

Surgical Management of Diabetic Foot Ulcer (DFU): Systematic Review

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Abstract: Diabetes mellitus (DM) is one of the primary problems in health systems and a worldwide public health hazard that has actually increased dramatically over the past two decades. We aimed by this review to demonstrate the approaches of surgical management of diabetic foot ulcers, effectiveness, when to decide for surgical procedures efficiency and outcomes, all through reviewing the evidence based on previous studies. We searched for articles published through October 2016 in the following five electronic databases: PubMed, Science Direct, Embase, Web of Science, and Scopus, for both English and non-English language articles with the following keywords: “diabetic foot ulcer”, “amputations”, “wound management”, “debridement”, “advanced dressings”, “offloading modalities”, “hyperbaric oxygen therapy”, “electrical stimulation”, “negative pressure wound therapy”, “bio-engineered skin”, “growth factors”, and “foot care” as the medical subject heading (MeSH). The risk of injury to the diabetic foot is high, and the consequences of injury can be severe, therefore prevention is undoubtedly the best strategy. Tight glycemic control is essential but many problems can also be avoided by strict attention to foot hygiene and to the use of well-fitting footwear. Injury or infection may be overlooked in the early stages due to the difficulty some patients experience in inspecting their feet, as well as the effects of poor eyesight and reduced perception of pain. The role of the clinician in detecting these problems is of particular importance. Once all nonsurgical therapeutic options have been attended to, preventive surgery should be considered as a means of correcting deformities and minimizing the development of ulcerations, which may lead to much more drastic interventional surgery at a later date.

Keywords: Diabetic foot ulcer (DFU), Diabetes mellitus (DM).

1. INTRODUCTION

Diabetes mellitus (DM) is one of the primary problems in health systems and a worldwide public health hazard that has actually increased dramatically over the past 2 decades^(1,2). According to epidemiological research studies, the variety of patients with DM increased from about 30 million cases in 1985, 177 million in 2000, 285 million in 2010, and estimated if the scenario continues, more than 360 million people by 2030 will have DM^(3,4).

Patients with DM are prone to multiple issues such as diabetic foot ulcer (DFU). DFU is a typical complication of DM that has actually shown an increasing pattern over previous years^(5,6). In total, it is estimated that 15% of patients with diabetes will suffer from DFU throughout their lifetime^(7,8).

To recently, DFU is considered as a major source of morbidity and a leading cause of hospitalization in patients with diabetes^(1,5,9,10). It is approximated that approximately 20% of healthcare facility admissions amongst patients with DM are the outcome of DFU⁽¹¹⁾. DFU can lead to infection, gangrene, amputation, and even death if required care is not provided⁽¹¹⁾. On the other hand, when DFU has developed, there is an increased threat of ulcer progression that may ultimately lead to amputation. In general, the rate of lower limb amputation in patients with DM is 15 times higher than patients without diabetes⁽⁸⁾. It is approximated that approximately 50% -70% of all lower limb amputations are because of DFU⁽⁸⁾.

Recent studies have actually suggested several threat factors related to the advancement of DFU ^(12,13,14,15). These threat elements are as follows: gender (male), duration of diabetes longer than 10 years, advanced age of patients, high Body Mass Index, and other comorbidities such as retinopathy, diabetic peripheral neuropathy, peripheral vascular disease, glycosylated hemoglobin level (HbA1C), foot defect high plantar pressure, infections, and, inappropriate foot self-care habits ^(12,15).

We aimed by this review to demonstrate the approaches of surgical management of diabetic foot ulcers, effectiveness, when to decide for surgical procedures efficiency and outcomes, all through reviewing the evidence based on previous studies

2. METHODOLOGY

Systematic review was conducted according to reviews guideline:

Search Strategy:

we searched for articles published through October 2016 in the following five electronic databases: PubMed, Science Direct, Embase, Web of Science, and Scopus, for both English and non-English language articles with the following keywords: “diabetic foot ulcer”, “amputations”, “wound management”, “debridement”, “advanced dressings”, “offloading modalities”, “hyperbaric oxygen therapy”, “electrical stimulation”, “negative pressure wound therapy”, “bio-engineered skin”, “growth factors”, and “foot care” as the medical subject heading (MeSH). Study designs that were included were randomized controlled trials (RCTs), case-control studies, cohort studies, prospective and retrospective uncontrolled studies, cross-sectional studies, and review studies. Case reports and case series were excluded. We searched bibliographies for all retrieved and relevant publications to identify other studies.

3. RESULTS AND DISCUSSION

Diabetic foot surgery plays an essential role in the prevention and management of DFU ⁽¹⁶⁾ and has actually been on the increase over the past 2 decades ^(17,18). Surgical interventions for patients with DFU are not without risk, the selective correction of consistent foot ulcers can improve results ⁽¹⁹⁾ In general, surgical treatment for DFU healing consists of non-vascular foot surgical treatment, vascular foot surgery, and in some cases amputation. Nonvascular foot surgical treatment is divided into optional, prophylactic, curative, and emerging surgical treatments that aim to fix deformities that increase plantar pressure ⁽²⁰⁾ (**Table 1**). Today, a couple of research studies have actually reported long-term results for diabetic foot surgical treatment in RCTs ^(21,22) In one study carried out by Mueller et al ⁽²¹⁾, topics were randomized into two groups of Achilles Tendon-Lengthening (ATL) group, who received treatment of ATL and TCC, and a group who got TCC only. Their outcomes showed that all ulcers healed in the ATL group and the risk for ulcer reoccurrence was 75% less at seven months and 52% less at 2 years than for the TCC group ⁽²¹⁾.

Table1: Different types of nonvascular diabetic foot surgery

Type	Explanation
Elective	The main goal of this surgery is to relieve the pain associated with particular deformities such as hammertoes, bunions, and bone spurs in patients without peripheral sensory neuropathy and at low risk for ulceration
Prophylactic	These procedures are indicated to prevent ulceration from occurring or recurring in patients with neuropathy, including those with a past history of ulceration (but without active ulceration)
Curative	These procedures are performed to effect healing of a non-healing ulcer or a chronically recurring ulcer when offloading and standard wound care techniques are not effective. These include multiple surgical procedures aimed at removing areas of chronically increased peak pressure as well as procedures for resecting infected bone or joints as an alternative to partial foot amputation
Emergent	These procedures are performed to arrest or limit progression of acute infection

Data were cited from Frykberg et al ⁽¹²⁾.

Vascular foot surgical treatment such as bypass grafts from femoral to pedal arteries and peripheral angioplasty to enhance blood flow for an ischemic foot have actually been just recently developed⁽²³⁾. While studies have revealed that these treatments assist to recover ischemic ulcers^(24,25,26) no RCT has actually been shown to minimize DFU.

While the primary goal of DFU management focuses on limb salvage, in some cases amputation may use a better functional result, although this is frequently not plainly specified⁽²⁷⁾. This decision is individualized and multifactorial to match patient lifestyle, medical, physical, and psychological comorbidities⁽²⁷⁾. In general, amputation is thought about as a immediate or curative surgery and need to be the last resort after all other salvage strategies have actually been checked out, and the patient should remain in agreement⁽²⁸⁾. Signs for an amputation consist of the elimination of gangrenous or infected tissues, control of infection, and creation of a functional foot or stump that can accommodate footwear or prosthesis⁽²⁹⁾.

Surgery treatment of diabetes foot infection:

Eneroth et al.⁽³⁰⁾ demonstrated that deep foot infections in diabetic patients are a heterogeneous entity, and the type of infection is associated with the outcome. Amputation was needed more frequently for patients with deep soft-tissue infection, either alone or in mix with osteomyelitis, than for those with osteomyelitis alone. Armstrong et al.⁽³¹⁾ validated a diabetic foot-wound category system that showed that the combination of infection and ischemia led to the worst outcome. Both of these studies highlight the need for an extensive assessment of the infection. Extreme infections position an immediate risk to the leg and, potentially, to the patient's life. Thus, timely surgical intervention is required. Severe infections can occur when a mild to moderate infection is complicated by vital ischemia or when an effectively perfused foot reveals a marked local participation (e.g., necrotizing fasciitis or an infection with anaerobic gasforming organisms) or systemic signs and symptoms (throwing up, fever, and hypotension, suggestive of bacteremia). Necrotizing fasciitis is a severe illness with a death rate of 24%-- 33%. It has actually classically been gotten in touch with b-hemolytic streptococci, however a current review of 163 cases discovered that 71% of those with a favorable result of tissue culture had polymicrobial infections⁽³²⁾. Numerous reports have documented an association of necrotizing fasciitis with diabetes mellitus^(33,34). The existence of serious discomfort with a deep plantar foot infection in a diabetic patient is often the first disconcerting symptom, particularly in a patient with a previously insensate foot. Numerous aspects might result in quick wear and tear and its attendant complications. The majority of ulcers take place on the plantar surface of the foot, at the head of the metatarsal bones. With infection and subsequent cellulitis, edema can develop in the underlying compartment, resulting in a compartment syndrome⁽³⁴⁾.

Vascular reconstruction:

Arterial reconstruction Lower extremity ischemia is classified according to the location of the arterial obstruction relative to the inguinal ligament. Ischemic symptoms can result from aortoiliac occlusive lesions (inflow disease) or femoropopliteal occlusive lesions (outflow disease). Despite extensive medial calcification of the aortoiliac system, patients who have diabetes do not usually have significant isolated aortoiliac occlusive disease. Ischemic rest pain in patients with such proximal disease is uncommon because of the extensive collateral network that develops. However, patients with aortoiliac occlusive disease will commonly demonstrate concomitant obstructive arteriopathy in the femoropopliteal or infrapopliteal segment. Generally, correction of hemodynamically significant inflow lesions will result in substantive improvement in symptoms in all genders^(35,36,37,38,39).

Amputation:

In 1949, Jonas Ertl described the technique of producing a distal tibiofibular bone bridge that now bears his name⁽⁴⁰⁾. In theory, the Ertl method should create an amputation stump that tolerates more axial loading and reduces discomfort as a result of increased distal tibio-fibular stability as compared with standard BKAs. Pinzur examined his series of 20 amputees who underwent distal tibiofibular bone bridging and did not find any difference in their result when compared to a matched friend who did not have distal tibiofibular bone bridging⁽⁴¹⁾. Life expectancy decreases as each subsequent section of the leg is cut off: toe < foot < lower leg < knee thigh⁽⁴²⁾. At Georgetown, we compared our survival and ambulation rate of foot amputees with below-knee amputees in 937 successive patients from 1999 to 2000. There were 88 foot amputations (Chopart, tma and lisfranc) of whom 80% were still alive at 2 years with 64% ambulating. There were 25 BKAs with 52% alive and 64% of those ambulating at 2 years. The higher death rate amongst the BKAs is most likely discussed by a selection predisposition versus more limb salvage because of advanced disease⁽⁴³⁾.

4. CONCLUSION

The risk of injury to the diabetic foot is high, and the consequences of injury can be severe, therefore prevention is undoubtedly the best strategy. Tight glycemic control is essential but many problems can also be avoided by strict attention to foot hygiene and to the use of well-fitting footwear. Injury or infection may be overlooked in the early stages due to the difficulty some patients experience in inspecting their feet, as well as the effects of poor eyesight and reduced perception of pain. The role of the clinician in detecting these problems is of particular importance. Once all nonsurgical therapeutic options have been attended to, preventive surgery should be considered as a means of correcting deformities and minimizing the development of ulcerations, which may lead to much more drastic interventional surgery at a later date. Many ulcerations and complications of infection can be avoided or minimized if surgery is carried out in a timely fashion to improve vascularity, or to reduce mechanical trauma to the foot, wound, or plantar surface.

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