Injuries to the foot and lower leg are the result of either direct trauma, such as sprains or fractures, or some type of repetitive stress such as tendinitis or plantar fasciitis. The injuries that result from repetitive stress are often linked to some type of motion disorder in the foot (Krivickas, 1997). These abnormal movements, or pathomechanics, are believed to contribute significantly to the injury—if not as the direct cause, at least as a contributing factor. The abnormal motion either predisposes a person to injury or magnifies the symptoms that result from repetitive stress. The principal cause of this type of injury is errors in training. Such injuries are commonly referred to as overuse injuries (Krivickas; McPoil & Hunt, 1995).

Because efficient, injury-free functioning of the lower extremity depends on normal foot function, it is important to understand disruptions in the foot’s normal motion. There is a tendency to treat foot-related disorders by first making a diagnosis based on the observed signs and symptoms. Treatment is then selected based on that diagnosis. If the clinician approaches treatment of foot injuries in this way, the decisions regarding what type of treatment to use can become unnecessarily complicated. I propose that the clinician approach treatment from a pathomechanics perspective instead, which involves looking for the foot function or functions that have been lost or diminished and designing a treatment program that addresses these limitations. By using this approach, treatment success can be increased.

There are three major functions that the foot must accomplish during locomotor activities such as walking and running. The foot must adapt to uneven surfaces through frontal plane motion of the subtalar and midtarsal joints (pronation/supination), absorb the shock of foot strike, and, finally, convert transverse plane rotation of the lower extremity to frontal plane rotation of the foot and then back again (Nuber, 1988; Perry, 1992). Pathomechanics of the foot result in a diminished ability to accomplish these functions and can be grouped into the following four categories:

- Excess motion in the subtalar or midtarsal joint of the foot
- Limited motion in the subtalar or midtarsal joint of the foot
- Impaired shock attenuation at foot strike
- Impaired conversion of lower extremity rotation to foot motion

This article first discusses normal motion of the foot during closed chain activities such as walking and then each of the four pathomechanical categories. A brief discussion of injuries...
commonly associated with each pathologic motion category, as well as guidelines for treatment, is presented.

**Foot Mechanics During Gait**

The normal (or more correctly, typical) motion pattern of the foot is highly complex. There is still much we do not know about how each of the 26 bones and the even greater number of articulations behave during such commonplace activities as walking or running. In the published literature, researchers and clinicians have primarily focused on the calcaneus, or rear foot, to describe how the foot does or should move (Liu et al., 1997; Moseley et al., 1996; Pierry-nowski & Smith, 1996). This preoccupation with the rear foot is related, in part, to the fact that it is closely associated with motion of the subtalar joint. In addition, it is relatively easy to observe a person’s calcaneus during an activity and extrapolate what is occurring at the subtalar joint. Although clinically useful, this focus on the calcaneus effectively ignores the rest of the foot. As important as motion about the subtalar joint is, the clinician who treats foot and ankle disorders needs to look beyond it and realize that movement of the foot is much more global (Cornwall & McPoil, 1999).

Because many of the joints in the foot move about an axis in a single cardinal plane, the term *triplane motion* has been used to indicate that movement occurs simultaneously in three planes rather than just one. Instead of a single motion such as dorsiflexion or plantar flexion, there is a combination of dorsiflexion/plantar flexion, abduction/adduction, and eversion/inversion (Donatelli, 1996a). The percentage of total motion contributed by any one of these individual movements depends on the orientation of a joint’s axis. For example, the average orientation of the subtalar joint axis is 41° up from the horizontal and 23° medial from the midline of the foot (Figure 1; Sammarco, 1989). This means that a foot with such an axial position demonstrates mostly eversion/inversion, followed by abduction/adduction and dorsiflexion/plantar flexion. Because the reported position of the axis is an average value and the range of possible values is quite large, the relative contributory amounts of these motions vary from one individual to another. It is important to note that research has demonstrated that, as in the knee, the center of axis of motion in the ankle is not stationary but advances in the direction opposite of that of the moving limb (Lundberg et al., 1989). This tremendous variability makes evaluating foot and ankle disorders not only challenging but interesting, as well. Finally, the concept of axis orientation is important when discussing the role of impaired lower extremity conversion in proximal lower extremity disorders, especially of the patellofemoral joint.

**Closed Kinetic Chain Movement**

Instead of naming each of the three separate motions when we refer to movement about a particular foot joint axis, we commonly use the terms *pronation* and *supination*. During closed chain movements of the foot (weight bearing), pronation is a combination of eversion, adduction, and plantar flexion. Supination, on the other hand, is a