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*.

D.H. Richie (✉)
Private Practice, Alamitos Seal Beach Podiatry, 550 Pacific Coast Hwy, Suite 209, Seal Beach, CA 90815, USA

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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

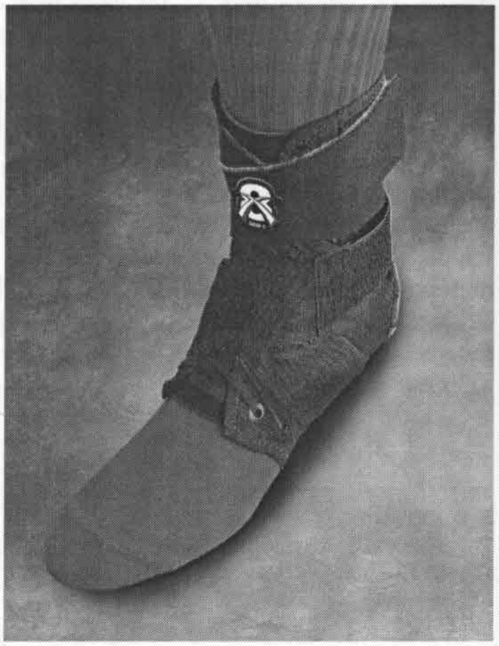

Fig. 13.1 *Lace-up or gauntlet style braces* are usually made of canvas or nylon material. (Courtesy of Swede-O Inc., North Branch, MN)

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

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).

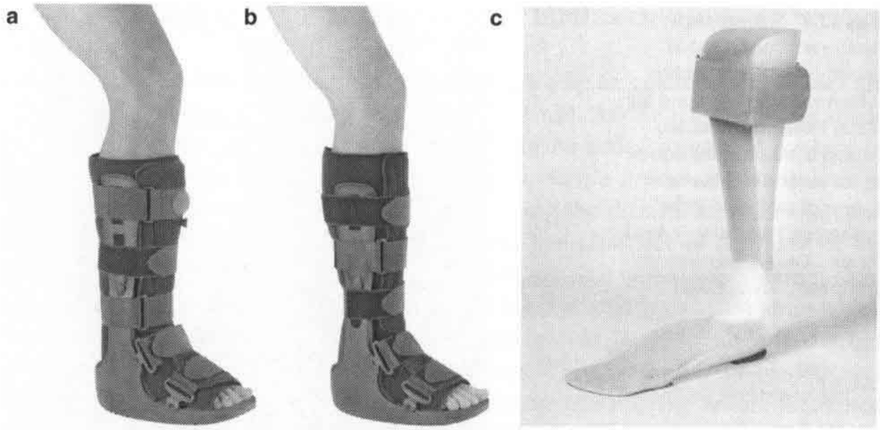

Fig. 13.4 (A–C) Ambulatory ankle foot orthoses can take the form of both a custom and a non-custom (pre-fabricated) device. Pre-fabricated ankle foot orthoses include walking boots, solid and posterior leaf spring AFOs, and articulated AFOs with ankle joints. (**A** and **B**, photos courtesy of Ossur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

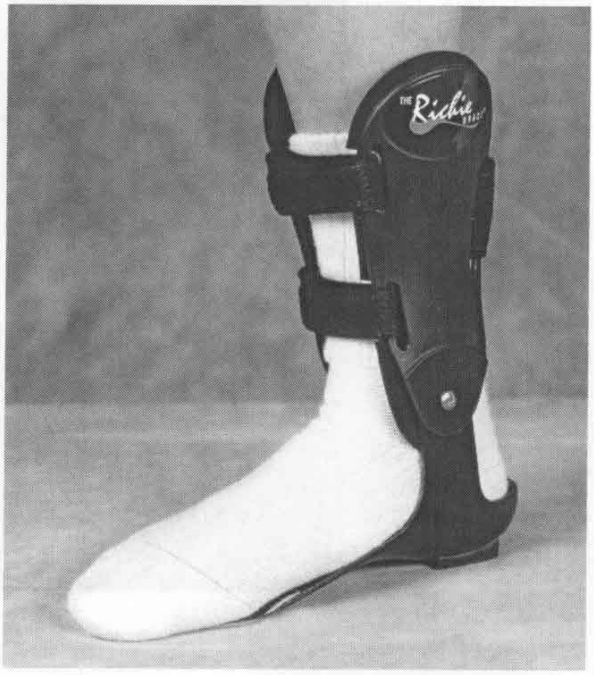

Fig. 13.5 Custom ankle foot orthoses can also use a solid and posterior leaf spring design, while articulated custom AFOs are generally a more preferred device for the active, athletic patient. (The Richie Brace, courtesy of Douglas H. Richie Jr., DPM)

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].

Similar results of taping were demonstrated by Gross [7]. Both taping and an Aircast stirrup significantly limited passive inversion and eversion of the ankle, but this range of motion increased after exercise in the tape group only. Greene and Hillman also compared the results of ankle taping to a semirigid ankle brace [8]. Again, both interventions significantly reduced inversion and eversion of the ankle. After 20 min of exercise, the taping intervention demonstrated a 40% loss of stability, which was not seen in the braced condition. Further studies have validated the finding that tape looses its ability to restrict ankle joint range of motion after as little as 10 min of exercise [9, 10].

Shapiro et al. studied the role of footwear on the effectiveness of taping and bracing the ankle in a cadaveric study [11]. High-top shoes alone and these same shoes combined with taping or bracing significantly improved resistance to ankle inversion compared to the low-top shoe. There was no difference between taping and any of the eight different braces studied.

Ashton-Miller et al. also studied the role of shoe design and found that a three-quarter-top upper allowed an athlete to develop an additional 12% voluntary resistance to inversion moment compared to a low-top shoe [12]. Also, a similar improvement was seen when the subjects wore a lace-up style brace, air-stirrup, or wore athletic tape. No differences were found among the protective devices.

Vaes et al. used an interesting dynamic measurement technique to determine both the speed and the magnitude of talar tilt in a braced and unbraced condition [13]. Patients with functional ankle instability demonstrated significant decreased range and velocity of talar tilt during a simulated sprain when wearing an air-stirrup ankle brace. A slower velocity of inversion was proposed to be an advantage for the athlete, giving more time for muscular activation to prevent a sprain.

Podzielny and Henning also studied restriction of inversion (supination) velocity with four different ankle braces, compared to the unbraced condition [14]. A "supination platform" was used to induce sudden ankle perturbation. Three of the ankle braces reduced overall supination range and supination velocity. No differences were found in plantar pressure distribution patterns.

Further kinetic studies of ankle bracing were conducted by Cordova et al. [15]. Ankle bracing did not change ground reaction forces during lateral dynamic movement. However, ankle bracing did reduce EMG activity of the peroneus longus during peak impact force.

Siegler et al. were among the first to investigate kinematic changes induced by ankle braces in all rotational directions [16]. Four braces (Ascend, Swede-O, Aircast, and Active Ankle) were studied to determine angular displacement of the segments of the ankle joint complex in three body planes with 6 degrees of freedom. The authors discovered that significant differences existed among the braces in terms of limitation of inversion–eversion, internal–external rotation, and plantarflexion–dorsiflexion.

Conflicting results of previous studies showing restriction of inversion with ankle bracing were reported by Simpson et al. [17]. Kinematic data were collected from 19 subjects with previous history of ankle sprain during lateral cutting movement.

Compared to wearing any of three different ankle braces (AirCast, Malleoloc, or Swede-O), the non-brace condition had a lower amount of ankle inversion. The authors speculated that the subjects may have used injury avoidance behavior in the no brace condition in order to prevent ankle inversion.

Gudibanda and Wang performed a similar study to Simpson, evaluating ankle position during cutting maneuvers, but using healthy subjects [18]. These investigators found that the ASO lace-up strap-reinforced brace did reduce maximum ankle inversion angle by 48% during forward lateral cutting which was significant. However, sideward lateral cutting, decreased inversion angle was only 3% with the brace which was insignificant. Also, the ASO brace decreased ankle plantarflexion angle significantly, by over 40% during both cutting maneuvers. The authors suggested that a reduced ankle plantarflexion angle was advantageous in reducing ankle sprain, citing previous studies by Wright and Neptune who showed that increased ankle plantarflexion resulted in decreased supination torque necessary to cause an ankle sprain [19]. Finally, ankle dorsiflexion was not affected by the ankle brace which the authors concluded would allow normal energy absorbing capacity of the ankle musculature.

Cordova et al. published a meta-analysis of 19 previous published studies comparing three types of ankle support (tape, lace-up, and semirigid) and kinematic changes before and after exercise. It should be noted that only studies of healthy, non-injured subjects were included [20]. The semirigid ankle brace provided the most significant restriction of ankle inversion initially and after exercise. After exercise, the semirigid ankle brace provided an overall decrease of ankle inversion by 23 degrees compared to the control condition. Conversely, the tape and lace-up conditions lost support over time, resulting in an overall restriction of inversion by 12 and 13°, respectively. For ankle joint eversion, the semirigid device was again more effective in reducing motion than either a tape or a lace-up brace. Dorsiflexion and plantarflexion range of motion was not affected by the semirigid condition but was most affected by the tape condition compared to the lace-up condition. Taping significantly decreases ankle joint dorsiflexion compared to a lace-up brace and a semirigid brace.

Nishikawa et al. studied shifts of center of pressure and foot pronation–supination angle in 12 healthy subjects in four conditions (semirigid, lace-up, taping, and no brace) [21]. Both the lace-up and the taping conditions were associated with greater pronation angle during static stance. During gait, the center of pressure was more laterally displaced with the lace-up and taping condition, increasing the ankle joint moment arm for pronation.

Eils and Rosenbaum studied subjects wearing 10 different models of ankle braces during free fall and maximum inversion during a trapdoor ankle perturbation maneuver [22]. Differences in the braces were found in maximum inversion angle which were dependent upon restriction of inversion velocity during free fall.

Spaulding et al. measured kinetic and kinematic variables in 10 healthy subjects and 10 subjects with chronic ankle instability [23]. Differences were noted in both kinetic and kinematic parameters between the two groups while walking on a level surface, up a step and up a ramp. There were no changes when the subjects wore ankle braces. The authors concluded that ankle braces did not alter selected gait parameters in individuals with chronic ankle instability.

Omori et al. performed a cadaveric study to determine the effects of an air-stirrup ankle brace on the three-dimensional motion and contact pressure distribution of the talocrural joint after lateral ligamentous disruption [24]. After severing of the lateral collateral ankle ligaments, inversion and internal rotation of the talus occurred. Application of the ankle brace only restored inversion displacement, not internal rotation. High pressure developed on the medial surface of the talar dome after ligament sectioning which was not corrected with the ankle brace. The authors concluded that the stirrup ankle brace functions to primarily restrict inversion. They also point out that ankle sprains also have a component of plantar flexion and internal rotation which are not controlled by this type of brace.

The role of footwear and its effect on performance of an ankle brace was studied by Eils et al. [25]. While an air-stirrup, lace-up, and taped condition significantly reduced passive ankle joint motion when worn in a shoe, this support was significantly compromised in the barefoot condition with the air stirrup only. The authors recommended a lace-up brace for activities which involve a barefoot condition such as gymnastics and dance.

Studies of Kinetics and Kinematics of Ankle Foot Orthoses

Kinetic and kinematic effects of ankle foot orthoses have been extensively studied [26–30]. However, most of this research has focused on the effects of ankle foot orthoses on patients with neuromuscular conditions. Few reports have been published on the effects of ankle foot orthoses in healthy subjects, and virtually no studies have been conducted on sport applications of these types of devices.

Kitaoka et al. studied the kinetic and kinematic effects of three types of ankle foot orthoses in 20 healthy subjects walking over ground [31]. In the frontal plane, all three orthoses (a solid AFO with footplate, solid AFO with heel portion only, and articulated AFO with footplate) significantly reduced maximal hindfoot inversion, but did not affect eversion. The solid ankle AFO design significantly reduced both plantarflexion and dorsiflexion of the ankle, while the articulated ankle AFO did not affect ankle sagittal plane motion compared to the unbraced condition. Midfoot motion was reduced with the articulated AFO, and increased with the solid AFO. Cadence was reduced with the solid AFOs. All three braces were associated with decreased aft and medial shear forces compared to the non-braced condition.

Radtka et al. studied the kinetic and kinematic effects of solid and hinged (articulated) ankle foot orthoses on 19 healthy subjects during stair locomotion [32]. A unilateral hinged ankle foot orthosis produced kinematic and kinetic effects which were similar to subjects wearing no orthosis. The unilateral solid ankle foot orthosis produced more abnormal ankle joint angles, moments and powers, and more proximal compensations at the knee, hip, and pelvis than the hinged AFO during stair locomotion. Subjects wearing orthosis walked slower during stair locomotion compared to the non-braced condition.

Hartsell and Spaulding measured passive resistive torque applied throughout inversion range of motion of the ankle in healthy subjects and those with chronically unstable ankles [33]. A hinged semirigid non-custom ankle foot demonstrated significant increased passive resistive inversion torque forces and restricted overall inversion motion better than a lace-up ankle brace.

In summary, the kinetic and kinematic effects of ankle bracing have been well studied with consistent results in several areas. Most ankle braces and ankle foot orthoses have been demonstrated to have an ability to restrict ankle joint inversion. Some braces affect ankle joint eversion, and little data are available to determine the effects of bracing the ankle in the transverse plane. In the sagittal plane, significant restriction of range of motion of the ankle joint and the midfoot can be accomplished, depending on the design of the brace, or use of simple taping.

What remains obscure is an understanding of the optimal range and plane of motion controlled by an ankle orthosis to achieve a desired treatment effect. There are clear indications that restriction of motion of any joint in the lower extremity will have negative effects in the neighboring joints, both proximal and distal. Of concern for the athlete is the effect of bracing on overall lower extremity function and sports performance.

Effects of Ankle Bracing on Sports Performance

Many forms of sport combine elements of running, jumping, and side-to-side movements. Speed and power of these movements are dependent upon an intact lower extremity which has efficient muscle firing and transfer of moment to the various joints for motion and subsequent displacement of the body to an intended direction. The range of motion and alignment of the joints of the foot and ankle are critical to the efficient movement of the entire body. Limitation of motion of any joint of the hindfoot complex could be an advantage if excessive motion were available. Conversely, limitation of motion could potentially have negative consequences if a joint is restricted to a less than optimal range.

Thus, many studies have been undertaken to determine the effects of bracing and taping on overall athletic performance. As seen in kinematic studies, performance studies of ankle bracing lack consistency in methodology and have given conflicting results.

One of the first studies of performance and ankle bracing was conducted by Burks et al. [34]. Thirty healthy collegiate athletes performed four performance events: the broad jump, vertical leap, 10-yard shuttle run, and a 40-yard sprint. The tests were performed with both ankles taped, or with both ankles wearing two types of lace-up braces. The results were compared to the no-tape, no-brace condition. Half of the subjects perceived that at least one device decreased their performance. All three conditions significantly reduced vertical jump. Shuttle run was not affected by the braces, but was slowed by the taping. Broad jump was affected by only one of the lace-up braces, not by taping.

Sprinting was affected by taping and one of the braces.

A different type of subject pool was utilized to study performance and bracing in a study by Hals et al. [35]. Twenty five subjects who had recent acute ankle sprain, but who had mechanically stable ankles with residual symptoms of functional instability, were studied. Performance tests included a shuttle run and a vertical jump, with and without an Aircast stirrup brace. Use of the semirigid ankle support significantly improved shuttle run time, but not vertical jump performance.

Jerosch and Schoppe also studied subjects with functional ankle instability to determine the effects of a flexible strap style ankle brace on dynamic movements [36]. In a side step running test, the ankle support produced a significant faster time than the unbraced condition. In addition, the authors found no negative effect after 3 months of brace use in terms of isokinetic strength as well as speed of side step running.

Cordova et al. performed a meta-analysis of 17 randomized controlled trials which used a cross-over design to measure effects of bracing on performance measures [37]. The studies included comparison of tape, semirigid, and lace-up braces. Of these studies, approximately 30% used injured subjects. In terms of sprint speed, the largest effect was found with a lace-up brace, which yielded a 1% impairment. For agility speed, the net effects of all three supports were negative, but only 0.5%. For vertical jump, a 1% decrease in performance was found in all three conditions. The authors concluded that these negative effects are trivial for most individuals, but may have greater significance for elite athletes. They also recommended that the benefit of external ankle support in preventing injury outweighs the small negative effects on sports performance.

Balance and Proprioception

Athletes with functional instability of the ankle have been demonstrated to have deficits in balance and proprioception [38–41]. Restoration of proprioception has resulted in reduced frequency of ankle sprain [42]. Research has shown that lower extremity orthoses can have a positive effect on balance and proprioception.

Functional ankle instability consistently causes deficits in postural control [43–45]. Studies of foot orthoses have shown positive effects in improving postural control in both injured and non-injured subjects [46–53]. Mechanisms by which foot orthoses can improve postural control include optimizing foot position, reducing strain and load on supportive soft tissue structures, and improving the receptor sensory field on the plantar surface of the foot [54].

Neuromuscular control of the ankle relies on afferent input to the central nervous system. In the lower extremity, the somatosensory system provides this afferent input. This system includes the mechanoreceptors in the ligaments of the ankle, the cutaneous receptors in the feet and lower legs and the stretch receptors located in the muscles and tendons around the ankle.

Feuerbach et al. determined that the afferent feedback from skin and muscle around the ankle joint was more important than ligament mechanoreceptors in

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providing proprioceptive feedback [55]. Their studies on healthy subjects showed that a stirrup ankle brace significantly improved accuracy of ankle positioning tasks performed off weight bearing. Other studies have shown improvements of ankle joint position sense when ankle braces are worn [56, 57].

Chronic ankle instability has been associated with delayed peroneal reaction time, which may be the result of proprioceptive deficits [58, 59]. Karlsson showed that athletes with unstable ankles had significant delayed peroneal reaction time when tested on trap doors which could simulate inversion ankle sprains [60]. When the subjects were taped around the ankles, peroneal reaction time significantly improved.

Improvements of the peroneal stretch reflex with ankle bracing were verified in other studies of healthy subjects [61, 62]. However, another study by Shima et al. showed that ankle taping and bracing would delay the peroneal reflex in both normal and hypermobile ankles [63]. They speculated that the effects of external support would limit ankle inversion and thus delay the peroneal stretch reflex.

The effects of ankle braces on postural control has been extensively studied. Baier and Hopf studied 22 athletes with functional instability of the ankle joint compared to 22 healthy athletes [64]. A significant improvement of postural control, as evidenced by reduced mediolateral sway velocity, was found in the instability group when wearing a both rigid and semirigid stirrup ankle brace. However, other studies, performed on both healthy subjects and subjects with functional ankle instability have failed to show any improvements of postural control with the use of ankle braces [65–68].

Studies of effects of ankle foot orthoses on balance have been performed on neurologically impaired subjects and have not been performed on athletes [69, 70]. Cattaneo et al. showed that AFOs would improve static balance in patients with multiple sclerosis, but would compromise dynamic balance during gait [70].

In summary, studies of effects of ankle orthoses on balance and proprioception do not provide consistent findings. Yet, studies of treatment effects of these devices commonly attribute any positive findings to improvements in proprioception. As with previous studies, investigations of proprioceptive effects show varied results because of the various types of subjects (injured vs non-injured vs symptomatic) and the methodology employed (static stabilometry vs dynamic posturography). Furthermore, ankle orthoses have not demonstrated the consistent improvements in postural control which have been previously demonstrated with foot orthoses in healthy subjects and subjects with chronic ankle instability. Further research is needed to determine the role of support of both the foot and the ankle in the treatment of athletes with chronic ankle instability.

Prevention of Injury

The ankle sprain is the most common injury in sport, comprising at least 20% of all traumatic episodes affecting athletes [71]. Braces are used more frequently for the prevention and treatment of ankle sprains, and for chronic instability of the ankle than any other musculoskeletal condition.

Several studies have validated the role of ankle braces to prevent sprain in various sports. However, the mechanism by which ankle braces and AFOs achieve positive treatment outcomes for ankle injury remains speculative despite a large volume of research on this subject.

The role of shoe design and athletic taping in basketball players was studied by Garrick and Requa [72]. The combination of a high-top shoe with taping reduced ankle sprains fourfold compared to standard shoes with no taping.

Rovere et al., in a retrospective study, compared the effects of tape to a lace-up brace in the prevention of ankle sprains in football players [73]. The lace-up brace was associated with one-half the number of ankle injuries as the taped condition.

Two prospective studies have been published comparing the effects of an Aircast splint to the non-braced condition in the prevention of ankle sprains. Sitler et al. followed 1601 cadets at the United States Military Academy while playing basketball over a period of 2 years [74]. There were 46 ankle injuries to this group during the time period, of which 35 occurred in the non-braced group. The braced group experienced 11 injuries, revealing a threefold increase incidence of sprain in the non-braced group. There was no statistical difference in injury rate comparing those athletes who had been previously injured prior to the study vs those who were not. The severity of ankle sprain was not different in the braced vs non-braced groups.

Surve et al. studied 504 soccer players randomized into two groups, braced with an Aircast vs no brace, and followed for an entire season [75]. The use of an air-stirrup brace reduced the incidence of ankle sprain by nearly fivefold, in the previous injured group of athletes only. The brace did not significantly affect injury rate in those athletes who had not been injured prior to entering the study. The severity of sprain was also significantly reduced with use of the brace in the injured subjects only. Thus, the benefits of the ankle orthosis was limited to those subjects with a previously sprained ankle.

Both studies by Sitler and Surve showed no increased incidence of knee injuries when wearing ankle brace. Sitler showed that bracing would not prevent severity of sprain, only incidence of sprain. They speculated that ankle bracing did not achieve its benefit by restricting joint range of motion, but rather by facilitating proprioception. Conversely, Surve showed a preventive benefit in severity of sprain by use of an ankle brace, but only in previously injured subjects. Olmstead et al. conducted a numbers needed to treat analysis of three previous studies (Garrick, Sitler, and Surve) to determine the cost–benefit of taping vs bracing in the prevention of ankle sprains [76].

To prevent ankle sprains over an entire season, taping was found to be three times as expensive as bracing. This cost was based upon supplies alone; the labor cost of repeated application of tape by the trainer was not included. The authors concluded that taping and bracing appear to be more effective in preventing ankle sprains in athletes with a history of previous sprain. Furthermore, the superiority of taping vs bracing in preventing injury has yet to be proven, but the cost–benefit analysis clearly shows an advantage for bracing.

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Treatment of Injury

Ankle braces and ankle foot orthoses are commonly used in the treatment of injuries of the leg, ankle, and foot. There is no uniform consensus about the timing, selection, and criteria for use of ankle braces or ankle foot orthoses in the management of lower extremity injury.

Acute tears of the lateral ligaments of the ankle are best treated non-surgically with a functional rehabilitation program [77, 78]. Functional treatment of an ankle sprain utilizes early mobilization of the ankle joint to stimulate healing and improve the strength of ligaments after injury [79, 80]. Ankle braces have been recommended as a simple way to provide protection for the ankle after acute sprain, while allowing easy removal for range of motion exercises [78, 81, 82].

However, some researchers have suggested that simple ankle braces do not effectively stabilize the ankle after acute ligament injury, and long-term functional complaints can occur if weight bearing is allowed to early while wearing these devices [83, 84, 85]. Glasoe et al. recommend that a more protective "immobilizer boot" (i.e., pre-fabricated plastic ankle foot orthosis with soft liner and Velcro closures) be used for initial weight bearing in the treatment of Grade II and Grade III ankle sprains [86]. This report as well as others advocates early weight bearing, with protection around the ankle, to increase stability and stimulate ligament repair [87].

Pre-fabricated ankle foot orthoses such as walking boots appear to provide necessary protection of the ankle after acute ligament injury to allow early weight bearing, without the potential negative results that could occur with simple ankle bracing. In addition, these "walking boots" have been shown to be as effective as a cast in reducing soleus and peroneal muscle activity during the stance phase of gait, while actually significantly reducing gastrocnemius activity compared to a cast [88]. Thus, a walking boot may be preferred compared to a cast, in the management of trauma to the tendoachilles.

Progression from a walking boot to an ankle brace should occur sometime during the rehabilitation program for treatment of the ankle sprain. There is no consensus of opinion about the timing of this progression, and there are no accepted objective criteria for when to institute and discontinue bracing of the ankle during the recovery process. Since complete maturation of collagen does not occur until 9–12 months after ligament injury, many authorities advocate the use of some type of external orthosis for the treatment of ankle sprains until complete recovery has been attained [89].

Ankle foot orthoses are being increasing utilized, in favor of traditional ankle braces, in the treatment of tendinopathy of the ankle, degenerative arthritis of the ankle, and midfoot sprains [90]. Simultaneous control of both the ankle and the subtalar joint make ankle foot orthoses more suitable than ankle braces for the treatment of peroneal tendon injuries and posterior tibial tendon dysfunction [91]. In addition, ankle foot orthoses have demonstrated better recovery from syndesmosis sprain than a traditional lace-up ankle brace [92, 93].

Summary

1. Ankle braces have been thoroughly studied to determine the kinematic and kinetic effects on both injured and healthy subjects. These braces can limit the range and velocity of inversion, with less effects on eversion and plantarflexion.
2. Compared to tape, ankle braces are less likely to loose supportive benefit during exercise. Braces are more cost-effective than tape when used to prevent ankle sprains.
3. The effects of bracing on athletic performance are minimal and do not preclude the use of these devices for the prevention or treatment of injury.
4. There is some evidence that ankle braces will improve proprioception and sensory feedback, although studies of postural control do not show as positive of outcome as similar studies with foot orthoses.
5. Ankle braces have demonstrated a preventive effect for ankle sprain in subjects with previous sprain and may also prevent an ankle sprain in healthy subjects.
6. Ankle braces may not provide enough restriction of motion and support around the ankle joint for the immediate treatment of severe ligament injury of the ankle. Solid short leg walking boots (ankle foot orthoses) are preferred for this intervention.
7. Ankle foot orthoses support and control rotation of both the subtalar and the ankle joints and appear better suited for treatment of tendinopathy of the foot and ankle.

Chapter 14
Prescribing
The Game I

Matthew B. Werd

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M.B. Werd (✉)
Foot and Ankle Assoc

M.B. Werd, E.L. Knig
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