# Chapter 13
# Ankle Foot Orthoses for the Athlete

**Douglas H. Richie**

Ankle braces have emerged as a standard therapeutic modality in the treatment of the athlete. Over the past 30 years, more research has been published studying the treatment effects of ankle braces than any research on foot inserts or foot orthoses. Still, there remain many misconceptions and questions about the use of bracing of the athlete. This chapter provides an overview of the types, indications, and effects of braces used in the lower extremity.

## Terminology

An *orthosis* is an apparatus used to support, align, prevent, or correct deformities or to improve the function of movable parts of the body [1]. The term *brace* is essentially synonymous with orthosis. The term *orthotic* is an adjective, i.e., "orthotic therapy" or "orthotic device." Yet, today most dictionaries list both an adjective and a noun usage of the term *orthotic* and consider an orthotic to be synonymous with the term *orthosis*.

An ankle foot orthosis (AFO) is any orthosis that covers the foot, spans the ankle joint, and covers the lower leg [2]. Thus, many popular ankle braces in use today would not qualify as true ankle foot orthoses simply because they do not cover a significant area of the foot.

Thus, for this chapter, the term *ankle foot orthosis* applies to the preceding definition, whereas the term *ankle brace* is used to describe an orthosis that covers a portion of the leg and spans the ankle joint, but that does not cover or support a substantial portion of the foot. The term *prophylactic ankle stabilizer* (PAS) is also found in the medical literature and should be considered synonymous with the term *ankle brace*.

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## Types of Ankle Braces and Ankle Foot Orthoses

Ankle braces fall into three general categories. *Lace-up or gauntlet style braces* are usually made of canvas or nylon material (Fig. 13.1). Additional stabilizers made of metal or plastic are often provided which can be added to special pockets in the medial or lateral side of the gauntlet. *Stirrup ankle braces* are comprised of semirigid plastic uprights which are oriented along the distal fibula and tibia and extend across the ankle joint to the medial and lateral aspect of the body of the calcaneus (Fig. 13.2). Thus, stirrup ankle braces are also commonly referred to as *semirigid ankle braces*. The uprights are usually connected by a nylon strap which extends under the heel. The leg portion of the uprights is secured with Velcro straps in multiple locations. The limb uprights are usually padded with air bladder, gel bladder, or foam material. Stirrup style ankle braces can also be custom fabricated from plaster or other moldable materials for short-term use by the athlete.

A newer variation of the standard ankle stirrup brace is the *articulated stirrup brace*. Here a hinge connects a foot plate to the limb uprights at the level of the ankle joint (Fig. 13.3). The foot plate of an articulated stirrup ankle brace does not cover a substantial portion of the foot, usually extending from the heel to the proximal arch.

Ankle foot orthoses can take the form of both a custom and a non-custom (pre-fabricated) device. There are pre-fabricated AFOs gaining popularity for use in a non-ambulatory setting known as *night splints*. These devices are primarily used to prevent contracture of the gastrocnemius–soleus or the plantar aponeurosis during sleep.

Ambulatory ankle foot orthoses can take the form of both a custom and a non-custom (pre-fabricated) device. Pre-fabricated ankle foot orthoses include walking

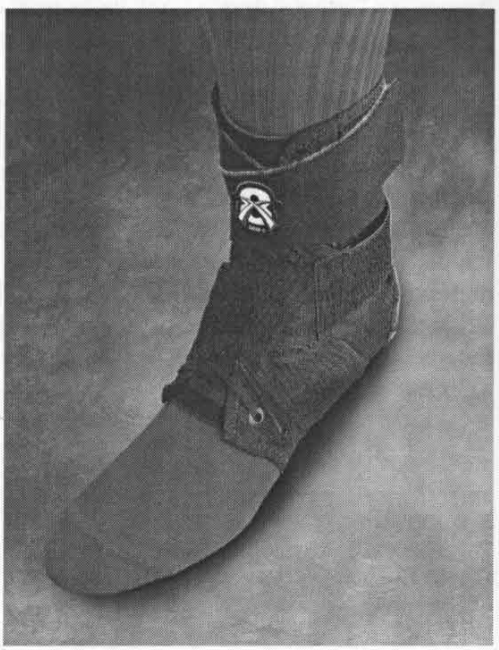

**Fig. 13.1** *Lace-up or gauntlet style braces* are usually made of canvas or nylon material. (Courtesy of Swede-O Inc., North Branch, MN)





**Fig. 13.2** *Stirrup ankle braces* are comprised of semirigid plastic uprights which are oriented along th distal fibula and tibia and extend across the ankle joi to the medial and lateral aspect of the body of the calcaneus. (Air-Stirrup An Brace, Aircast, courtesy of DJO, Inc., Vista, CA)

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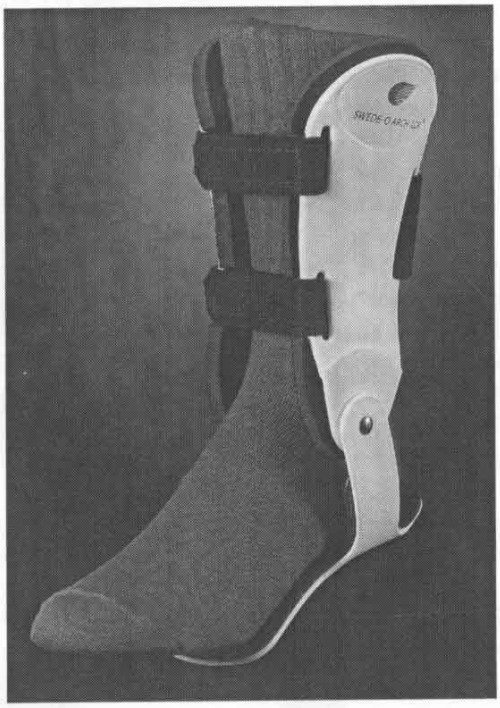


**Fig. 13.3** A newer variation of the standard ankle stirrup brace is the *articulated stirrup brace*. Here a hinge connects a foot plate to the limb uprights at the level of the ankle joint. (Courtesy of Swede-O Arch Lok, Swede-O Inc., North Branch, MN.)

boots, solid and posterior leaf spring AFOs, and articulated AFOs with ankle joints (Fig. 13.4). Custom ankle foot orthoses can also use a solid and posterior leaf spring design, while articulated custom AFOs are generally a more preferred device for the active, athletic patient (Fig. 13.5).

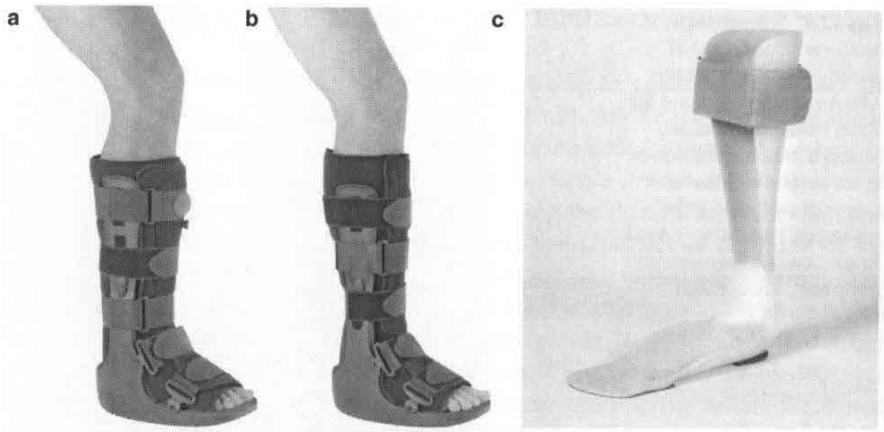


**Fig. 13.4** (**A**–**C**) Ambulatory ankle foot orthoses can take the form of both a custom and a non-custom (pre-fabricated) device. Pre-fabricated ankle foot orthoses include walking boots, solid and posterior leaf spring AFOs, and articulated AFOs with ankle joints. (**A** and **B**, photos courtesy of Ossur Americas, www.ossur.com; C, courtesy of Douglas H. Richie, Jr., DPM)

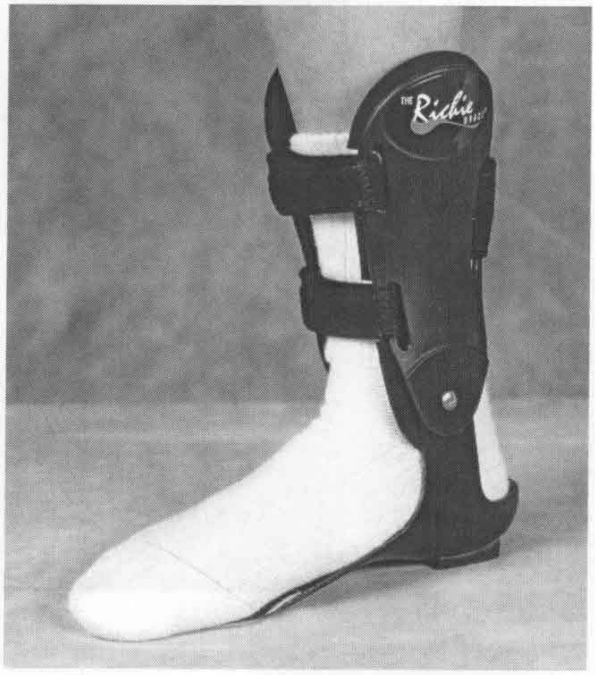


**Fig. 13.5** Custom ankle foot orthoses can also use a solid and posterior leaf spring design, while articulated custom AFOs are generally a more preferred device for the active, athletic patient. (The Richie Brace, courtesy of Douglas H. Richie Jr., DPM)

Virtually all ankle braces and AFOs are worn outside the sock of the athlete. In many cases, the sock is vital in providing protection of the integument from friction and pressure of the orthosis. At the same time, compared to athletic taping, the ankle orthosis is usually never in direct contact with the skin which may compromise sensory stimulation and proprioceptive benefits.

## Treatment Effects of Ankle Braces and Ankle Foot Orthoses

### *Studies of Kinetics and Kinematics of Ankle Braces*

Most studies of ankle bracing have focused on the kinematic effects, or change in range of motion of the joints of the ankle and hindfoot. In most cases, these investigations have compared various braces, or have compared the results of bracing to athletic taping. Kinetic studies have focused on changes in ground reaction forces as well as displacement of center of pressure.

Kinematic studies have employed various methodologies which explain conflicting outcomes. In scrutinizing these studies, it is important to note if healthy vs injured subjects were studied. In some cases, subjects were evaluated soon after an ankle sprain, while other studies involved subjects with a history of chronic ankle instability. The majority of studies, however, used healthy, non-injured subjects.

When effects on range of motion of the ankle are studied, confusion may arise from the use of terminology. Most kinematic studies of ankle bracing measure effects on "ankle joint" range of motion. The axis of motion of the ankle joint, as originally proposed by Inman [3], is primarily a dorsiflexion/plantarflexion axis allowing almost pure sagittal plane motion. The subtalar joint axis, described by Manter [4], is an inversion/eversion axis, allowing motion primarily in the frontal plane. Thus, when kinematic studies document reduced inversion of the calcaneus, when wearing an ankle brace, the effects of the brace were really at the level of the subtalar joint, rather than the ankle joint. Other studies have measured effects of ankle braces on talar tilt, which is a true measurement of ankle joint inversion/eversion.

Finally, kinematic studies may measure displacement of the ankle during passive movements or during dynamic movements. Studies utilizing passive motion devices vary in terms of position of the ankle in either a plantarflexed or a dorsiflexed position. There is mounting evidence that ankle braces affect the ankle differently, depending on the sagittal plane position of the ankle. Dynamic studies simulating real sport movement, such as cutting maneuvers, may be more accurate methodology for assessing effects of ankle bracing.

Early studies of the effects of taping the ankle involved the use of varus stress radiography to measure changes in joint stability. Vaes and Lofvenberg used this technique to demonstrate that tape and a thermoplastic orthosis would be able to significantly reduce talar tilt [5, 6]. However, Vaes showed that the protective effects of taping reduced with exercise [5].