In every case of non-traumatic sinus tarsi syndrome that I have treated over the years, the individual had a maximally pronated STJ during standing and walking, had a flatter-than-normal medial longitudinal arch, and had a medially deviated STJ axis (Kirby KA: Subtalar joint axis location and rotational equilibrium theory of foot function. JAPMA, 91:465-488, 2001). These feet with medially deviated STJ axes will always have increased magnitudes of interosseous compression forces between the lateral process of the talus and the floor of the sinus tarsi of the calcaneus. Common pathologies which may co-exist with non-traumatic sinus tarsi syndrome include posterior tibial tendon dysfunction and adult-acquired flatfoot deformity.

Initial conservative therapy for patients with non-traumatic sinus tarsi syndrome include recommending no barefoot or low-heel shoes since barefoot and low-heel shoes will tend to increase the STJ pronation moments that increase interosseous compression forces between the lateral talar process and calcaneal sinus tarsi floor. In addition to shoe gear recommendations, custom foot orthoses are made for the patient with the goal of supinating the foot out of the STJ maximally pronated position during weightbearing activities. Anti-pronation orthosis modifications such as medial heel skives of 2-6 mm, deep heel cups of 16-18 mm, thicker heel contact points of 2-3 mm and more rigid and conforming foot orthosis shells which resist medial arch deformation have the best chance of relieving sinus tarsi pain in these patients. All of these orthosis modifications will increase the STJ supination moments during weightbearing activities in an attempt to meet the goal of reducing the pathological interosseous compression forces within the sinus tarsi.

In patients with post-traumatic sinus tarsi syndrome, a flat longitudinal arch and medially deviated STJ axis is not as commonly seen. Rather, these patients generally have only a mildly pronated foot. However, it is likely that these post-traumatic sinus tarsi syndrome patients have increased scar tissue within the sinus tarsi which may become pathologically compressed within the small confines of the sinus tarsi, resulting in chronic sinus tarsi pain. In these patients, custom foot orthoses designed with more mild anti-pronation feature are used along with a series of 3-5 cortisone injections into the sinus tarsi, spaced about a month apart, to reduce the scarring and pain within the sinus tarsi during weightbearing activities.

In conclusion, sinus tarsi syndrome may be either traumatic or non-traumatic, with the non-traumatic variety of sinus tarsi syndrome likely being caused by the increased interosseous compression forces within the sinus tarsi due to abnormal magnitudes of STJ pronation moments. In the traumatic variety of sinus tarsi syndrome, it is likely that scar tissue within the sinus tarsi is being over-compressed, irritated and inflamed within the tight confines of the sinus tarsi when the STJ reaches its maximally pronated position during gait. Being able to understand the biomechanics behind these two common causes of sinus tarsi syndrome will enable the podiatrist to better decide what the best treatment plan will be for these painful conditions.



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