

The Prevention of Foot Ulceration in Diabetic Patients

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KEYWORDS

- Diabetic foot • Ulceration • Prevention • Patient education
- Orthotic devices

The prevalence of diabetes in the United States and worldwide is growing steadily, and with it the impact of diabetes-related morbidity is likewise growing and presenting new challenges for public health systems. In 2007, there were an estimated 23.6 million people in the United States living with diabetes mellitus, representing a 13.5% increase since 2005.¹ This trend is not limited to the United States alone, because the prevalence of type 2 diabetes mellitus and the economic stress of its associated complications is growing at a rapid rate globally. The growing burden of chronic disease is changing the face of health care and most profoundly affecting developing nations, where it is estimated that 80% of the world's 250 million persons with diabetes reside.^{2,3}

Diabetic foot ulcerations and amputations are dreaded complications related to diabetes and have a severe impact on the individual and society. On an individual level, foot ulcers often represent a chronic disorder that may severely limit function, work capacity, and quality of life. On a public health scale, foot disorders represent a costly burden on the medical system as one of the leading causes for hospitalization in persons with diabetes. The rate of amputation in individuals with diabetes is 10 times higher than in persons without diabetes. Diabetes is associated with 60% of nontraumatic lower-limb amputations; in the United States, this represented 71 000 amputations in 2004.¹ Even if an ulcer heals with medical therapy, the recurrence rate in patients with diabetes remains high at nearly 70% within 5 years.⁴

Reducing the incidence of diabetic ulcerations and amputations has been pronounced a main public health goal for many years in the United States and abroad; however, despite the acknowledgment of this serious public health challenge, the number of amputations in persons with diabetes continues to rise, increasing 30% from 1980 to 1990.⁵ One of the main challenges in reducing the incidence of diabetic foot ulcerations is in determining what interventions are most

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effective toward this end. Unfortunately, research in prevention is still somewhat sparse in comparison to the body of evidence for treatment. Many of the current practice guidelines are based on consensus and tradition rather than research and evidence-based medicine. The aim of this article is to outline the current understanding of the pathologic process underlying diabetic foot ulceration, the risk factors associated with the development of ulcers, and interventions that are in use or have been studied to modify this risk.

PATHOGENESIS OF DIABETIC FOOT ULCERS

The feet of patients with diabetes are at increased risk for ulceration because of the damaging effects of diabetic peripheral neuropathy. Ulceration is usually the end result of interplay between several component factors, including poor sensation, structural foot abnormalities, and local trauma. The course leading from hyperglycemia to neuropathy is not entirely understood, although neural hypoxia secondary to metabolic abnormalities of hyperglycemia and dyslipidemia may be a contributing factor.⁶ Diabetic peripheral neuropathy is a length-dependent, mixed sensorimotor, demyelinating, and axonal process affecting multiple nerve fiber subtypes. The most well-known and common of these is sensory neuropathy, which leads to loss of protective sensation. Motor neuropathy also may produce intrinsic foot muscle atrophy and subsequent anatomic foot deformity, such as clawfoot, hammertoes, or Charcot foot. Range-of-motion limitations are also thought to result from direct glycosylation of tendons in the lower extremity.

The result of these foot deformities is abnormal weight-bearing distribution in the foot, which places high-pressure areas at risk for skin breakdown (**Fig. 1**). Finally, autonomic neuropathy decreases normal temperature and secretion regulation, which impairs the effectiveness of the skin barrier. Despite the extensive repercussions of diabetic neuropathy, ulcerations generally do not occur spontaneously in the foot of a patient with diabetes but occur as a result of local trauma in a predisposed foot. This may occur from local trauma caused by poor footwear or other external insult, such as trauma from nail clipping, falls, or repetitive trauma.



Fig. 1. Diabetic foot ulceration. Note presence of callous heralding high-pressure-bearing regions, particularly beneath the great toe, metatarsals, and calcaneous. (Courtesy of Gregory Raugi, MD, Seattle, Washington.)

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