The Biodynamics of Soccer and Soccer Cleat Design

Different field conditions require different patterns and types of cleats.

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Soccer is constantly immersed in a dynamic of strategic change and physical demand as players become stronger, faster, more agile, and fit at younger ages. All this is evident to the observer of professional soccer, but especially so for those who follow and participate in youth soccer globally. Soccer’s public face is the focus of billions of fans and participants around the world, and more recently its popularity has unquestionably taken a foothold in the United States. It now finds itself embedded within our culture (Figure 1), be it on the street, beach, playground, or the uncountable soccer fields that dot our country, and one is now hard pressed to find a moment where the game is not being played.

As a result of the exponential growth of soccer in the United States and continued growth and sophistication of soccer/football around the world, manufacturers of soccer shoes/boots are now more committed than ever to meeting the needs of youth, adolescent, and advanced players. By integrating concepts previously reserved for the elite and professional player, in conjunction with evidence-based design and bio-compatible components, soccer boots are reaching consumers with a quality and functional capacity that has never been seen before.

As a profession and as individual practitioners, we now more than ever have the responsibility to embrace soccer as part of our culture and professional landscape (Figure 2). The millions of beginning, intermediate, and advanced players who live near our clinics require the highest level of care from sports podiatrists and members of the multidisciplinary sports team to meet their growing clinical needs. Having a basic introduction into the biodynamics of soccer and a sophisticated understanding of the functional components of soccer boots can put the clinician in good stead with the challenges that he or she will face when the next soccer injury or podiatric-related soccer malady presents.

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Movement Dynamics

Soccer is characterized by sprinting, stopping, cutting, and pivoting situations where shoe relations are essential and frictional resistance must be within an optimal range. During the progressions of a typical 90-minute professional or international match a player will frequently cover 8,000 to 11,000 meters. Two-thirds of the total distance covered is generally associated with walking and jogging and one-third is associated cruising, sprinting, and backing. Approximately 800 meters of each game requires bursts of 10-40 meters. Within these movements, there is a change of speed every five to six seconds. Such activity requires a most supportive and comfortable cleat construction (Figure 3).

Although youth soccer players might not come within a fraction of running as much as or as forcefully as those in the professional game, soccer shoe development teams now incorporate the most important characteristics of professional cleats for proportionate play.

Functional Requirements of Soccer Boots

A quality and biodynamically sound soccer shoe must allow for complete freedom of function and movement. It must also provide total comfort and support. Unfortunately, the principles governing control and comfort will often be at odds with each other. The more control a cleat exhibits, the less flexible and more sturdy and controlling its structure will be. The opposite is true of the comfort scenario. One will find the more comfortable cleat to have a more flexible and somewhat less stable environment. Both present with advantages and disadvantages. Developing a hybrid cleat that provides ergonomic performance and the best combination of comfort and control should be a guiding principle for manufacturers.

Basic Structural and Functional Characteristics of Soccer Boots

The goal of today’s product development teams is to adequately address flexibility and stability within the confines of a lightweight boot. Incorporating these elements in conjunction with a clean functional kicking surface will yield longer periods of grip, increased friction between the boot and ball, greater ball control, increased power and swerve, along with biomechanical stabilities (Figure 4).

Excessive motion of the foot during play has long plagued boot manufacturers and development teams. This has been addressed vigorously over the past several years. Numerous improvements are now part of the boot’s environment; these include bet-

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ter lining materials, softer/more conforming constructions, and more effective lacing systems.

Excessive motion can lead to a multitude of issues ranging from simple blistering to severely debilitating tendinopathies and stress injuries. Many soccer-specific functional and stabilizing components are now combined to provide the control and comfort needed for youth, adolescent and advanced play.

Lasting Characteristics of Soccer Boots

**External Last Dynamics**

Lasts are forms on which boots are constructed. The global three-dimensional shape of a boot mimics the design form of the last and gives the upper its shape and volume. Anatomical lasts are more contoured to match the shape of the foot, while generic lasts are based on morphological averages.

Individuals with rectus or moderately pronated foot types will likely find themselves most comfortable in boots fabricated from a somewhat straight or slightly curved last. Those with an adducted forefoot or a clinically supinated foot type will find a slightly curved lasted or a more significantly curve lasted boot to their liking.

**Internal Last Dynamics**

A boot’s footbed can have a profound impact on player performance. Foot-bed construction delivers the optimal blend of stability and flexibility and lends personality to the shoe. It is the functional interface between the player’s foot and the studs found on the exterior of the outsole plate. The internal last refers to the structure of the footbed found under the sockliner of the boot. A quality internal last construction, along with a well-designed sockliner, can help provide proper midfoot support, torsional control, and forefoot flexibility for the user.

Despite best attempts, supportive adjuncts found in many boots may not always provide the needed control for the foot and might need to be replaced by a prescriptive insert or functional orthotic appliance. Orthotic control in soccer boots is a constantly evolving science due to the myriad of seasonal manufacturing changes in boot design. Boots should be submitted to a soccer-specific orthotics laboratory, along with the patient’s casts and/or digital data to properly accommodate the player’s foot, chosen footplate design, and internal/external lasting dynamic.

Elite and professional soccer players are known to occasionally wear their cleated shoes one to one and a half sizes (U.S.) smaller than their known Brannock measurements. For this reason, it is essential to follow the boot submission guidelines for proper orthotic fabrication and fit.

A properly advised internal and external supportive boot structure can minimize common soccer maladies such as calcaneal apophysitis, plantar fasciitis, shin splints/anterior tibial tendinitis, posterior tibial tendinitis, and turf toe, just to name a few.

**The Upper**

The upper is that portion of the cleat visualized from

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dorsal, medial and lateral views. It covers all but the contacting plantar surface of the boot. More than just a place for advertising, it acts as a protective functional foot covering. It is firmly bonded to the outsole plate. The upper contributes significantly toward medial to lateral stability within the boot and is also of importance in controlling the ball during play. It has unique and distinct features as determined by the fabricator; the upper may be synthetic or leather. Synthetics don’t over-stretch and don’t absorb water. In addition, they are gaining popularity because of their ability to influence swerve on the ball.

Some synthetically manufactured boots now weigh less than six ounces. Despite the perceived benefits of lightweight boot technology, studies are now beginning to indicate that weight reduced versions should not take precedence at the expense of pedal stability. There also appears to be evolving evidence validating differences in stability between the various versions of lightweight shoes.

**The External Heel Counter**

The heel counter is a structure that anatomically cradles the back of the heel. It must be bonded strongly to the outsole plate as well as the remainder of the upper (the soft portion of the cleat that surrounds the foot). Higher heel counters tend to yield greater rear-foot control to the vigorously training player. A well-constructed counter will not bend out of alignment with varus or valgus game force and will maintain a parallel, vertical position when viewed from the posterior of the cleat, even after long-term use. If the counter “gives” to either side or a parallelogram appears, then the cleat is at a functional deficit. A quality external heel counter should be rigid. It must also be accompanied by comfortable padding on the internal surface to prevent friction, irritation, and blistering.

**Sockliner**

The sockliner is a dynamically fabricated insole that offers cushioning to the foot, disperses stud pressure, and reduces foot-to-boot slip (that can lead to blisters and frictional conditions).

**Field Conditions and Cleat Assortment**

Field conditions frequently dictate the need for variation and change in one’s cleat pattern and cleat type. We generally break down pitch conditions and cleat types into various categories for outdoor play:

- Turf Fields (TF)
- Hard Ground (HG)
- Firm Ground (FG)
- Soft Ground (SG)

Regardless of environmental conditions, the outsole and cleat pattern must communicate with the pitch and yield maximum grab and traction.

**Cleat, Blade, and Stud Patterns for Outdoor Play**

Cleat, blade, and stud patterns, as well as their placement and design, are an art and a science. Re-
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Search and development in conjunction with field-testing have provided the playing public with a myriad of excellent choices. Studs are firmly bonded or optionally screwed into the outsole plate depending on preference, functional need, and pitch conditions.

- **Turf Field (TF)**—for play on extremely hard and/or original synthetic surfaces
  These cleats have been designed for harsh and/or extreme field conditions as well as older original synthetic surfaces. These finely studded shoes are most helpful where the field is balanced or when natural grass may not be available or in its best form. They are grippy and can provide maneuverability.

- **Hard Ground (HG)**—for play on hard unforgiving field conditions
  These cleats generally have short studs and appear in fairly uniform patterns across the outsole plate. In this grouping of cleats, the studs are prepared from thermal plastic or rubber-like materials. They are very effective for grab in difficult-to-penetrate field surfaces and conditions. They can provide adequate traction and simultaneous comfort without significant loss of mechanical control. Studs tend to be shorter and softer than the Firm Ground (FG) variety.

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- **Firm Ground (FG)**—for playing on the firm to moderately forgiving field
  Firm ground cleats are perhaps the most commonly used cleat type; they generally vary from 10-14 on the outsole plate. Firm ground blades and studs provide and address pivot points, impact points, and stability in order to maintain control and comfort for the average player. Blades and round studs are equally preferred in today’s market place. In addition, firm ground cleats help each player keep a low center of gravity on a field that has been fairly well manicured (Figure 5).

- **Soft Ground (SG)**—for playing on soft field
  Soccer shoes for rain-soaked or soft field conditions occasionally require longer, detachable studs. Replaceable studs are found in various shapes and forms, generally numbering six, and are used most frequently by the most advanced and competitive player. They are fabricated in different lengths (12mm-19mm), so one can adjust his or her soccer shoes based on the condition of the field at the time of play. Soft ground studs should not be used on firm fields because they can lead to a higher injury rate. Detachable studs are declining in popularity due to the fact that today’s fields have better drainage. Many professional soccer players now use a mixed SG/FG system for standard field conditions.

**Summary**

Biomechanical design concepts, once reserved for cleats worn only by professional athletes, are now found in numerous models used by youth players. Choosing the proper soccer boot based on the athlete’s foot type will lead to improved performance and will reduce the frequency of injury. With a fundamental understanding of the biodynamics of soccer and soccer cleats, podiatrists can advise and protect those athletes who seek advice and guidance. By embracing soccer as part of our new cultural sports landscape, the “beautiful game” or “jogobonito” can bring you the same enjoyment experienced by those who have sought your services.

**References**


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