

Current Epidemiology of Diabetic Foot Ulcers

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Abstract

Diabetes mellitus continues to be one of the mode widespread diseases around the world. More prevalently, type II, or non insulin dependent diabetes, is associated with a more sedentary lifestyle, lack of daily exercise, and chronic hyperglycemia related to poor diet. Of all the body systems and organs affected by diabetes, the foot is perhaps one the most brutally affected and relates the most devastating consequences. Diabetes Mellitus continues to be the number one cause of non traumatic lower limb amputations , which leads to mortality rates higher than several types of cancer. This article will review the epidemiological data and review the clinical warning signs of the high risk diabetic foot.

Introduction

Diabetes affects 382 million people worldwide and its prevalence is expected to rise to 592 million within the next 19 years. Specifically, the International Working Group on Diabetic Foot (IWGDF), it is estimated that in 2013 approximately 382 million people have diabetes – 8.3% of the world's population. Around 80% of these people live in developing countries. By 2030, the global estimate is expected to rise to over 552 million – 9.9 % of the adult population. What is even more concerning is that with child obesity being on the rise, the incidence of childhood non-insulin dependent diabetes mellitus is also increasing. Diabetes Mellitus continues to be the leading cause of non-traumatic lower limb amputation in the world. Most amputations will be proceeded by an ulceration of the foot, most commonly located on the plantar aspect of the foot.

This predisposes the patient to developing an infection which will typically be exacerbated by some degree of peripheral arterial disease, and typically preceded by undiagnosed diabetic peripheral neuropathy which is the most common denominator to an ulceration and the ubiquitous denominator in Charcot Arthropathy. According to a study by Screpnek et al for the IWDGF 2015, Diabetic foot ulcers accounted for more ED admissions than Cancer, Heart Disease and Chronic Kidney Disease [1]. In a study by Barshes et al, the cost of diabetic foot complications exceeded 16 billion USD which is more than what was spent on Lung Cancer, Prostate Cancer and Colorectal Cancer [2].

The purpose of this article is to review the pathophysiology of the diabetic foot its clinical complications as well as to highlight the implications for the patient and the public health system in general when comparing the morbidity and mortality of diabetic foot to other diseases.

Epidemiology and Public Health Implications of Diabetic Foot Ulcers

Every 20 seconds a lower limb is lost to diabetes somewhere in the world. This indicates an impending pandemic of this disease process which combined with more and more sedentary lifestyle and diet habits is expected to worsen [1,2]. Diabetic Neuropathy is estimated to affect nearly 50% of patient with diabetes mellitus and is associated with significant increase in morbidity and mortality. Particularly, the onset of a diabetic foot ulcer is a pre cursor to limb loss and early death. Up to 85% of lower limb amputations in diabetic patients are preceded by a foot ulcer [3]. Diabetes related amputations result yield a 5 year mortality rate of 39% to 68% with a below knee amputation, and 89% with a single above knee amputation [4,5]. Patients with a previous below knee amputation have a 42% chance of a contralateral same level amputation within 1-3 years and 56% chance at 3 to 5 years. Patients with bilateral below knee amputations have a 80% mortality rate at 2 years [6,7]. Furthermore, if the patient concomitantly suffers from chronic kidney disease, the mortality rate status post lower limb amputation is far more grim.

In a study by McWhinnie et al. 8 only 26% of patients were able to ambulate with a below knee prosthetic two years after major amputation. One year survival rates for a single limb, below knee amputation was approximately 50% versus 76.6 and 85% in patient without kidney disease, with chronic kidney disease and patient on kidney replacement therapy [9-11]. One study by Brownrigg, the crude mortality rates in the diabetic groups with diabetic foot ulceration and without diabetic foot ulceration were 27.0% and 6.4% respectively [12]. In a study by Armstrong in 2007, the mortality rate of a single limb, below knee amputation was found to exceed the mortality of Colon Cancer, Hodgkin's

Clinical Presentation of Diabetic Foot Ulcerations

There are 3 main pathways to the development of diabetic foot ulcers; diabetic Polyneuropathy; Peripheral Arterial Disease and Skeletal Deformity. The clinician should also keep in mind that the diabetic patient is typically also deficient nutritionally and immunologically because of the general disease process of diabetes mellitus. Discussing each pathway is beyond the scope of this review.

Several mechanisms may explain the link between diabetic foot ulcers (DFU's), and increased overall mortality. Approximately 15% of all diabetic patients will develop an ulcer in their lifetime [14]. In a study by Reiber GE et al in 1999, showed that diabetic foot ulcers were caused by peripheral sensory neuropathy in 63% of the cases [15]. The prevalence of Diabetic Poly-Neuropathy (DPN) increases with duration of the diabetes. In a study by Pirart J. et al, the incidence of neuropathy increased from 7.5% on initial presentation to 50% at 25 years follow up [16].

As previously stated, peripheral neuropathy is the leading causative factor in developing an ulcer, whereas ischemia will predict the outcome of infection. It affects approximately 50% of the patients with diabetes mellitus. DPN can be categorized in 3 main types: sensory neuropathy, motor neuropathy and autonomic neuropathy. DPN is a disease whose symptoms are related to dysfunction of peripheral nerves, such as demyelination, axonal atrophy, blunted regenerative potential, and loss of peripheral nerve fibers that occur specifically in patients with diabetes [17].

Typically sensory neuropathy is the first stage of DPN, and if not treated appropriately and strict blood glucose control is not implemented, it will progress to motor and autonomic. Motor neuropathy will lead to loss of intrinsic muscle innervation causing different foot deformities. The foot deformities can range from slight contracture of the proximal interphalangeal joints causing the classic "hammer toe" deformity", to more devastating deformities which destroy the anatomic architecture of the foot, such as Charcot Arthropathy. Foot deformities will result in abnormal pressure distribution which will invariably lead to ulcer formation. Autonomic neuropathy will lead to skin changes associated with altered cutaneous blood flow and loss of normal function of sweat and oil glands, creating skin that is dry and fragile like in the case of callous.

Overall, approximately 20% of the neuropathy is painful, meaning it is a small fiber neuropathy. Large fiber neuropathy is typically painless. However, hypoesthesia or anesthesia has a worse prognosis as often it will be neglected as patients do not perceive the painful stimuli of abnormal foot pressures and the development of a DFU. This will lead to delayed recognition of the ulcer and a delay in seeking help for it until a family member will notice the wound; or serious infection sets in [18].

Although the formation ulcer is clinically announced by the

appearance of a hyperkeratotic lesion at the site, diabetic peripheral neuropathy is the underlying precursor to both the formation of an ulcer and Charcot Arthropathy. In fact, despite patients with Charcot Arthropathy not being exclusively diabetic, peripheral neuropathy is a pre requisite to developing this horrific disease process. For this reason, it is paramount for a clinician to be familiar with common diagnostic techniques to identify a patient with peripheral neuropathy. More importantly, once the diagnosis of peripheral neuropathy is made, regular evaluation by a foot specialist is essential to prevention of diabetic foot complications. Any patient that presents to a clinic with a red, hot and swollen foot, with bounding pedal pulses, concomitant to peripheral neuropathy, should be considered "guilty" of Charcot Arthropathy [19].

A referral to a foot surgeon should be expedited in order to confirm the diagnosis of Charcot Arthropathy so that the decision of whether the patient can be treated conservatively through a combination of bisphosphonate infusion and total contact cast or surgical treatment can be made accurately in order to preserve the limb. Charcot Arthropathy is a destructive process where the structure of the foot is compromised; acute stage findings will include loss of arch height, multiple and diffuse fragmentation of bone; dislocation of the foot joints, which results in a non plantigrade foot. Untreated with lead to further loss of bone structure through extensive fracturing and increase in osteopenia as well as the development of ulcerations. In the incidence of skeletal deformity or loss of plantigrade structure of the foot concomitant to an ulceration, correction of the deformity is essential to healing the ulceration and saving the limb.

The author of this review has found that Ilizarov, external fixator surgery is very effective in restoring pedal architecture via arthrodesis of the involved joints after reduction of any subluxation. The author also recommends using external fixation during the acute stage of Charcot in order to arrest further dislocation and loss of bone density, which is not the traditionally accepted school of thought. However, early intervention with minimal incisions required and selective arthrodesis with an external fixator can prevent the need for aggressive wedge osteotomies and further loss of bone and permanent aberration of the foot which will be left shortened and less stable and more difficult to brace. If the ulceration is being caused by an underlying skeletal deformity, treatment will be greatly unsuccessful if the deformity is not corrected in the long term. Underlying peripheral arterial disease should be also carefully ruled out. Because of the incidence of atherosclerosis and arteriosclerosis present in the diabetic patient population, palpation of pedal pulses is unreliable. A delay in 3 seconds or more of the capillary refill time at the digits with absence of hair growth at the feet is a good clinical indicator that some extent of peripheral arterial disease is present. When these are findings are present, non invasive arterial studies through segmental pulse pressures and ankle brachial index are warranted and should not be delayed. Also transcutaneous oxygen pressures can give quantitative information on the potential for wound healing as a reading of 30mmHg usually is an indicator of poor potential for healing.

When examining the patient with a DFU, the author recommends using the University of Texas Classification System for diabetic foot ulcers. This system allows to assess the wound from different aspects. It distinguished whether a wound is infected or not; whether there is underlying vascular disease as well as the extent of the depth of the wound. A representation of this classification system is shown in Table 1.

Stage	Grade	Grade	Grade	Grade
	0	1	2	3
A	Pre/post lesion, completely epithelialized	Superficial wound not involving tendon, capsule or bone	Wound penetrating to tendon or capsule	Wound penetrating to bone or capsule
B	Infection	Infection	Infection	Infection
C	Ischemia	Ischemia	Ischemia	Ischemia
D	Ischemia/Infection	Ischemia/Infection	Ischemia/Infection	Ischemia/Infection

Table 1: University of Texas Classification System for Diabetic Foot Ulcers

Conclusion

Diabetic Foot Ulcers continue to be the number one cause of lower limb amputation worldwide. The implication of a diabetic foot ulcer is nothing short of a serious prognostic towards amputation and death for a patient with diabetes mellitus. It is of paramount importance as a clinician, whether an internist or a foot specialist or anyone evaluating a patient with diabetes, that early recognition and diagnosis of a diabetic foot ulcer be made and appropriate specialty referral expedited. Rapid and aggressive intervention can greatly reduce the time to heal of the ulcer, thus precluding worse complications. In turn this leads to preservation of the limb and quality of life for the patient. The importance of the referral to the specialist is that he or she can examine the diabetic foot as if it were an organ in of itself in order to make accurate diagnosis and implement appropriate treatment to successfully heal the wound, restore function and prevent amputations whose sequelae can be devastating.

References

1. Skrepnek GH, Mills JL Sr, Armstrong DG (2015) A Diabetic Emergency One Million Feet Long: Disparities and Burdens of Illness among Diabetic Foot Ulcer Cases within Emergency Departments in the United States, 2006-2010. *PLOS One* 10: e0134914.
2. Barshes NR, Sigireddi M, Wrobel JS, Mahankali A, Robbins JM, et al. (2013) The system of care for the diabetic foot: objectives, outcomes, and opportunities. *Diabet Foot Ankle* 4.
3. International Diabetes Federation (2013) *IDF Diabetes Atlas*, International Diabetes Federation, (6th Edn) Bruxelles, Belgium.
4. [No authors listed] (1999) Consensus Development Conference on Diabetic Foot Wound Care: Boston, Massachusetts. American Diabetes Association. *Diabetes Care* 22: 1354-1360.
5. Pecoraro RE, Reiber GE, Burgess EM (1990) Pathways to diabetic limb amputation. Basis for prevention. *Diabetes Care*

- 13: 513-521.
6. Halkos ME, Puskas JD, Lattouf OM, Kilgo P, Kerendi F, et al. (2008) Elevated preoperative hemoglobin A1c level is predictive of adverse events after coronary artery bypass surgery. *J Thorac Cardiovasc Surg* 136: 631-640.
7. Boulton AJ, Kirsner RS, Vileikyte L (2004) Clinical practice. Neuropathic diabetic foot ulcers. *N Engl J Med* 351: 48-55.
8. McWhinnie DL, Gordon AC, Collin J, Gray DW, Morrison JD (1994) Rehabilitation outcome 5 years after 100 lower-limb amputations. *Br J Surg* 81: 1596-1599.
9. Moss SE, Klein R, Klein BE (1999) The 14-year incidence of lower-extremity amputations in a diabetic population. The Wisconsin Epidemiologic Study of Diabetic Retinopathy. *Diabetes Care* 22: 951-959.
10. Reiber GE (1995) Lower extremity foot ulcers and amputations in diabetes. In: National Diabetes Data Group of the National Institutes of Diabetes and Digestive and Kidney Diseases, National Institutes of Health.
11. Cancelliere P, Knight J (2013) Identifying Chronic Kidney Diseases (CKD) as an Independent Risk Factor for Increased Morbidity and Mortality after Proximal Amputations. *Clin Res Foot Ankle* 1: 111.
12. Brownrigg JR, Griffin M, Hughes CO, Jones KG, Patel N, et al. (2014) Influence of foot ulceration on cause-specific mortality in patients with diabetes mellitus. *J Vasc Surg* 60: 982-986.
13. Armstrong DG, Wrobel J, Robbins JM (2007) Guest Editorial: are diabetes-related wounds and amputations worse than cancer? *Int Wound J* 4: 286-287.
14. Lavery LA, Hunt NA, Ndip A, Lavery DC, Van Houtum W, et al. (2010) Impact of chronic kidney disease on survival after amputation in individuals with diabetes. *Diabetes Care* 33: 2365-2369.
15. Reiber GE, Vileikyte L, Boyko EJ, del Aguila M, Smith DG, et al. (1999) Causal pathways for incident lower-extremity ulcers in patients with diabetes from two settings. *Diabetes Care* 22: 157-162.
16. Pirart J (1977) Diabetes Mellitus and its degenerative complications: a prospective study of 4400 patients observed between 1947 and 1973. *Diabetes metab* 3:245.
17. Farmer KL, Li C, Dobrowsky RT (2012) Diabetic peripheral neuropathy: should a chaperone accompany our therapeutic approach? *Pharmacol Rev* 64: 880-900.
18. Cancelliere P (2016) A Review of the Pathophysiology and Clinical Sequelae of Diabetic Polyneuropathy in the Feet.3: 2.
19. Al-Busaidi, Mason R, Lunt H (2015) Diabetic Charcot neuroarthropathy: The diagnosis must be considered in all diabetic neuropathic patients presenting with a hot, swollen foot. *N Z Med J* 128:77-80.

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