Eight Methods of Improving Orthotic Outcomes

These steps will improve your success rate.

By James Clough, DPM

Orthotic therapy as described by Root, et al. focused on changes in the frontal plane position of both the forefoot and the rearfoot.1 Many researchers have investigated the effects of orthotics on frontal plane motion of the foot and axial rotation of the limb.[2-16] The concept of improving first ray function with orthotic inserts has become popularized over the last few years as sagittal plane biomechanics of the foot structure has been described and appreciated to a degree that historically has not been present.[17-31] The understanding of first ray function and its importance has now been recognized, as witnessed by the number of continuing education presentations and recent research on this topic.

Dr. Hicks30 described the windlass mechanism in the 1950s.It explains very well how passive motion of the first metatarsophalangeal joint functions to stabilize the bone structure of the foot. This mechanism is not dependent on muscle activity, but is dependent on unrestricted range of motion of the first metatarsophalangeal joint for normal dorsiflexion to occur. In a maximally dorsiflexed position of the first metatarsal-phalangeal joint, a close-packed position of the foot structure occurs, providing inherent foot stability, which allows the foot to propel forward normally on a stable platform.[30, 31] When this mechanism is impaired, the ability of the windlass mechanism to provide a closed-packed position of the foot is hampered and this results in a very unstable or loose-packed position of the bone structure30,31 This is not desirable in propulsion, as a stable platform is not provided to propel the body forward for the next step.

A pronated rearfoot is almost always associated with a supinated forefoot.[4,19,33] As the forefoot supinates, the first metatarsal elevates from ground reactive forces, changing the relative position of the axis of the first MTPJ.[33-36] Elevation of the first metatarsal results in decreased motion of the first MTPJ, also known as functional hallux limitus. When this occurs, it can readily be appreciated in the clinical setting that the windlass mechanism fails to stabilize the foot structure in a closed-packed position as described by Hicks.[30]

> ***The understanding of first ray function and its importance has now been recognized.***

Perhaps even more significant is the lack of plantarflexion of the first metatarsal into the ground (necessary for normal dorsiflexion to occur) as motion of the first MPJ is limited.[27,28,31,36,37] This lack of inherent foot stability must be addressed if the orthotic is to assist the foot in doing its job of becoming more closed-packed in propulsion to provide a stable platform for propulsion to occur normally. The orthotic must be capable of controlling the foot in all three phases of the gait cycle to provide optimal therapeutic outcomes. We will look at some options to achieve this.

The data suggests that foot orthotics do work well subjectively for a variety of musculoskeletal complaints; however, in a study looking at long distance runners, there were a large number of people (24.5%) who did not receive benefits from flexible (63%), semi-rigid (23%), or rigid (14%) orthotics. In addition, 13.3% of runners developed a new lower extremity complaint while wearing the foot orthotics.32 There could have been a variety of manufacturing and casting techniques utilized in this large retrospective study. The study points out, however, that the process with which we utilize orthoses needs to be constantly evaluated and improved based on our understanding of foot function and data on the effectiveness of orthoses for a variety of musculoskeletal problems.

The Eight Steps

These eight steps, when incorporated into the orthotic process and prescription, will make the or-

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Figure 1: Dorsiflexion of the hallux results in placing the STJ in neutral position and locking the midtarsal joint in the closed packed position.

thotic a better tool for your patients' mechanical control. When this is achieved, the device will be more effective at controlling the presenting symptoms, and gait efficiency will be improved as foot stability is achieved through propulsion.[31]

Our goal in orthotic therapy should not be to support normal foot function, but to encourage normal foot function by providing a "minimal resistance movement path" as described by Nigg.[39] When foot stability is achieved, it is felt that muscle activity should be minimized to provide proper foot function.[40] It is theorized that this will result in improved clinical outcomes and comfort.[7]

Rule 1: *Place the STJ in neutral position.*

When casting for orthotics, always make certain the STJ is in neutral position and the midfoot is locked.[1] Subtalar neutral position can be determined by feeling for talar congruity at the anterior ankle as described by Smith.[48] While there is research to indicate that the foot functions near its resting stance position,[49] casting in this manner will optimize the contour of the medial longitudinal arch and provide for better support of the mid-foot, a

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critical element of a custom device.

A good and simple way of achieving this is by dorsiflexing the hallux as you take the cast (Figure 1). You will also put the STJ in neutral position by doing this (Figures 2 and 3).

Exception to Rule 1: STJ is not able to move from tarsal coalition or surgical fusion.

Rule 2: *Reduce the forefoot supinated or inverted position.*

In addition to placing the STJ in neutral position, plantarflexion of the first ray is achieved by dorsiflexing the hallux—this reduces any forefoot supination in the cast (Figures 4 and 5). The object here is to create a position in the cast where the bisection of the calcaneus is perpendicular to the plane of the forefoot. It is critical to reduce any elevation of the first ray as this will restrict proper range of motion of the first MTPJ, delaying the engagement of the windlass mechanism.[2] A forefoot varus post is contraindicated for this same reason. When obtaining a cast in this manner, the need for a forefoot post is eliminated.

Exception to Rule 2: The forefoot inverted position is not able to be reduced, or is rigid.

Figure 2: The foot in resting calcaneal stance position

Figure 3: The foot in neutral calcaneal stance position as a result of dorsiflexing the hallux.

Rule 3: *Enhance first ray function and the function of the windlass mechanism.*

The first MTPJ needs to move to allow the windlass mechanism to work well and provide for proper foot stability during

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propulsion. A forefoot varus post (Figure 6) is contra-indicated and may actually decrease mobility of the first MTPJ in dorsiflexion.[41,42] An inverted orthotic does not have a significant impact on improving first MTPJ motion.[43]

Orthotic modifications to allow better mobility of the first MTPJ include the Cluffy wedge™ (Figures 7 and 8), reverse Morton's extension, kinetic wedge, and first ray cut-out (Figure 9). Proper casting can also have a beneficial effect on first MTPJ motion.[37] When the first metatarsal is allowed to plantarflex into the device, and the device does not restrict this, first MTPJ motion will be enhanced.[42] Of all the modifications, only the Cluffy wedge™ allows increased first MTPJ dorsiflexion while not decreasing pressures by putting a cutout under the first metatarsal head.[28] It is important for the first metatarsal head to bear weight in propulsion to allow supination and external limb rotation to occur at toe-off and during swing.[47] When a cutout is applied to the first metatarsal head, the net effect is to move the medial arm of tripod support more lateral, allowing more pronation in late midstance (Figure 10).

Figure 4: A supinated forefoot position is appreciated.

Figure 5: The forefoot supination has been reduced with dorsiflexion of the hallux.

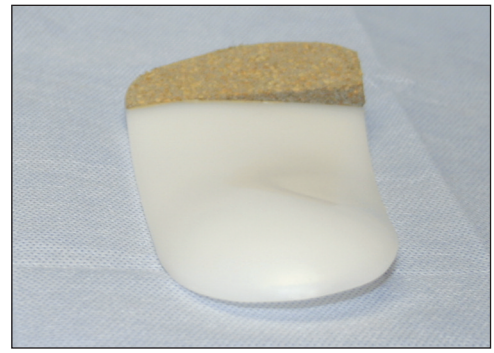

Figure 6: A forefoot post is not necessary and can decrease motion of the first MTPJ.

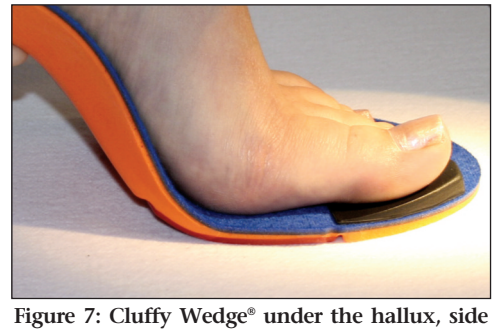

Figure 7: Cluffy Wedge® under the hallux, side view.

Exception to Rule 3: There is no or limited first MTPJ motion and you wish to limit this further, then Rule 3 does not apply.

Rule 4: *Make sure the orthotic interfaces well with the shoe.*

If the shoe is not allowing the orthotic to sit on a flat surface, or is pushed forward too much by a curved heel posteriorly, the orthotic will not only function incorrectly, but will be extremely uncomfortable for the patient. Take time to grind heel posts, if necessary, (Figure 11) and do other modifications as needed to assure that the orthotic and shoe work in tandem (Figure 12). A shoe with poor heel counter support (Figure 13) and too much rigidity in the forefoot (Fig. 14) will have adverse effects on foot function by impeding motion of the forefoot.

Exception to Rule 4: The orthotic is made as an integral part of the shoe.

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Rule 5: *Provide gait training.*

Patients often present with compensatory strategies secondary to abnormal gait mechanics.[45] Functional hallux limitus is one of the most common disorders creating significant compensatory patterns. Once this is overcome with proper orthotics, which allows the first MTPJ to move unrestricted with proper casting technique and addresses the proper function of the first ray with appropriate modifications, your patient still may not necessarily walk normally.

It is often necessary to have a trained therapist or experienced foot specialist work with these individuals to establish a more normal walking pattern. The hip flexors oftentimes become tight, as well as the Achilles tendon, from a common compensatory gait strategy of early knee and hip flexion as a result of functional hallux limitus. Other patients may need work on

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Figure 8: Position of the Cluffy Wedge® on top of the insole.

Figure 9: Reverse Mortons extension and first ray cutout respectively.

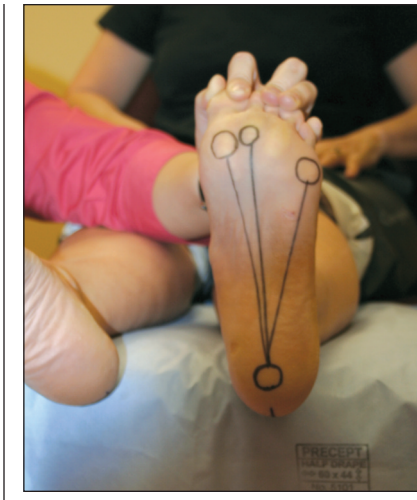

Figure 10: The tripod base of support is altered as the medial arm is moved lateral, which lessens the ability of the foot to resist pronatory forces.

Figure 11: Grinding of the heel posts may be necessary to maximize shoe fit with the orthotic.

Figure 12: Insoles should be modified to allow the orthotic to sit back in the heel counter well.

Figure 13: A shoe with poor rearfoot stability

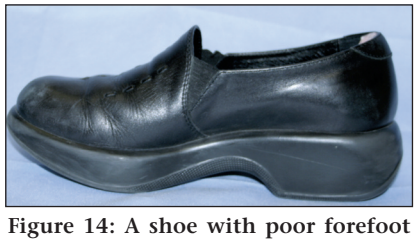

Figure 14: A shoe with poor forefoot flexibility

using the hallux and engaging the high gear propulsion described by Bojsen-Moller.[31] This may involve working on the angle of the foot to the line of progression. The overall object here is to establish the three rockers of normal gait as described by Perry in her book on gait analysis.[50] Once these patients start to set a new neuromuscular pathway with their improved gait this becomes a new pattern, requiring no further conscious effort. Focal therapy on selected muscle groups that are tight or weak is just as essential and cannot be minimized in the treatment program.

Exception to Rule 5: None. Always evaluate the gait pattern of your client after dispensing the orthosis and address key issues.

Rule 6:

Use minimal fill on your prescriptions.

An orthotic that contours the foot better will provide better support of the plantar fascia and decrease tension through the fascia (Figure

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15).[46] The materials can be softened to create more give to the device when needed, based on the stability of the foot structure. Excessive padding is rarely needed and becomes a maintenance issue down the line. Allow accommodations for boney prominences. A plantar fascial groove will be unnecessary when dorsiflexing the hallux during the casting procedure as the plantar fascia tension will create a natural groove in the orthotic device. Consider a Richie brace AFO (Figure 16) or gauntlet bracing for the more severe foot deformities and when rearfoot instability is significant. An orthotic in these situations is never comfortable as the foot cannot react to the orthotic normally and will continue to pronate through the device.

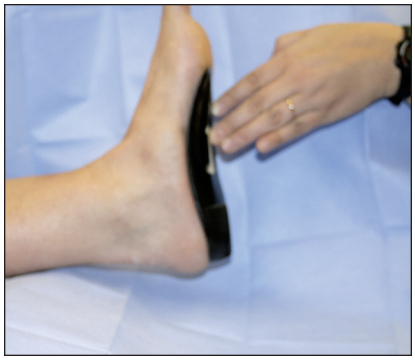

Figure 15: The orthotic should contour the foot well with the hallux dorsiflexed.

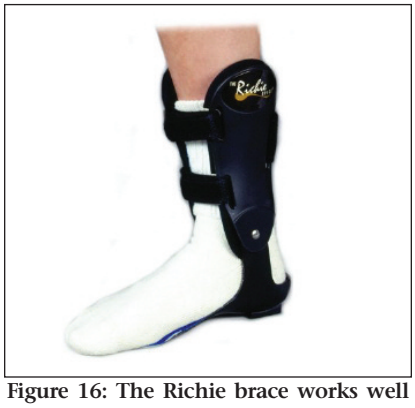

Figure 16: The Richie brace works well with severe rearfoot instability.

Exception to Rule 6: The medial longitudinal arch lacks structural integrity and collapses into the support, often the result of a long-standing deformity.

Rule 7: *Consider an AFO when foot stability is poor.*

Consider a Richie brace AFO (Figure 16) or gauntlet bracing for more severe foot deformities and when rearfoot instability is significant. An orthotic in these situations is never comfortable as the foot cannot react to the orthotic normally and will continue to pronate through the device.

Exception to Rule 7: Surgical correction is a more practical decision.

Rule 8: *Refer when necessary.*

Refer when necessary. Some problems simply will not respond well to conservative care and referral to a surgical specialist needs to be considered in recalcitrant cases. Recognize the limitations of functional orthotics, and you will be better prepared for successful outcomes and have a happier patient who is more likely to be a referral source for additional friends with sore feet.

Exception to rule 8: None.

Conclusion

Orthotic therapy has proved to be a valuable clinical tool for treatment of a number of foot and lower extremity problems. When casting is done properly, the orthotic should enhance normal foot function. Newer technologies to orthotic therapy, such as the Cluffy wedge™, should make orthotics more effective in many clinical situations, while our quest to both identify and treat abnormal foot function continues.

A pronated rearfoot is almost always associated with a supinated forefoot.

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