

with Robert Gailey, PhD, PT  
 Illustrations by Frank Angulo

# Keeping the Sound Limb Sound:

## Foot Issues for Amputees With Diabetes

*When planning a rehabilitation program for the lower-limb amputee with diabetes, management of the sound limb plays an important role.*

Preservation of the sound limb, in many cases, allows people to continue walking and delays further medical complications that can reduce their quality of life. One main reason for this concern is that the sound limb routinely compensates for the amputee's inability to maintain equal weight distribution between limbs, resulting in altered walking mechanics. Two effects on the nonamputated limb raise concern: The first is the additional forces being placed on the weight-bearing surfaces of the foot, which introduce the soft tissues, such as the skin, to the risk of ulcers, and the second is the change in ground reaction forces throughout the skeletal structures of the limb, which will place undue stress to the joints of the foot, knee and hip.

Increased forces placed on the intact limb can be of considerable concern during ambulation since the foot often presents with neuropathic symptoms, such as loss of sensation, foot deformity and muscle weakness, which make the soft tissues vulnerable to injury or ulcers. The general walking pattern of diabetic patients with neuropathy is tentative, stemming from feeling unsafe when they stand or walk. This conservative walking style is characteristically the product of poor proprioception (sense of where the foot is in space),

diminished sensory information, poor balance and an overall lack of stability. It could, however, lead to slower walking, inconsistent step length and adverse forces or pressure being applied to the foot (Figure 1.) Even nonamputee diabetic subjects with peripheral neuropathy demonstrate alterations in foot biomechanics that could increase peak foot pressures and facilitate foot injuries or ulceration. In some cases, a shuffling gait is adopted that, while reducing peak foot pressures by distributing applied forces over a greater area, also causes increased fatigue and stress to the soft tissues of the foot, which could lead to foot ulcers.

Able-bodied diabetic subjects with peripheral neuropathy have a high risk for developing ulcers on the sole of the foot, and it is believed that most of these ulcers develop during walking. Fifty percent of diabetic amputees will also develop sound-foot infections and possible amputation within two years of the amputation of the first foot; therefore, clinicians working with a diabetic amputee must be alerted to the potential of complications that may arise in the residual foot. The term "sound" limb can be very misleading. In fact, it is probably just a twist of fate that one foot became infected before the other and thus only a matter of

time before problems begin to arise with the sound limb if the patient does not take extreme care. The odds are certainly working against the amputee, especially if any other foot deformity is present, such as toe clawing or flat feet, as the amputee learns to use his or her prosthesis.

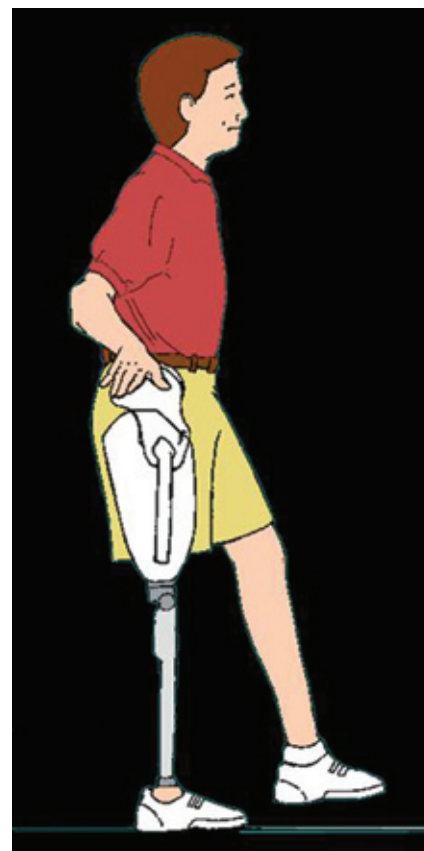


Figure 1. Poor walking biomechanics increases the forces on the sound foot creating greater risk for skin breakdown and ulcers.

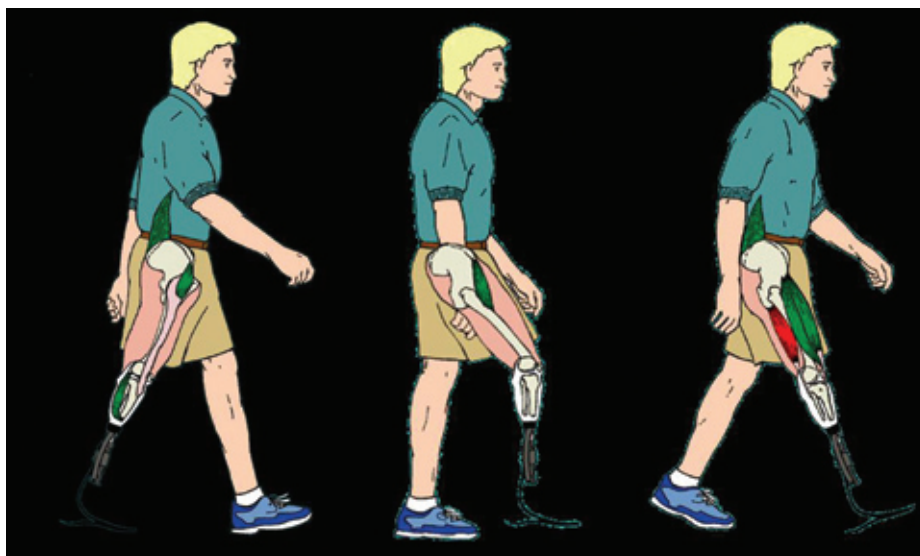


Figure 2.

- A) Lack of prosthetic stability increases ground reaction forces as the sound anatomical heel strikes the ground.  
 B) Forces decrease as the body's weight moves rapidly over the sound foot.  
 C) Increased time of double support as the amputee slowly moves his or her weight onto the prosthesis increases the forces on the toes of the sound foot.

Because diabetic amputees with neuropathy will often avoid full weight bearing through the prosthesis, the sound limb must accept a greater proportion of body weight. Typically, because the amputee unconsciously tries to get off the prosthetic limb as quickly as possible, the sound limb swings much faster than normal, striking the ground with greater force and causing increased insult to the heel of the foot. Then, as the prosthetic foot strikes the ground, the body weight often moves rapidly forward over the sound foot to the metatarsal heads (foot bones) and toes (Figure 2). Most amputees hold this position a little longer than normal as they prepare to put their full weight onto the prosthesis, and this prolonged time on the forefoot can frequently cause calluses at the base of the first three toes. Calluses must be taken seriously because they can create and hide tissue damage, which can lead to foot ulcers. In cases where the great toe has been amputated, stricter precautions must be adhered to since the second and third toes must now accept the body's weight. Because these toes were not designed to accept these increased forces, there is an increased risk of callus formation and tissue damage. It is extremely important, therefore, that daily inspections of the foot are made and any changes to the skin are reported to the physician.

The combination of additional vertical forces and shear stresses placed on the sound foot and the increased possibility of disproportionate weight bearing can result in increased skin lesions, ulcers and/or joint degeneration. This is apparent by the unsettling fact that 50 percent of amputees will have another amputation involving the same or the sound limb within four years after the primary amputation. Without hesitation, new amputees should be made aware of the impending dangers from the onset of rehabilitation. Accordingly, foot care becomes even more critical after amputation for diabetic amputees, especially since a high percentage will lose their sound limb within a few years

and their chances of achieving functional ambulation as a bilateral amputee will decline. Therefore, the goal of rehabilitation must include regular clinical follow-up, appropriate shoe wear, education, and instructional measures designed to reduce the risk of skin lesions, ulceration, and additional degeneration of the sound limb. ■

#### About the Author

Robert Gailey, PhD, PT, is an assistant professor at the University of Miami School of Medicine, Department of Orthopaedics, Division of Physical Therapy.

Illustrations used with the permission of Advanced Rehabilitation Therapy, Inc., Miami, Florida