Lower leg overuse injuries are common in all athletes. These injuries cause tissue irritation resulting in pain, swelling, and loss of function in activities of daily living and athletic performance. The predominance of lower leg overuse syndromes challenges sports-medicine practitioners to design and implement appropriate rehabilitation programs. Effective, efficient programs address both the physical symptoms and the causative factors.

There are a variety of causes of lower extremity overuse injuries. Examples include improper training (frequency, intensity, or duration), type of footwear and surface, muscle imbalances (strength and flexibility), and biomechanical or anatomical factors. Examples of biomechanical influences include rotational and malalignment problems in the hip and knee, as well as structural foot deformities.

A lower extremity biomechanical evaluation, in combination with traditional evaluation techniques, provides a systematic approach to identifying causative factors when developing the most appropriate intervention. The purpose of this article is to provide patient-management options to facilitate decision making in cases of chronic lower leg dysfunction secondary to biomechanical factors. The article begins with a basic overview of lower extremity functional biomechanics. The next section explains intrinsic and extrinsic factors that affect lower leg function and outlines special tests to identify biomechanical causes of pathology. The article concludes by relating evaluative findings to treatment techniques designed to specifically address impairments.

Foot and Ankle Functional Biomechanics

Because of the obliquity of the joint axes, the subtalar joint does not have cardinal planes of motion. Instead, its motion is said to be triplanar and is referred to as subtalar pronation and supination. Weight-bearing pronation is a combination of calcaneal eversion, talar adduction, talar plantar flexion, and tibial lateral rotation. Weight-bearing supination is a combination of calcaneal inversion, talar abduction, talar dorsiflexion, and tibial medial rotation. During gait, the foot goes from a non-weight-bearing to a weight-bearing position and must supinate and
pronate to accommodate changes in impact forces and varied terrain.

At the beginning of the gait cycle the foot is in a supinated position at heel contact but immediately pronates when moving from heel contact to weight acceptance. Pronation increases foot mobility to absorb ground-reaction forces and adapt to uneven terrain. The foot reaches maximum pronation at the end of the weight-acceptance phase and then must supinate through the toe-off phase. Supination transforms the foot into a rigid lever arm used for propulsion. During the swing phase, the foot pronates to a neutral position in preparation for heel contact.

The subtalar joint also acts as a lower extremity torque converter by helping to dissipate ground-reaction forces transmitted from the foot during weight-bearing activities. As energy is transferred from the foot upward, the rotational action at the subtalar joint helps reduce the torque to the upper segments. Subtalar pronation results from tibial medial rotation, whereas subtalar supination results from tibial lateral rotation. Excessive tibial rotations can stress lower leg muscles and soft tissue. Therefore, an understanding of the effect of these rotations on subtalar-joint function is paramount in identifying biomechanical causes of lower leg dysfunction.

Pathology and Functional Biomechanics

Root et al. have described intrinsic and extrinsic factors that can influence foot function. Intrinsic factors are structural foot deformities; extrinsic factors are those proximal to the foot and ankle. Clinicians must understand the interaction that intrinsic and extrinsic factors have on foot function and how the lower extremity compensates for these factors.

The foot can compensate for many influences if it has the available motion. Compensation represents a change in position of one part of the foot to neutralize the effect of an abnormal force resulting from a deviation in structural alignment or position of another part. Understanding abnormal compensation, the manner in which the foot adjusts for a structural deformity, is key to identifying the causal factors of lower leg pathology.

For example, an athlete with a subtalar varus would begin the gait cycle (heel contact) with the foot in a more inverted position. In order for the foot to contact the ground, the athlete will need increased pronation. As the body passes over the foot during stance, the foot must supinate in preparation for toe-off. Excessive pronation occurs earlier in the gait cycle and hinders the foot’s ability to effectively supinate. In summary, the foot achieves foot contact through overpronation that stresses lower leg soft tissues and leads to inefficient foot function during the latter phases of stance.

Pathology can also result from underpronation. An athlete with a rigid, high-arched foot remains in a relatively supinated position throughout the entire gait cycle and lacks the motion needed for shock absorption. This underpronation decreases the foot’s ability to dissipate ground-reaction forces and results in prolonged tissue stress. Table 1 summarizes these principles and correlates them to specific pathology.

Extrinsic factors can either be structural in nature or involve soft tissue. Patients with hip anteversion, an increased angle of femoral torsion, appear to have excessive hip medial rotation that can increase tibial medial rotation. Knee genu valgum similarly increases tibial rotation. These influences place the foot in a more pronated position that can lead to lower leg dysfunction resulting from overpronation. Alternatively, hip retroversion decreases the angle of femoral torsion and clinically presents as excessive hip lateral rotation. Knee genu varus has an effect similar to that of a rigid, high-arched foot. These influences place the foot in a more supinated position that can lead to lower leg dysfunction resulting from underpronation.

Both lower extremity muscle tightness and weakness represent extrinsic factors. Gait requires adequate gastrocnemius flexibility to allow the tibia to pass over the foot during stance. Patients with calf-muscle tightness but adequate foot mobility can “unlock” the midtarsal joint through excessive pronation to allow this action. Furthermore, the gluteus maximus, gluteus medius, piriformis, and posterior tibialis muscles eccentrically control pronation during gait, and weaknesses can contribute to lower leg overpronation pathology. Table 2 summarizes muscle actions during pronation and supination.