Orthotic Treatment of the Adult Acquired Flatfoot

Here's what you need to know when using FO's and AFO's to treat AAF.

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Editor's Note: *This is the second in a new series of PM articles dedicated to a practical approach to biomechanics—that is, articles that will present biomechanically-focused information that can be used on a day-to-day basis in podiatric practices.*

The adult acquired flatfoot (AAF), also known as posterior tibial tendon dysfunction (PTTD), represents one of the more common and challenging pathologies treated by the podiatric physician.[1] Different than the pediatric flatfoot, AAF is characterized by rupture of the posterior tibial tendon as well as key ligaments supporting the ankle and hindfoot.[2] This lack of integrity of passive and dynamic supporting structures of the foot imposes significant challenge when using orthotic devices to restore alignment, relieve soft tissue strain and hopefully restore mobility to the affected patient.

This article will provide clinical pearls for the podiatric physician when using foot orthoses (FO's) and ankle-foot orthoses (AFO's) to treat adult acquired flatfoot. The primary goal is improving both rearfoot and forefoot position, which will decrease load on damaged soft tissue and articular structures (Figure 1). While most of the recommended treatments have strong scientific foundation, some of the information shared will be based upon the author's own experience treating patients with his own unique designed ankle-foot orthosis, also known as the Richie Brace®.

Examination

Before initiating orthotic therapy for an adult patient presenting with painful flatfoot deformity, the clinician must carry out a thorough exam to confirm the diagnosis and stage the severity of the deformity. Beyond the scope of this article, the details of this examination will have to be found in other articles[3,4] but the essential findings will be summarized:

1) The single foot heel rise test may be the quickest way to determine the level of impairment of the patient with AAF. This test detects an unstable midtarsal joint resulting from spring ligament insufficiency. (Figure 2)

2) Other signs of ligament attenuation are loss of the Hubscher maneuver and a first metatarsal rise when the hindfoot is corrected.

3) Rigidity vs flexibility of deformity will help dictate the choice of an AFO device when treating AAF. If the hindfoot can be manually reduced from a valgus to a rectus position, an articulated (hinged) AFO device is preferred.

4) Gait analysis will demonstrate severity of forefoot abduction, which is a challenge to control with orthotic therapy.

The single foot heel rise test may be the quickest way to determine the level of impairment.

Figure 1: The Adult Acquired Flatfoot is characterized by excessive hindfoot eversion and forefoot abduction.

Choosing the Correct Orthotic Device

The first decision is whether a foot orthotic will achieve treatment goals or whether an ankle-foot orthosis will be required. A secondary decision will be

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choosing between custom or off-the-shelf devices although the AAF almost always requires custom due to the severity of deformity and need for specific modifications as described below.

The difference in biomechanical function between foot orthoses and ankle-foot orthoses has been described in detail in a previous article in *Podiatry Management*.[5] Foot orthoses rely on intact ligaments and stable articular structures of the foot to direct ground reaction forces in a favorable direction. Ankle-foot orthoses can direct ground reaction forces but can also apply force above and below certain key joints of the lower extremity to add further control when tendon and ligament function are lost. With partial or complete rupture of the posterior tibial tendon as well as evidence of ligament attenuation as described previously, an AFO device is recommended over a FO device.

Podiatric physicians often settle into a comfort zone and prescribe the same type of AFO device for every patient they treat with AAF. Falling into this treatment habit would be equivalent to performing the identical surgical procedure for every case of AAF. In short, this condition has various levels of severity which require different types of AFO bracing. As with surgical procedures, preservation of motion of key joints in the ankle and rearfoot complex should be the primary strategy when bracing the AAF.

Figure 2: The single foot heel rise is difficult to perform if not impossible in Stage 2 AAF.

The effects of orthoses on patients with AAF have been well studied in the literature.[6-8] Neville et al found that custom ankle-foot orthoses performed better than prefabricated devices. They also found that an articulating AFO device restored function in stage 2 AAF better than a rigid gauntlet device. Flemeister and Houck warned about the plantar flexion weakness in gait which is found in patients with AAF.[9] Thus, Flemister and Houck concluded "orthoses that restrict ankle motion (solid AFO), while very popular, may induce plantar flexor weakness and increase dependence on the orthosis for support."

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Rigid gauntlet AFO devices are best reserved for treating only late stage AAF where deformity is rigid and non-reducible. For stage 2 AAF where there is available subtalar and ankle motion, articulated AFO devices are preferred and have been documented to be superior to solid devices in restoring alignment and function of the foot during gait.[9]

Casting

Neutral suspension casting for fabrication of custom foot orthotic devices has been the mainstay of podiatric practice for over fifty years.[10] Podiatric biomechanics was developed on a foundation of how correction and improvement of function could occur with a different approach to foot orthotic therapy from what had been accepted in the orthopedic community prior to 1970.[11,12] The unique features of the podiatric "functional foot orthosis" included an impression casting technique which:

1) Captured the foot in a non-weight bearing condition where the subtalar joint was placed in an optimal "neutral" position.

2) At the same time, the midtarsal joint was fully pronated to end range of motion.

3) The shape and alignment of the calcaneus was captured for subsequent bisection and balancing of forefoot-to-rearfoot deformities.

4) The anatomy and plantar contours of the foot were captured and not altered by weight bearing and ground pressure against the negative cast.

The neutral suspension casting technique has stood the test of time, allowing the successful treatment of millions of patients by podiatric physicians implementing custom functional foot orthotic therapy over the past fifty years. Only recently have some podiatric physicians overlooked the unique and effective methodology of podiatric biomechanics and have reverted back to techniques practiced by non-podiatric clinicians which employ weight bearing casting and fabrication of orthotics which do not balance forefoot to rearfoot deformities.

The most essential part of impression casting for FO's and AFO's when treating patients with AAF is reducing acquired forefoot varus deformity, also known as forefoot supinatus. Originally described by Steindler in 1929, this compensatory torsion of the forefoot occurs as the rearfoot pronates or everts.[13] Ground reaction forces cause the forefoot to invert or supinate on the rearfoot. Over time, the ligaments of the medial column attenuate and an acquired forefoot varus or supinatus deformity develops in the AAF. This deformity can be reduced or corrected during the neutral suspension

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casting procedure by pushing down dorsally on the first metatarsal. (Figure 3)

If the forefoot supinatus deformity is not reduced, the impression cast will capture a forefoot varus deformity, which when intrinsically balanced by the fabrication laboratory will cause the forefoot to slide laterally off of the orthotic footplate. At the same time, reducing the forefoot supinatus will restore the natural shape of the medial arch of the foot and provide a more controlling orthotic footplate.

Figure 3: Neutral suspension impression casting with reduction of forefoot supinatus in Stage 2 AAF:

Supinatus preserved Supinatus reduced

Weight bearing and semi-weight bearing impression casts fail to capture the true forefoot to rearfoot relationship and often create a forefoot varus deformity. This was described in a previous article written by the author and Jeff Root, published in *Podiatry Management* in 2007.[14] This study revealed that weight bearing impression casting causes a significant flattening of the heel contour and loss of capture of the true shape of the medial and lateral longitudinal arches. All of these features are critical to control of the flatfoot with foot orthoses and ankle-foot orthoses.

To summarize, the essential key points for negative impression casting for treatment of adult acquired flatfoot are:

1) Use a neutral suspension technique.

2) Reduce forefoot supinatus by pushing down on the first ray.

3) Mold the plaster or fiberglas material tightly to capture the shape of the heel and arch of the foot.

Prescription

The adult acquired flatfoot requires specific modification or enhancement of the standard prescription for fabrication of foot orthoses or ankle-foot orthoses. All of these enhancements are designed to limit hindfoot eversion or valgus rotation, medial and plantar collapse of the talonavicular joint and abduction of the forefoot.

Rearfoot control with a foot orthosis begins with a deep heel cup. For adult acquired flatfoot heel cup depth of 20 to 30 mm is recommended. The standard Richie Brace® incorporates a 35 mm heel cup, which is well tolerated by the patient and causes minimal challenge with shoe fit.

The positive cast can be modified for enhanced control of valgus rotation of the subtalar and ankle joints. Carlson originally described a technique where the positive cast was modified by shaving or removing plaster under the medial side of the calcaneus, extending to the sustentaculum and talo-navicular joint.[16] The result is a change of shape to the heel and midfoot area of the orthotic device where a varus wedge effect is accomplished. Carlson demonstrated how this modification would result in greater supination moment to the subtalar and ankle joints (Figure 4). Later, Kirby described a more detailed and precise technique for modifying the heel cup section of the positive cast using the term "medial heel skive" to again increase supination moment of the orthosis at the subtalar joint.[17] Today, most podiatric foot orthotic laboratories offer medial heel skive modifications to the positive cast. This is also offered as an enhancement on the Richie Brace® when treating AAF.

Severe flatfoot deformity often results in plantar boney prominences along the medial column. Accommodations or "sweet spots" can be provided with the positive cast correction to assure relief from pressure while not affecting the overall contour of the device to the plantar surface of the foot. Precise marking of these anatomic landmarks will accurately transfer to the negative plaster cast or fiberglass cast. This is not possible with computer-generated casts of the foot.

A medial flange is a popular modification of standard foot orthotics and AFO devices to control adult acquired flatfoot. While this modification will provide increased surface area for support of the talonavicular joint, the mechanics of this addition can actually work in a negative fashion

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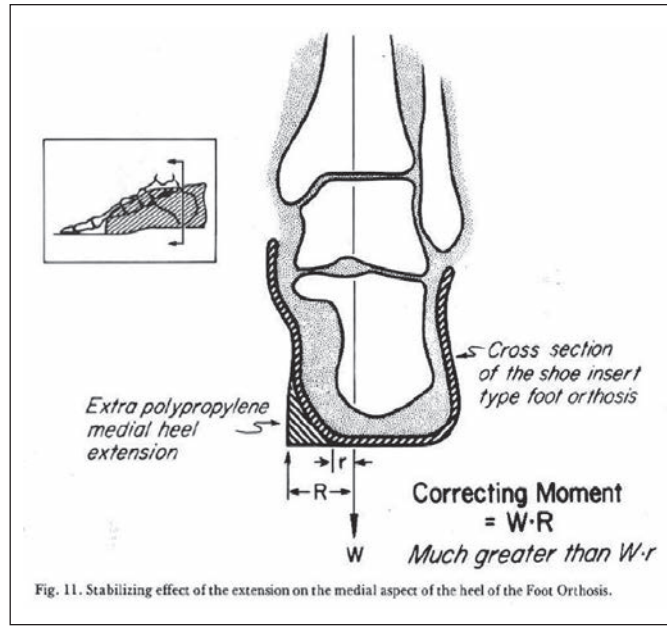

Fig. 11. Stabilizing effect of the extension on the medial aspect of the heel of the Foot Orthosis.

Figure 4: Positive cast and orthotic enhancements for improved pronation control as described by Carlson[15].

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when trying to control the triplane subluxation of the adult acquired flatfoot.

Studies have shown that abduction, particularly of the forefoot, is the dominant motion of subluxation of the AAF. A medial flange, with any inclination upwards from lateral to medial, will create a ramp effect which directs ground reaction forces lateral against the navicular and medial cuneiform. The result can be abduction of the forefoot at the midtarsal joint.

For similar reasons, the application of a lateral flange can provide advantageous pressure against the midfoot and forefoot to prevent abduction. A lateral flange provides a "wall" or block for abduction. This can be a powerful tool to correct alignment and prevent subluxation of the AAF. (Figure 5)

In general, it is recommended to always prescribe a lateral flange to the footplate of the orthosis or AFO device when treating the AAF, and applying a medial flange should be done with caution. Whenever prescribing a medial flange, always add a lateral flange when treating the AAF.

When prescribing extrinsic posting, be wary of using forefoot posts when treating AAF. Many practitioners prescribe a forefoot varus post to foot orthoses, expecting improved control of the flatfoot. Often the forefoot varus post tilts the entire orthotic device into varus and the foot abducts laterally. Improved orthotic control is rarely achieved by forefoot posting of FO's or AFO's when treating flatfoot. The fabrication laboratory should intrinsically balance any forefoot to rearfoot deformity and additional forefoot correction should be avoided.

Conversely, rearfoot posting can have a profound and positive influence in maintaining correction and preventing subluxation of the AAF. An extended, longer rearfoot post has the potential to stiffen the entire footplate which can resist sagittal plane motion of the rearfoot and midfoot A varus rearfoot post can provide enhanced supination moment across the ankle and rearfoot complex.

To summarize, the following prescription features are recommended when treating the AAF with foot orthoses and AFO braces:

1) Deep heel cup: 20-30 mm
2) Medial heel skive: 6mm
3) Lateral flange
4) Extended rearfoot post inverted 2-4 degrees

Whenever prescribing a medial flange, always add a lateral flange when treating the AAF.

Conclusion

Orthotic and ankle-foot orthotic prescription strategies for treating the adult acquired flatfoot are based upon addressing the biomechanics of the disorder. Applying supination moment to the rearfoot complex while preventing forefoot abduction are the primary treatment goals. Success cannot be gained without accurate contour of the footplate of the device to the plantar surface of the foot. Neutral suspension impression casting with intrinsic balancing of the positive cast are critical to achieve optimal control of the orthotic device. **PM**

Figure 5: Using a lateral flange to control forefoot abduction
Patient with Stage 2 AAF with forefoot abduction.

Figure 5: (continued)
Effect of lateral flange to control forefoot abduction.

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