

Foot Orthoses in Sports Medicine

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Annotation: In today's age of sports medicine, there is real focus on biomechanics, proprioception, and kinesthetic awareness. This facilitates prevention and treatment of foot and ankle as well as more proximal injuries, and has led to an increase in the use of foot orthoses. Competitive and recreational leg-based sports frequently require orthosis to enable the foot plane to more efficiently direct load up the extremity. Its uses, described here, can be both preventive and therapeutic. This article will address the clinical success, efficacy, and indications for foot orthoses in sports medicine.

A foot orthosis (orthotic) is a device inserted inside the shoe to assist in accomplishing a certain goal in prevention and/or rehabilitation of injury. It helps to support, prevent, or correct deformities and improve function. Other terms are used to describe orthoses, such as inserts, arch supports, and insoles. Prefabricated or custom-made orthoses are available to the athlete in a variety of options. Moreover, an orthotic is only as good as the shoe in which it has been placed. Proper shoe selection and fit, in fact, are essential to all aspects of sport and activity. Over the counter (OTC) orthoses are often used to give an indication whether more expensive customized orthoses will further benefit the athlete.

There are several health care professionals that can and do fabricate foot orthoses: physicians (podiatry, orthopaedic, primary care sports medicine), physical therapists, athletic trainers, orthotists, and pedorthists (CPeds). Pedorthics is the design, manufacture, modification, and fit of footwear, including foot orthoses, to alleviate foot problems caused by disease, overuse, congenital defect, or injury.¹ Physicians most often prescribe orthoses to assist in the rehabilitation and recovery process. Yet orthoses should be realized as just one component of the rehabilitation process that can help return an athlete back to his or her preexisting level of performance or recreation.

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Common Athletic Injuries and the Role of Foot Orthotics

Foot orthoses are commonly prescribed as an intervention for treating lower extremity musculoskeletal pathology.²

There is limited knowledge about the specific functioning an orthotic provides.^{3,4} There is evidence that they do reduce and/or prevent movement-related injuries,^{3,5} while assisting the shoe in producing a more "effortless" gait. These aspects can assist acutely after surgery and in the rehabilitation process to minimize excessive muscle work and help protect joints involved. Though the benefit of foot orthoses is clinically unquestioned, specific research results vary. More longitudinal controlled studies are needed.

General objectives of foot orthoses are to provide cushioning, control, and support. Below are listed several more specific objectives of orthosis use. There is some degree of functional overlap between objectives.

Assessment, Design, and Fabrication

Assessment

Before orthoses are prescribed and fitted, an extensive assessment/evaluation of the lower extremities (particularly the foot and ankle), biomechanics, gait, and posture is performed. The hindfoot, midfoot, and forefoot are inspected in the open and closed kinetic chain postures. Mobility of the first ray is also examined. Conditions and compensatory movements are noted as they relate to the subtalar joint "neutral position". This subtalar "neutral position" is believed to be a better functioning position for the foot for walking. Gait is assessed for hyperpronation or supination. The feet and ankles are also assessed to determine if a flexible/functional foot exists (as is found in most athletes), or if a more rigid, less adaptable foot and/or ankle deformities are present. Generally, an orthosis will be designed to "control" a functional foot and accommodate or cushion a fixed/rigid foot.

Methods of impression

The design of an orthosis can range from a simple soft flexible insert to a more complex, rigid device. After a thorough evaluation is performed, a method of impression (blueprint) of the athlete's feet must be chosen. This impression, when done correctly, will yield an exact mold of the athlete's foot in a neutral, more functional position, and will allow orthotic materials to be chosen and molded to that impres-

sion, producing a custom fit. The following are options for making impressions of the feet to fabricate a pair of orthoses:

- *Foam impressions:* A crushable foam box, semi-weight-bearing, most popular (Fig. 1).
- *Plaster casting (slipper cast):* Traditional, nonweight bearing, allows for more control in positioning the foot.
- *Wax impressions:* Produces a more clean/clear impression when needed.
- *CAD-CAM (Computer-Aided Design/Computer-Aided Manufacture):* New, a digitized computer image of the foot

Material selection

Material selection is an important factor in the fabrication of an orthosis. Materials are divided into 3 categories:^{2,6}

- *Soft:* Polyethylene foams are most common, primarily the shell of an orthotic, accommodating.
- *Semirigid:* Leather and cork (cork is usually combined with plastic compounds to make them moldable when heated).
- *Rigid:* Acrylic plastics and thermo plastic polymers, primary functional, most durable and supportive.

Most of the materials selected for athletic conditions are semirigid to rigid, with the intent to provide more functionality and support. Softer materials tend to “bottom out” and break down quickly from the amount of athletic activity, therefore significantly reducing the life of the orthosis. A semirigid device usually contains a degree of all three categories, with a soft yet more durable shell, a middle supportive layer that keeps its shape and does not bottom out quickly, and a cork or thermoplastic base that can be adjusted to fit the athlete’s needs. Prefabricated materials and OTC options are also available to the athlete. OTC orthotics may give the athlete some symptomatic relief, though often temporary, and can be more cost-effective.

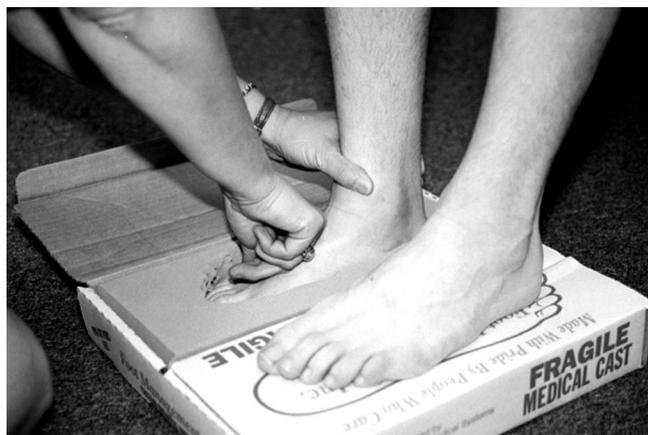


Fig. 1 A crushable foam box is one option for making impressions of the feet to fabricate a pair of orthoses.

Fabrication

Once the materials are chosen and molded from the impression of the athlete’s foot, many options are available to “fit” and adjust the orthotics to meet the goal(s) laid out from the assessment. Posting, or material added to the orthotic, can produce specialized aspects, such as medial or lateral wedging (hindfoot and/or forefoot), heel lifts, metatarsal pads, and first ray cutouts. The orthotic is then finished using a grinder as shown in Figure 2.

Indication and Application of Foot Orthoses in Sports Medicine

A flat, pes planus (low-arched) type foot which often hyperpronates is a loose, hypermobile foot susceptible to foot fatigue and overuse injuries, (ie, posterior tibial and/or Achilles tendonitis). A pes cavus, high-arched type foot is a tight, rigid, often inflexible type foot that can hypersupinate and is susceptible to stress fractures, and metatarsalgia, because of the decreased ability to absorb shock. Any injury can easily occur in either foot type, but it is good to understand certain relationships and trends in foot type and injury susceptibility. Proper shoe selection and fit should include a removable insole to allow adequate depth for the orthotic, a firm heel counter, adequate forefoot and toe room, and proper midfoot support. The following are possible pedorthic options for common athletic injuries discussed earlier.

Common Athletic Injuries of the Midfoot and Hindfoot

Plantar fasciitis/heel pain syndrome

Plantar fasciitis and heel pain are common. Pes planus type feet that hyperpronate are predisposed to plantar fasciitis. Pedorthic objectives include:

- Supporting the longitudinal arch.
- Cushioning the heel (usual symptoms at the insertion of the fascia).



Fig. 2 A grinder is used to complete an orthotic.

- Reducing pronatory forces.

This can be accomplished with a multilayered, total contact orthosis with adequate arch support, and possibly a medial hindfoot “wedge”, and/or a medial forefoot post to address hyperpronation. A cavus, high-arched foot can also have plantar fasciitis. Therefore, orthoses for these athletes should address arch support, yet with additional shock absorption.²

Achilles tendonitis

Hyperpronation (especially in the forefoot) can increase stress on the Achilles tendon.² A cavus foot that is less flexible can contribute to Achilles tendonitis. Pedorthic objectives include limiting dorsiflexion forces and reducing pronatory forces. A total contact orthosis with arch support, wedges and posting as needed, and a heel lift approximately 1/8th of an inch in height will decrease stress on the Achilles and assist in the resolution of the overuse tendonitis.

Posterior tibial tendonitis/shin splint pain (PTSS)

The posterior tibialis is the major inverter of the foot and a minor plantar flexor of the ankle. It inverts the foot and pulls it into supination for regaining the “rigid lever arm” needed for toe-off in walking or running gait. Hyperpronation and a pes planus foot contribute to weakness and strain in the posterior tibialis tendon and other medial structures. This leads to overuse injuries such as tendonitis and “shin splints” or posterior tibial stress syndrome (PTSS). Pedorthic objectives include longitudinal arch support and reduction of pronation forces. A semirigid or rigid orthosis (for more support of severe cases) with wedging and/or medial forefoot posting as needed has been shown to work well in these conditions.² A more advanced orthosis with a vertical medial buttress may be required along with referral to a foot and ankle specialist in sports medicine.

Midfoot strains/sprains and recurrent ankle sprains

Pedorthic management of these conditions include proper support of midfoot structures such as the Lisfranc joint and midtarsal articulations. These tend to be overlooked. There is extensive research and focus into the mechanism(s) of recurrent ankle sprains and chronic ankle instability. Predisposing factors could possibly be peroneal tendon dysfunction, biomechanical issues within the hind-, mid-, and/or forefoot). Foot orthoses are used within this spectrum, with favorable results.⁷ The “high sprain”—a more serious eversion/external rotation ankle injury—is commonly missed. Orthoses play a part in its rehabilitation as well.

Common Athletic Injuries of the Forefoot

Turf toe/Morton foot/toe

Turf toe is considered an acute or chronic sprain of the plantar capsule of the first metatarsalphalangeal (MTP) joint.

Pedorthic objectives include reduction of the first MTP joint extension, cushion, and protection of that joint, and redistribution of forefoot pressures. A total contact orthosis with a carbon fiber or plastic footplate will attempt to limit MTP extension while a metatarsal pad or bar placed proximal to the metatarsal head(s) with selective materials can cushion, protect, and redistribute plantar pressures.

Morton foot is a condition that includes a significantly shorter first metatarsal in relation to the second metatarsal. It also includes a hypermobile cuneiform first metatarsal joint and retrocessed sesamoids. This condition can contribute to a variety of injuries because the first metatarsal is often hypermobile, and is not allowed to bear its share of weight (which should be considerably more than the other four metatarsals, relatively one half of the forefoot’s weight-bearing responsibilities). The longer second metatarsal will bear more weight than is intended, which can contribute to, among other injuries, stress fractures and metatarsophalangeal synovitis (which are discussed below). A Morton extension can be incorporated into an orthotic by way of a specialized foot plate or fabricated out of cork or similar material (Fig. 3). This device is employed in an attempt to help the shorter first metatarsal bear more of its share of weight and force, and redistribute pressure.



Fig. 3 An orthotic formed from a Morton extension by way of a specialized foot plate or placement of cork-like material.

Stress fractures/metatarsalgia/sesamoid pain

Stress fractures are common. The second and fifth (Jones fracture) are the most common metatarsal fractures. The navicular, sesamoids, and calcaneus are also susceptible. Pedorthic objectives are redistribution of forefoot pressures, reduction of the “bending” stress of the metatarsal(s), alignment of the first ray, and addressing biomechanical abnormalities. These objectives can be met with a semirigid orthosis incorporating a metatarsal bar or pad, a foot plate to reduce the bending stress, and appropriate wedging and/or posting of the forefoot. A section of the orthotic can be excavated at the site of the stress fracture and filled with a softer material (a viscoelastic polymer) to assist with pain and discomfort.

Metatarsalgia, like “shin splints”, is an all-encompassing



Fig. 4 A metatarsal pad used to aid in pain occurring under the metatarsal head.

term used for pain under the metatarsal head(s), or “pain in the ball of the foot”. Objectives are generally the same as above. A metatarsal pad is usually placed proximal to the painful metatarsal head (Fig. 4), or a metatarsal bar can be used when more than one is painful. MTP synovitis is usually associated with this problem.

Other injuries in which foot orthoses may be indicated

Addressing the biomechanical chain when evaluating injuries is essential to a complete, definitive diagnosis and plan of care, especially with lower extremity and axial musculoskeletal injuries. Foot orthoses can decrease pain associated with patellar-femoral pain syndrome (addressing genu valgum and hyperpronation) and low back pain.² Genu valgum, scoliosis, leg length discrepancy, torsion problems, and injury itself are factors to consider.

Conclusion

Foot orthoses are commonly needed. They often play important roles in athletic injury prevention, recovery, and rehabilitation. The perceived benefits and evidence that orthotics reduce and prevent movement-related injuries need more basic biomechanical research. Unequivocally, their usage is appropriate and integral in solving most overuse and acute sports injury problems.

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In the End, we will remember not the words of our enemies, but the silence of our friends.

—Martin Luther King Jr.