

TROUBLESHOOTING PRONATION INSTABILITY IN FOOT ORTHOSES

Custom foot orthoses have been used for over two centuries to treat symptoms and medical conditions caused by excessive subtalar joint (STJ) pronation forces acting within the foot (Kirby KA: "Evolution of Foot Orthoses in Sports", in Werd MB, Knight EL, Langer PR (eds), *Athletic Footwear and Orthoses in Sports Medicine. Second Edition*. Springer, New York, 2017). With appropriate anti-pronation modifications such as a medial heel skive, a higher and stiffer medial longitudinal arch and deeper heel cups, custom foot orthoses can help improve foot and lower extremity biomechanics and can also greatly relieve the "over-pronation" symptoms that the patient may experience during their daily weightbearing activities (Kirby KA: The medial heel skive technique: improving pronation control in foot orthoses. JAPMA, 82: 177-188, 1992).

However, there are times when, after dispensing what is thought to be a well-designed anti-pronation custom orthotic, the foot function of the patient does not seem to be significantly altered. In addition, patients may return for their follow-up orthotic visit and still complain that their custom foot orthoses have not appreciably changed their pronation-related symptoms. Even though the average podiatrist may initially conclude that the observed mediocre orthotic function and symptom relief is a case of "orthotic failure", the experienced podiatric biomechanics clinician knows that there are many causes for sub-optimal custom foot orthosis therapy when treating patients with the pronation-related symptoms. These podiatrists also know that many causes of suboptimal orthotic performance may often be remedied fairly easily in the clinical setting.

Troubleshooting options can generally be divided into either modifications to the patient's shoe gear or modifications to the custom foot orthoses themselves. First of all, the shoes must be examined for design features or excessive wear patterns which do not allow the custom foot orthosis to adequately control the patient's excessive STJ pronation. When observing that the patient is pronating more than they should when wearing their

custom orthoses, the podiatrist should inspect the shoe to make sure the heel counter is not everted relative to the shoe sole. This can be done by placing each shoe on a flat table-top. Also, the shoe heel counter should be inspected for deformation since this can lead insufficient pronation-controlling force from the shoe. In general, shoes with firmer soles and higher heel drops (i.e., larger difference between heel and forefoot sole height) will work much better at limiting the pronation of the foot with the orthoses.

Another shoe consideration, especially in children with more severe flatfoot deformity or in adults with posterior tibial tendon dysfunction, is to recommend that the patient wear high-top boots or shoes with their custom foot orthoses. By using the anti-pronation foot orthosis in a high-top boot or shoe, the excessive medial ankle motion seen during gait can be reduced much better due to the fact that the high-top boot or shoe supports the foot and ankle both inferior, and superior, to the STJ axis. Alternatively, in a low-top shoe, only the portion of the foot which is inferior to the STJ axis is supported by the shoe. I have seen many instances where the degree of foot pronation is so pronounced that even a custom foot orthosis with excellent pronation-control features may need to be worn in a high-top boot or shoe to reduce the pronation motion and pronation-related symptoms that

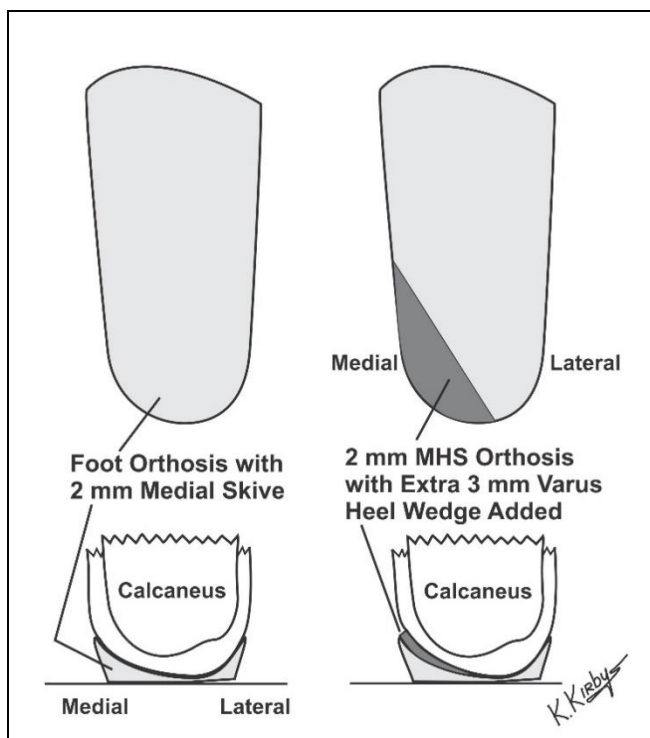


Figure 1. If a custom foot orthosis has only a 2 mm medial heel skive (MHS) and is seen to inadequately control the patient's pronation (left), a beveled 3 mm varus heel wedge may be adhered to the medial heel cup of the orthosis (right) to effectively increase the varus support of the plantar heel and increase the pronation-controlling ability of the foot orthosis.

the patient needs.

If the shoes have been inspected and are found to be structurally sound and able to effectively work with the custom foot orthosis in limiting STJ pronation in the patient, then the attention of the podiatrist must now be directed to the design features of the custom foot orthosis and whether these specific design features are adequate to control the excessive pronation that is observed during gait. In order to best assess the biomechanical ability of the custom foot orthosis to help limit the patient's STJ pronation, the foot orthosis should be evaluated both in a non-weightbearing setting and in a weightbearing setting.

While the patient is seated on the exam table or podiatry chair, the non-weightbearing fit of the orthotic to the patient's plantar foot should be initially evaluated. To accomplish this, the foot should be held in casting position with one hand while the examiner's other hand is used to position the orthosis against the plantar aspect of the patient's foot to evaluate the fit of the orthosis heel cup and longitudinal arch to the patient's plantar foot morphology. The medial arch of the orthosis should not "gap-away" from the patient's medial arch in order to ensure optimum pronation-controlling ability from the orthosis.

Next, the fit and support of the custom foot orthosis should be evaluated in the weightbearing setting. In order to accomplish this, the custom foot orthoses should be placed on the floor and the patient is then asked to stand on both of the orthoses. During this "Barefoot Standing Orthosis Test", the podiatrist should closely observe whether the medial longitudinal arch of the orthosis closely contours the medial arch of the patient's foot. In addition, the podiatrist should closely observe how much the medial arch of the orthosis collapses under the patient's weight. Ideally, the orthosis medial arch should not flatten more than 2-3 mm under the patient's weight in order to ensure the best "pronation-control" function from the orthosis.

Over my four decades of podiatric practice, one of the leading problems that I have seen with "anti-pronation" custom foot orthoses made by other podiatrists and foot-health clinicians is that orthosis plate/shell is simply too flexible to control excessive foot pronation. The medial arches of these orthoses will not only bend excessively when they are manually tested out of the shoe by the clinician, but will also deform excessively in the medial arch under the patient's body weight during the Barefoot Standing Orthosis Test. Certainly, having a custom foot orthosis that collapses excessively in the medial arch when the patient stands and walks on them does not stand much chance of either improving the patient's symptoms or gait function.

One modification that can be quickly made to an overly-flexible orthosis is to "pack the medial arch" of the orthosis with a relatively non-compressible material such as Korex or ethylene vinyl acetate (EVA). The addition of this non-compressible material to the plantar aspect of the medial arch of the orthosis effectively converts the orthosis from being a "shank-independent" orthosis, where the shank of the shoe does not contact the plantar aspect of the orthosis medial arch, to a "shank-dependent" orthosis, where the Korex or EVA fills in the plantar orthosis arch sufficiently to help limit orthosis medial arch collapse during the patient's activities. In the clinical setting, 1/8" (3 mm) or 1/4" (6 mm) adhesive felt can be used to test whether packing of the orthosis medial arch produces the desired biomechanical effects during gait, with more permanent Korex or EVA filler being glued onto the orthosis plantar arch at a subsequent visit.

Another clinical modification that can be added to a custom foot orthosis to improve the pronation-controlling ability of the custom orthosis and also reduce the patient symptoms is to add a medial shim to the heel cup of the orthosis to simulate an increased amount of medial heel skive in the orthosis (Kirby KA, 1992). A small beveled piece of 1/8" (3 mm) adhesive felt can be adhered to the medial-dorsal aspect of the orthosis heel cup to effectively add increased medial heel skive to the orthosis which, in turn, will help improve the pronation-controlling ability of the orthosis (Fig. 1). By properly assessing the patient's shoes and custom orthoses, these simple in-office modifications can be very effective at improving not only the biomechanical function of the patient's foot and lower extremity, but also greatly improve their pronation-related symptoms.



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