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BIOMECHANICS AND CLINICAL USE OF MEDIAL HEEL SKIVE ORTHOSIS TECHNIQUE

In 1990, I started development of the medial heel skive (MHS) orthosis technique. Two years later, my paper on the MHS was published which described how this custom foot orthosis modification could improve the therapeutic effectiveness of foot orthoses in patients suffering from pronation-related pathologies of the foot and lower extremity (Kirby KA: The medial heel skive technique: improving pronation control in foot orthoses. JAPMA, 82: 177-188, 1992). In the 31 years since the MHS technique was first published within the podiatric literature, the MHS has now become a standard custom foot orthosis modification that is used by foot orthosis laboratories worldwide, and is even used as a feature within many pre-made orthoses.

The MHS orthosis technique was initially performed by skiving plaster away from the medial-plantar heel of the plaster positive cast of the patient's foot (Fig. 1). A standard frontal plane varus angle of 15^0 was used as the initial skive angle on the positive cast. This initial medial skive of plaster was then rounded on its periphery so that the resultant custom foot orthosis would have a smoothly-shaped varus slope within the orthosis heel cup. The depth of the MHS, rather than its frontal plane angle, was decided as the parameter which would determine the magnitude of varus heel cup slope that was constructed into the resultant orthosis. In other words, a small amount of MHS was ordered as a "2-mm skive" and a large amount of MHS was ordered as a "6-mm skive" (Kirby, 1992). Now, in most modern foot orthosis labs, the MHS is created using computer software which constructs the plantar heel cup of the orthosis into a varus shape depending on the depth, in millimeters, of MHS ordered by the prescribing podiatrist.

As discussed in the last two ProLab Newsletters, a foot orthosis performs its biomechanical functions by altering the locations, magnitudes and temporal patterns of ground reaction force (GRF) acting on the foot during weightbearing activities, tending to "push" the foot into a better position by a "Direct Mechanical Effect". This biomechanical effect of the "plantar push" from the orthosis may also cause the central nervous system to alter the motor signals to the muscles of the foot and lower extremity by the "Neuromotor Effect", in order to increase gait stability and/or prevent injury due to changes in GRF caused by the foot orthosis.

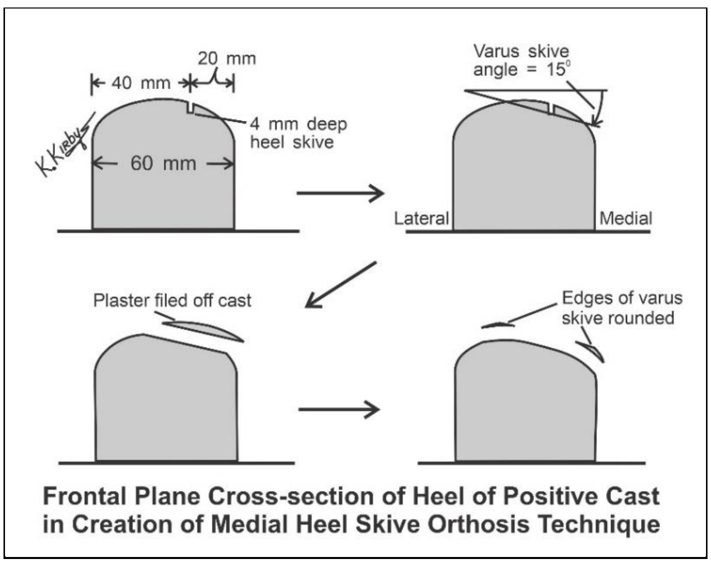

Figure 1. When the medial heel skive technique was initially developed, the positive cast of the foot was measured to determine heel width, and then a cut was made into the medial third of the plantar heel of the positive cast at a depth of 2-6 mm. The plantar medial heel of the positive cast was then skived into a varus angle and rounded. The resulting orthosis would have an increase in varus heel cup shape that increased subtalar joint supination moment to better treat pronation-related foot and lower extremity pathologies.

With the MHS technique, and its increase in varus heel cup contour within the orthosis, the GRF under the plantar heel becomes shifted more medial on the plantar calcaneus than with a traditional vertically-balanced Root-style foot orthosis. This medial shift in plantar heel GRF with the MHS technique has been studied within the scientific research literature. As a result of this research, it has been found that increasing amounts of MHS result in a significant increase in peak pressure under the medial rearfoot in adults with a flat-arched foot posture (Bonanno DR et al: The effect of different depths of MHS on plantar pressures. Journal Foot Ankle Research, 5(1):20, 2012).

The net biomechanical result of the medial shift in GRF on the plantar heel that occurs due to the MHS is an increase in magnitude of subtalar joint (STJ) supination moment and/or a decrease in magnitude of STJ pronation moment. By increasing the GRF on the medial aspect of the plantar heel and decreasing the GRF on the lateral aspect of the plantar heel, the varus slope of the MHS has a profound effect on the STJ moments that result from the plantar heel of the foot bearing weight on the ground. In an individual that has, for example, pronation-related symptoms such as posterior tibial tendon dysfunction (PTTD), sinus tarsi symptoms, medial tibial stress syndrome, or patella-femoral syndrome, the MHS can effectively reduce the excessive STJ pronation moments that are the cause of these foot and lower extremity pathologies. In addition, in feet that are maximally pronated at the STJ during gait and/or have an excessively flat medial longitudinal arch height causing gait pathologies, the MHS orthosis technique can have a potent effect at reducing the magnitudes of STJ pronation moments which are the cause of these pronation-related gait pathologies (Kirby, 1992).

One of the keys to understanding the biomechanics of the MHS orthosis technique and when to use this modification in custom foot orthoses for patients with mechanically-related foot pathologies, is to appreciate how medial deviation of the STJ axis can have a significant effect on the STJ moments exerted by GRF within an individual's foot. When a foot pronates in closed-kinetic-chain, the talus will internally rotate, plantarflex and slightly invert relative to the calcaneus. Since the STJ axis has been shown in numerous scientific studies to exit anteriorly through the central-dorsal aspect of the talar neck, then STJ pronation motion, or an abnormally pronated foot, will tend to cause an abnormally internally rotated STJ axis relative to the plantar foot so that the STJ axis will be in a more medial location relative to the plantar weightbearing structures of the foot, than if that foot was more normally shaped and less pronated at the STJ (Kirby KA: Subtalar joint axis location and rotational equilibrium theory of foot function. JAPMA, 91:465-488, 2001).

As a result, the spatial location of the STJ axis becomes very important when considering which patients need orthoses made with the MHS, and how much MHS (i.e. 2 mm, 4 mm, 6 mm) is needed in their custom foot orthosis to produce the most therapeutically effective foot orthoses for treatment of their biomechanically-related foot and lower extremity pathologies. Those feet with slight to moderate medial deviation of their STJ axes and those patients with less severe pronation-related symptoms will require smaller amounts of MHS. However, those feet with more severe medial deviation of their STJ axes and/or those patients with more severe pronation-related symptoms will require larger amounts of MHS in order to reduce the STJ pronation moments enough to best relieve their pronation-related pathology and symptoms.

A good clinical example of when the podiatrist may consider using a smaller amount (e.g. 2 mm) of MHS may be the patient who has a maximally pronated foot, but also with only a slight decrease in medial longitudinal arch height and mild pronation-related symptoms such as a posterior tibial (PT) tendinitis due to an increase in running activities. In this patient, who is likely suffering from inflammation within the PT tendon due to increasing their running training on a somewhat pronated foot, the 2 mm MHS will help shift GRF more medial during the first half of the support phase of running so that there will be less tension force on the PT tendon during running, allowing more rapid healing of the PT tendon to occur.

However, in the case of the patient with PTTD, where there may be actual structural damage to the PT tendon and there also may be a more severely medially deviated STJ axis involved, a larger amount (4-6mm) of MHS may be indicated for the patient's orthoses. In these more severely pronated feet with the STJ axis excessively medially deviated, the medial aspect of the plantar heel now becomes the only area of the plantar foot medial to the STJ axis where the foot orthosis has the potential to create additional STJ supination moment to help relieve these more severe pronation-related pathologies, such as PTTD.

In summary, the MHS orthosis technique is a valuable tool that should be used in custom foot orthoses when treating patients suffering from any pronation-related foot and lower extremity pathology to increase not only the biomechanical effectiveness, but also increase the therapeutic effectiveness of a patient's custom foot orthoses. The judicious use of the MHS technique and its powerful effect at increasing the STJ supination moments from custom foot orthoses can often mean the difference between orthosis failure and success.

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