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Indications for the Use of Functional Orthoses

By Merton L. Root, D.P.M.

In this paper, I will first list the indications for the use of functional orthoses, and then discuss each indication briefly to further define those indications. To satisfy these different indications, the functional orthosis must be modified by the laboratory in accordance with a doctor's prescription. The prescription is based upon the doctor's examination that determines what pathology is present, upon his awareness of variances available in the construction of functional orthoses, and finally upon his comprehension of mechanics and his judgement of what prescription variances are necessary to achieve a result with a patient's specific pathology. Furthermore, a suitable set of negative casts must be sent to the laboratory.

The functional orthosis, with its many modifications, may be used to:

1. *Support forefoot deformity that, without support, adversely forces the rearfoot to function abnormally during the stance phase of gait.*
2. *Resist abnormal forces from the leg that are supported by the rearfoot either more medial or lateral than the normal centralized support of extrinsic forces by the calcaneus.*
3. *Move the calcaneus to a slightly inverted position at heel strike when the calcaneus is in an everted or excessively inverted position in the final stage of the swing phase of gait.*
4. *Provide enough subtalar joint pronation at heel strike to initiate normal absorption of the shock associated with heel strike.*
5. *Provide enough transverse leg rotation during the stance phase of gait to prevent immobilization of the hip or abnormal torque at the knee.*
6. *Resist postural instability caused by some congenital osseous deformities of the foot.*
7. *Treat those postural problems that are caused by foot malfunction.*
8. *Immobilize the subtalar-midtarsal joint complex during the contact and midstance periods of the stance phase of gait to treat certain pathological conditions of the foot.*
9. *Resist further subluxation of the foot in some conditions when abnormal pronation of the foot cannot be prevented.*

THE SUPPORT OF FOREFOOT DEFORMITIES

Various deformities of the forefoot can cause the plantar forefoot plane to be either inverted or everted relative to the plantar plane of the heel.

An inverted forefoot deformity creates inequality between ground reaction forces directed upward against the medial and lateral sides of the forefoot when the calcaneus is vertical. Ground reaction force against the lateral forefoot exceeds the force against the medial forefoot. Ground reaction forces the forefoot to evert. The forefoot normally cannot evert relative to the rearfoot at the midtarsal joint when the foot bears weight; so forefoot eversion also everts the heel by subtalar joint pronation. Whenever a foot with a congenital inverted osseous deformity bears weight, ground reaction force against the lateral forefoot maintains the entire foot in a pronated position at the subtalar joint.

An everted forefoot deformity also causes an inequality between ground reaction forces acting on the medial and lateral sides of the forefoot, when the heel is vertical. With everted forefoot deformities, however, ground reaction force against the medial forefoot exceeds the force directed upward against the lateral forefoot. Ground reaction force inverts the forefoot and may or may not invert the heel, depending upon the size of the everted forefoot deformity and the range of motion (inversion with supination) at the longitudinal axis of the midtarsal joint. Longitudinal axis supination inverts the forefoot relative to the rearfoot about 6° on the average, but may vary from no range of motion to much more than 6°. During stance, a small amount of everted forefoot deformity will adversely supinate the rearfoot if the longitudinal midtarsal joint axis has little or no motion; or a fairly large everted forefoot deformity may be fully compensated at the longitudinal axis that provides a range of inversion. If the midtarsal joint cannot fully compensate an everted forefoot deformity, rearfoot inversion occurs as the subtalar joint supinates with the inversion force at the forefoot. This supination of the rearfoot may later cause further midtarsal joint supination leading to a Shaffer's Foot deformity. A fully compensated everted forefoot deformity does not adversely affect position of the rearfoot until heel lift occurs to initiate propulsion. In that event, the rearfoot inverts at the midtarsal joint at heel lift, causing lateral postural instability. To prevent excessive lateral instability, the patient learns to abnormally pronate the foot at heel lift.

To prevent retrograde force from the forefoot to rearfoot with either the inverted or everted forefoot deformities, the forefoot must be supported in its fully deformed position of either inversion or eversion by a functional orthosis.

The inverted forefoot deformities are forefoot varus, forefoot supinatus, congenital plantarflexed 5th ray, congenital plantarflexed 4th ray, or a plantarflexed cuboid that causes plantarflexed deformity of both the 4th and 5th rays. The deformity is supported by adding plaster under the 1st metatarsal head of the cast until the sagittal bisection of the heel of the cast is vertical while the cast rests on its plantar surface on a level table.

The everted forefoot deformities are forefoot valgus, congenital plantarflexed 1st ray, acquired plantarflexed 1st ray, and a congenital plantarflexed 2nd ray. The cast is balanced for one of these deformities by adding plaster under the 5th metatarsal head until the heel is vertical.

Elevatus deformities of the 1st or 5th rays require special cast balancing techniques, as do certain combinations of forefoot deformities.

Supporting a forefoot deformity is only effective when the deformity is supported in its entirety, so no abnormal retrograde force passes from the forefoot to cause rearfoot malfunction. When only part of a forefoot deformity is supported, the foot will slide off a functional orthosis, and the orthosis may be uncomfortable or cause further malfunction of the foot.

EXTRINSIC FORCES ACTING ON THE FOOT

The normal functioning foot supports forces from outside the foot, so that the average distribution of those forces falls just medial to the mid-saggital plane of the calcaneus during static stance.

During locomotion, at heel strike, extrinsic forces are supported slightly lateral to the center of the calcaneus because the normal foot is slightly supinated at the subtalar joint at heel strike. Wear pattern on the posterior aspect of the heel illustrates the average distribution of extrinsic forces through the heel. Normal heel wear pattern averages slightly off center in a lateral direction.

Abnormal medial distribution of extrinsic forces is indicated by a more medial heel wear pattern, and abnormal lateral distribution of extrinsic forces is indicated by a more lateral heel wear pattern.

Abnormal medial distribution of forces is caused by abnormal pronation of the foot, external or internal femoral torsion, external or internal malleolar torsion, rearfoot valgus, tibial valgum, rearfoot pronatus (peroneal spastic flatfoot), and excessive verticality of the oblique axis of the midtarsal joint. Numerous neuromuscular diseases and conditions can also cause abnormal medial distribution of extrinsic forces through the heel.

Abnormal lateral distribution of extrinsic forces through the heel caused by uncompensated or partially compensated rearfoot varus, including the tibial varum element. Rearfoot supinatus associated with everted forefoot deformity or supinatory muscle spasm (neuromuscular conditions or diseases) also cause lateral distribution of extrinsic forces.

To resist medial distribution of extrinsic forces, the functional orthosis must be made with a heel cup that is higher than average on the medial side and lower than average on the lateral side. A rearfoot post must be used, and the post may also need to be flared medially or be longer than average in the more extreme cases. The variance in heel cup height actually shifts the rearfoot post medialward to better resist the medial distribution of extrinsic forces. Medial distribution of forces in the heel causes abnormal subtalar joint pronation, and normal foot function cannot occur without resisting those abnormal forces.

To resist lateral distribution of extrinsic forces, the orthosis needs a high lateral heel cup and a low medial heel cup with a rearfoot post. A lateral post flare is also required. Lateral distribution of extrinsic forces causes lateral postural instability, and the primary purpose for using an orthosis is to improve postural stability during locomotion.

POSITIONING THE HEEL AT HEEL STRIKE

Various pathological conditions result in a foot being held in either a pronated position or an excessively supinated position just before heel strike. The rearfoot post of the functional orthosis guides the foot to a more normal position at heel strike; so weight transmission through the foot follows a more normal pattern. The inverted posting position determines the initial position that heel will assume at heel strike.

SHOCK ABSORPTION

The shock of heel strike is normally absorbed by subtalar joint pronation, knee flexion and hip flexion. Pronation of the foot is necessary to rapidly unlock the knee in both the transverse and sagittal planes, so the knee and hip can flex quickly. Regardless of the position of the heel at heel strike, active eversion of the heel must occur to absorb shock. The motion of pronation at the subtalar joint is necessary for shock absorption. If the foot is held during swing phase in its fully pronated position, the rearfoot post initially moves the heel into an inverted position as it first strikes, and then the motion ground into the post allows the calcaneus to evert by the amount of motion provided in the post. It is this calcaneal eversion, created by the rearfoot post, that provides shock absorption in a foot that failed to absorb shock because of an abnormally pronated position of the foot during swing. When the subtalar joint is fused, either naturally (synostosis) or by surgery (arthrodesis), no motion is available at the subtalar joint and no orthosis can provide motion to absorb shock.

TRANSVERSE LEG ROTATION

Normal locomotion requires that the tibia internally rotates during the contact period of the stance phase of gait, and externally rotates during the midstance and propulsive periods.

Foot pathology frequently immobilizes the tibia when it should be rotating. If the femur is attempting to rotate as is necessary for normal locomotion, but the tibia cannot rotate, abnormal torque is developed at the knee (causing ligamentous strain) and the hip stops rotating. Such an immobilized hip depresses arm swing and shoulder girdle function on the opposite side, thus reducing locomotor efficiency.

Just one example (forefoot varus) will illustrate the tibial immobilizing affect of foot pathology. The eversion force of ground reaction against the lateral forefoot while bearing weight causes a foot with significant forefoot varus to be held in a fully pronated position. A foot normally begins to supinate out of its pronated position and the leg begins to externally rotate at the beginning of and throughout the midstance period. The eversion retrograde force from a forefoot with a varus deformity will hold the rearfoot in a pronated position and will not allow supination or external leg rotation to occur. The tibia is immobilized until heel lift, when external leg rotation can occur by supination of the oblique midtarsal joint axis. Midstance immobilization is common with many types of deformities that hold the subtalar joint rigidly in a pronated position.

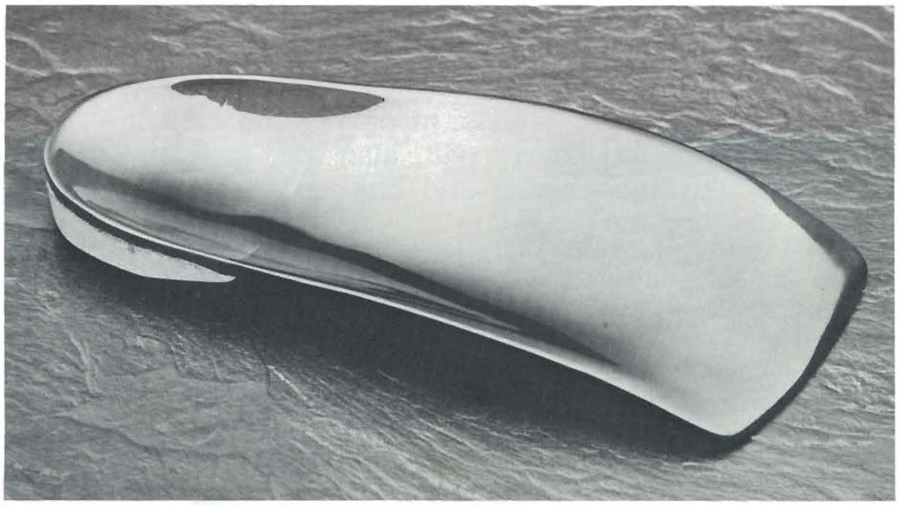
A rearfoot post on a functional orthosis can also immobilize the tibia if no motion of calcaneal eversion is provided by properly grinding the post. In some individuals, the sagittal inclination of the subtalar joint axis is very high, and in other patients, it is very low. The amount of post motion needs to be varied when prescribing a rearfoot post for these anatomical variances. The amount of motion provided needs to be decreased from average when an excessively high pitched subtalar joint axis is present, and increased when a low pitched subtalar joint axis is present.

SUMMARY

Unfortunately, the limitation of space prevents a complete discussion of all the indications for the use of functional orthoses. It is important to emphasize that not all foot pathology can be effectively treated with functional orthoses. Some abnormal forces cannot be resisted by any device confined within the margins of a shoe. Fortunately, the cases that cannot be treated with orthoses, even though the forces causing malfunction are mechanical in nature, probably represent less than ten percent of the mechanical pathology that a podiatrist sees.

It should also be pointed out in this conclusion, that there are some things a functional orthosis is not designed to do. A functional orthosis does not, and should not, support the arch of the foot. A functional orthosis should not extend medially under the 1st ray, as it would prevent normal 1st ray plantarflexion during propulsion. A functional orthosis does not depend on high medial or lateral phlanges to control the foot. The foot is controlled only by the plantar contour and rearfoot posting when using functional orthoses. Accommodations of lesions and painful soft tissue caused by abnormal osseous shearing is unnecessary when using functional orthoses. The functional orthoses are designed to eliminate the cause (shearing of bone against soft tissue) rather than to accommodate symptoms.

In answer to many questions, Dr. Merton Root is not a consultant and is not in any way connected with Podiatry Arts Lab. His articles are written to inform the professional about the use of functional orthoses as a means of treating mechanical problems of the foot.



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