

BIOMECHANICS AND FOOT ORTHOSIS TREATMENT OF SESAMOIDITIS

Sesamoiditis is one of the more common diagnoses in the plantar forefoot of active individuals. The two sesamoids of the first metatarsophalangeal joint (MPJ), the medial and lateral sesamoids, are attached to each other by a thick intersesamoid transverse ligament. Each sesamoid is also tethered to the base of the proximal phalanx of the hallux by a short sesamophalangeal ligament. Proximally, the central component of the plantar aponeurosis (i.e. plantar fascia) sends slips which attach to both the medial and lateral sesamoids that allows the passive tension force within the plantar fascia to be transferred to the hallux via the sesamoids (Sarraffian SK: Anatomy of the Foot and Ankle, J.B. Lippincott Co., Philadelphia, 1983, pp. 84-86).

In addition to the important attachments of the plantar fascia to the sesamoids, the sesamoids serve as points of attachment for three of the plantar intrinsic muscles of the foot: the abductor hallucis (ABH), flexor hallucis brevis (FHB) and adductor hallucis (ADH) muscles. These plantar intrinsic muscles function, through central nervous system control, to increase the tension forces acting on the sesamoids and, along with the plantar fascia, biomechanically help to stabilize and raise the longitudinal arch of the foot (Kirby KA: Longitudinal arch load-sharing system of the foot. Revista Española de Podología, 28(2), 2017).

On the dorsal aspect of each sesamoid is a smoothly curved cartilaginous surface that directly articulates with the trochlear grooves on the plantar aspect of the first metatarsal head. The sesamoids serve as important weightbearing structures which transmit the ground reaction force (GRF) acting on the plantar sesamoids directly to the plantar first metatarsal head. In addition, the sesamoids glide and rotate relative to the first metatarsal head as the hallux dorsiflexes and plantarflexes at the first MPJ. As the hallux dorsiflexes on the first metatarsal head, the sesamoids will glide and rotate distally on the first metatarsal head, and as the hallux plantarflexes, the sesamoids will glide and rotate proximally relative to the first metatarsal head.

The flexor hallucis longus (FHL) tendon also passes between the medial and lateral sesamoids and is located directly plantar to the intersesamoid transverse ligament. It is thought that one of the main functions of the sesamoids is to increase the plantarflexion moment arm for the FHL muscle, by increasing the distance from this important flexor tendon to the dorsiflexion-plantarflexion axis of the first MPJ (Aper RL, Saltzman CL, Brown TD: The effect of hallux sesamoid excision on the flexor hallucis longus moment arm. Clin Ortho Rel Res, 325:209-217, 1996). Likewise, the plantar fascia, ABH, FHB and ADH muscles also have an increased plantarflexion moment arm at the first MPJ due to their attachments to the medial and lateral sesamoids which increase the potential for these tension load-bearing structures to not only stabilize the hallux firmly against the

ground but to also allow the hallux to be a propulsive structure during gait.

Being that the sesamoids act both to transmit large magnitudes of tension loading forces from the plantar fascia and plantar intrinsic muscles to the base of the proximal phalanx of the hallux, and to transmit compression loading forces from the ground to the plantar first metatarsal head, it is apparent that the medial and lateral sesamoids are subjected to significant magnitudes of both tension and compression forces during weightbearing activities. These repetitive tension and compression forces acting on the sesamoids during high intensity and/or prolonged weightbearing activities may result in injury to the sesamoids.

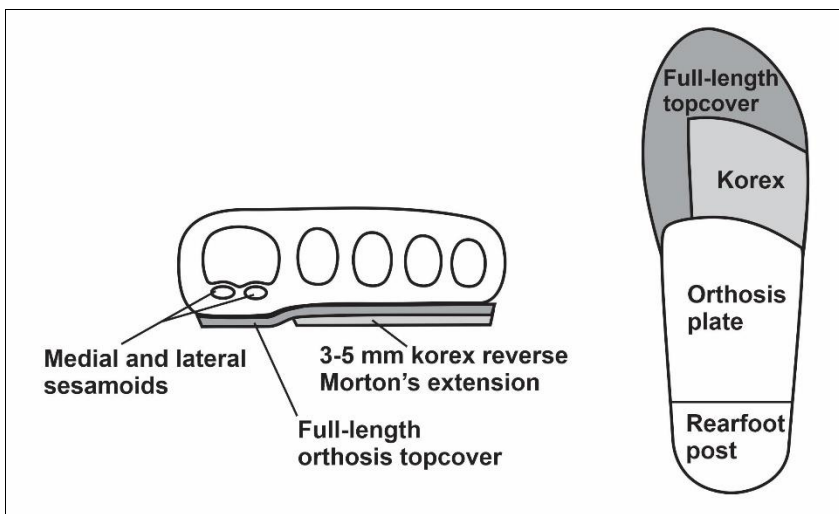


Figure 1. Custom foot orthoses designed to treat sesamoiditis should include a well-fitting medial arch and rearfoot post to limit pronation of the foot, along with a reverse Morton's extension on a full-length topcover to reduce ground reaction force acting on the sesamoids.

The diagnosis of sesamoidal injury is relatively straightforward in the clinical setting using manual examination techniques which every podiatrist should be proficient in. The medial and lateral sesamoids may be easily palpated and distinguished from each other using careful manual pressure on each structure. In the uninjured foot, firm manual pressure from the examiner on the plantar aspects of either the medial or lateral sesamoid will produce no sensation of pain from the patient. When the patient complains of pain located on the plantar aspect of the first MPJ and when firm manual pressure on medial and/or lateral sesamoids is reported as tenderness, one should assume that an injury to one or both of the sesamoids may have occurred.

Pain within the medial and/or lateral sesamoid should include a differential diagnosis of sesamoiditis, sesamoid stress fracture, sesamoid fracture, degenerative joint disease of the sesamoid-first metatarsal joint or avascular necrosis of the sesamoids. Plain film x-rays followed by MRI scans of the forefoot are the usual diagnostic tests which are used when sesamoid injury is suspected. However, CT scans and bone scans can also be used as adjunctive diagnostic studies if necessary. With sesamoiditis, the plain film x-ray will show no abnormalities. However, on MRI scanning of the forefoot, sesamoiditis will generally present with no fracture lines but may show bone marrow edema and high T2 signals within the sesamoids (Hillier JC, Peace K, Hulme A, Healy JC: MRI features of foot and ankle injuries in ballet dancers. *British J Radiol*, 77:532-537, 2004). In my treatment of milder cases of sesamoiditis, I have had patients with sesamoid pain and tenderness, but no apparent pathology either on x-ray or MRI scan. Therefore, manual clinical examination is still as an important part of following the progression of healing in many types of sesamoid pathology.

If sesamoiditis is suspected on examination of a patient, I will initially add a 1/8"- 1/4" adhesive felt pad plantar to the 2nd to 5th metatarsal heads (i.e., reverse Morton's extension) along with a medial arch pad of 1/4" adhesive felt to their shoe insole or sockliner. These accommodative and arch-supporting pads work together to effectively reduce both the GRF acting on the plantar sesamoids and the tension forces from the plantar fascia and plantar intrinsic muscles acting on the sesamoids. In addition, patients are instructed to avoid running and jumping activities, avoid squatting activities and avoid going barefoot on hard surfaces to reduce the compression forces acting on the sesamoids. Icing for 15-20 minutes, 2-3 times daily and wearing soft recovery-type sandals (e.g. Oofos, Hoka) indoors will also help with the discomfort of sesamoiditis.

When sesamoiditis does not respond well to initial in-shoe padding, I will highly recommend custom foot orthoses for its treatment. In my experience, custom foot orthoses work to heal sesamoiditis in 90-95% of patients and are, therefore, a very valuable clinical treatment tool in patients with sesamoiditis. Custom foot orthoses should be designed with the goal to reduce not only the compression forces from GRF acting on the sesamoids, but also to reduce the tension forces within the plantar fascia and plantar intrinsic muscles which insert onto the sesamoids. In general, an orthosis with a 4 mm polypropylene shell is ordered along with a rearfoot post, a 2-3⁰ inverted balancing position and a well-fitting medial longitudinal arch (Fig. 1). A full-length topcover is ordered along with a 3-5 mm thick korex reverse Morton's extension to help offload the sesamoids. In a more pronated foot, a 2-4 mm medial heel skive may also be ordered to help reduce the pronated position of the foot. But in a more stable foot with a plantarflexed first ray, a thicker reverse Morton's extension should be ordered, but not a medial heel skive nor inverted balancing position.

In my 39 years of treating sesamoiditis with custom foot orthoses, there has been a high degree of success in allowing patients suffering from this painful condition of the plantar first MPJ to return to their weightbearing activities without pain. The ability of well-designed custom foot orthoses to reduce the compression forces from GRF and the tension forces from the plantar fascia and plantar intrinsic muscles is unrivaled when compared to any other conservative care option for treating sesamoiditis. The busy podiatrist should take the time to understand these biomechanical principles to improve the well-being of their patients.



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