PROLAB ORTHOTICS
Evidence-Based Medicine

Biomechanics & Orthotic Therapy Newsletter
March 2024

BIOMECHANICS AND FOOT ORTHOSIS TREATMENT OF PERONEAL TENDINOPATHY

Peroneal tendinopathy, which includes the diagnoses of peroneal tendinitis, peroneal tenosynovitis, peroneal tendon splits and tendon tears, and even peroneal tendon subluxation and tendon dislocation, are common pathologies seen in podiatric practices. Biomechanically, the peroneus brevis (PB) and peroneus longus (PL) muscles are the only two muscles which can exert a strong pronation moment across the subtalar joint (STJ) axis. Since the peroneus tertius muscle is only present in about 89.5% of individuals and is a relatively weak muscle, it adds little to an STJ pronation moment (Joshi SD et al.: Morphology of peroneus tertius muscle. Clin Anat, 19(7):611-614, 2006). In addition, the extensor hallucis longus and extensor digitorum longus muscles normally have their tendons passing close to the STJ axis so that these muscles also likely have little ability to produce significant STJ pronation moments.

Since the PB and PL muscles are the strongest pronators of the STJ, these muscles will be activated by the central nervous system (CNS) when the individual's feet need to have acceleration of STJ pronation. The CNS will also activate the peroneals when a deceleration of supination, and/or a stabilization of the STJ against supination moments is needed. For example, if the individual is walking on a hillside so that their right foot is on a varus-inclined surface, the CNS will cause increased activity of the PB and PL muscles of the right foot and lower extremity so that the individual will not suffer an inversion ankle sprain when walking on the sloped surface. In this way, the PB and PL muscles can effectively counterbalance excessive supination moments coming from an external influence, such as a sloped surface or uneven ground.

In much the same way, if the feet of an individual have an inherent structure that results in ground reaction force (GRF) tending to over-supinate the feet, then the CNS will increase the contractile activity of the PB and PL muscles to increase the STJ pronation moment in order to avoid inversion ankle sprains. In the four decades that I have been measuring STJ axis locations (Kirby KA: Methods for determination of positional variations in the subtalar joint axis. JAPMA, 77: 228-234, 1987), I have consistently found that feet with the most "supination instability" are those feet with one or a combination of three deformities: a high degree of metatarsus adductus, a high degree of rearfoot varus and/or a rigid plantarflexed first ray deformity. Each of these pedal deformities will tend to have a more laterally deviated STJ axis location than normal which will directly cause increased STJ supination moments during weightbearing activities.

Lateral deviation of the STJ axis caused by any of the above-mentioned pedal deformities will increase the supination moment arm or decrease the pronation moment arm for every extrinsic muscle of the foot. In addition, lateral STJ axis deviation will greatly increase the magnitude of STJ supination moment caused by the effects of GRF acting on the plantar foot during weightbearing activities. The net biomechanical effect of both muscle action and GRF action on a foot with a rigid plantarflexed first ray, high degree of metatarsus adductus or rearfoot varus deformities is that these feet will biomechanically be subjected to chronically large amounts of STJ supination moment during nearly all weightbearing activities.

As a result of the significant increase in STJ supination moment that results from these foot types, the CNS naturally responds by increasing the contractile activity of the PB and PL muscles during weightbearing activities in order to counterbalance this potentially harmful excessive STJ supination. Increased intensity and duration of PB and PL contractile activity will also necessarily lead to increased magnitudes and durations of peroneal tendon tension force which can, over time, lead to increased risk of structural damage to the peroneal tendons (e.g., peroneal tendinitis, tenosynovitis, and tendon splits/tears). In other words, these foot types with their laterally deviated STJ axes, will need to have increased tension force within their peroneal tendons to keep the forefoot plantigrade and prevent inversion ankle sprains. All in all, the result of this increased magnitude and duration of peroneal tendon tension is an increased risk of peroneal tendinopathy.

Other than peroneal subluxation/dislocation which are best treated surgically, the best conservative therapy for treatment of patients with peroneal tendinopathy are specially-designed custom foot orthoses. Unfortunately, there are many podiatrists who still believe that STJ pronation is always a bad thing and that the STJ should never be purposely pronated with a custom foot orthosis. If one simply forgets many of the traditional

podiatric biomechanical concepts that we were taught as podiatry students, it becomes quite clear that if a patient has a pathology which is caused by over-supination of the foot, then the best treatment for that patient would be to try and pronate that foot out of the over-supinated position. Making simply a standard vertically-balanced foot orthosis foot orthosis without a forefoot extension invariably either fails or makes the pain from chronic peroneal tendinopathy worse since these orthoses will act to supinate the foot further and will not pronate the foot as is biomechanically required to effectively treat chronic peroneal tendinopathy.

In the 37 years that I have been treating peroneal tendinopathy, I have repeatedly observed, by trial and error experimentation, that ***the best custom foot orthosis design for treating peroneal tendinopathy are valgus-wedged orthoses that attempt to pronate the STJ and reduce the supinated position of the STJ***. Therefore, the biomechanical concepts that the podiatrist must understand to effectively treat chronic peroneal tendinopathy is that the orthosis must be designed to shift GRF from medial to lateral on the plantar foot. By using valgus wedge-type modifications in these orthoses, not only will the STJ supination moment be decreased, but also the STJ pronation moment will be increased during weightbearing activities. I have also found that all parts of the custom foot orthosis, from the rearfoot to the forefoot, needs to be modified to increase the valgus-wedging and lateral support effects in order to optimize the increase in STJ pronation moment from the orthosis that is biomechanically necessary to effectively treat peroneal tendinopathy.

Standard orthosis modifications for the treatment of chronic peroneal tendinopathy in the rearfoot include using a 2-4 mm lateral heel skive to increase the valgus-wedging in the rearfoot and using a flat-stiff rearfoot post in order to prevent inversion of the orthosis within the shoe (Fig. 1). In the midfoot portion of the orthosis, a filler of Korex or ethylene vinyl acetate (EVA) should also be added to the plantar-lateral arch of the orthosis (i.e., Denton modification) in order to help stiffen the lateral longitudinal arch of the orthosis and prevent lateral orthosis arch deformation during gait. Finally, a valgus-wedged forefoot extension of 1/8" to 1/4" Korex or EVA should be added from the 2nd to 5th metatarsal heads in order to evert the plantar metatarsal heads relative to the ground and further increase the GRF under the lateral metatarsal heads so that the STJ pronation effect from the foot orthosis is optimized to treat the peroneal tendinopathy.

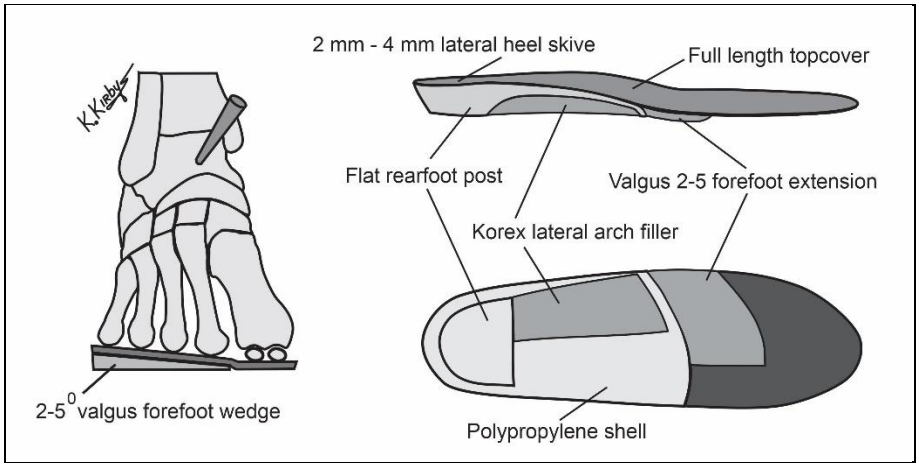

Figure 1. In orthoses designed to treat chronic peroneal tendinopathy, the orthoses need to increase the pronation moment acting across the subtalar joint (STJ) axis to counterbalance the abnormal STJ supination moments which can cause peroneal tendon symptoms. Typical orthosis modifications include lateral heel skives and flat rearfoot posts, Korex or EVA lateral arch fillers, and valgus 2-5 forefoot extensions. Orthoses made with these modifications have a much greater chance of relieving chronic peroneal tendon pain than more traditional orthosis designs.

With these foot orthosis modifications, which I have used during my relatively long practice career, I have been able to repeatedly reduce the pain and swelling from peroneal tendinitis, peroneal tenosynovitis and mild peroneal tendon tears in literally hundreds of patients. The podiatrist who can incorporate these specially-designed, valgus-wedged orthoses into their practice, will be able to provide their patients with a conservative treatment option which can reduce the pain and disability of peroneal tendinopathy.

Kevin

Kevin A. Kirby, D.P.M.
Biomechanics Director