

Diabetic Limb Salvage: Too Much of a Good Thing?

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Abstract

Diabetic foot complications exact a significant toll on patients specifically and the health care system in general. Most data suggest that limb preservation generally results in a higher quality (and quantity) of life for the patient and lower overall direct and indirect costs. However, when focusing on a specific patient, significant questions remain. The most significant being: how much effort is too much? The purpose of this manuscript is to present a case that explores this issue.

Keywords

limb salvage, diabetic foot infection, peripheral arterial disease

Introduction

When severe diabetic foot infections affect young and previously highly functional patients, vascular surgeons face the dilemma of pursuing lower extremity revascularization and aggressive foot debridement and reconstructive procedures versus performing a primary major amputation at the below-the-knee level given their assumed high level of functional recovery after an amputation and the high potential for ambulation with a prosthetic limb. This Case Report describes the presentation, management, and outcome of a young diabetic male with severe foot sepsis, who was managed with nontraditional, heroic methods of limb revascularization and feet reconstruction, which ultimately achieved limb salvage, after a prolonged and costly therapeutic strategy.

Case Description

A 52-year-old Caucasian diabetic man with a left foot ulcer that appeared spontaneously about 4 weeks prior and that was treated on antibiotics as an outpatient (with Cephalexin initially, eventually changed to sulfamethoxazole and trimethoprim due to lack of clinical improvement). The patient eventually developed fever, cough, and shortness of breath for which he went to the emergency room of an outside hospital. Congestive heart failure, severe foot infection, and a possible pneumonia were diagnosed, antibiotics were started and request was made to transfer the patient to our institution for further care. His past history is significant for hypertension, chronic renal insufficiency (baseline creatinine of 1.3 mg/dL), hyperlipidemia, and diabetes for the last 10 years, with poor outpatient blood sugar control. The patient has also a history of 2 diabetic right foot ulcers treated with local incision and drainage therapy.

On initial assessment, the patient had erythema that started at the forefoot and went up beyond the medial and lateral malleoli. Foul smell arising from the left foot, lack of palpable popliteal and pedal pulses, and left fourth and fifth dusky toes with evidence of wet gangrenous component were also noted. Some boggy areas at the level of the ventral aspect of the forefoot were noted consistent with a possible abscess underneath the skin. His initial blood work was remarkable for a white blood corpuscle (WBC) of 31 500 cells/ μ L, a blood sugar of 181 mg/dL, and blood urea nitrogen (BUN) and creatinine of 27 mg/dL and 1.5 mg/dL, respectively. Cardiac echocardiogram developed grossly normal cardiac function and his beta natriuretic peptide (BNP) was only minimally elevated, ruling out significant heart failure. Intravenous Ceftriaxone and Piperacillin/Tazobactam were begun, as well as Azithromycin for his supposed pneumonia. His WBC decreased only minimally despite administration of antibiotics. Vascular surgery consultation was made approximately 3 days after hospital admission.

Noninvasive ultrasound studies on admission revealed bilateral lower extremity arterial occlusive disease at the femoropopliteal and tibial artery levels, with poor arterial circulation at rest on the right with an ankle-brachial index (ABI) of 0.5 and severe arterial insufficiency at rest on the left with an

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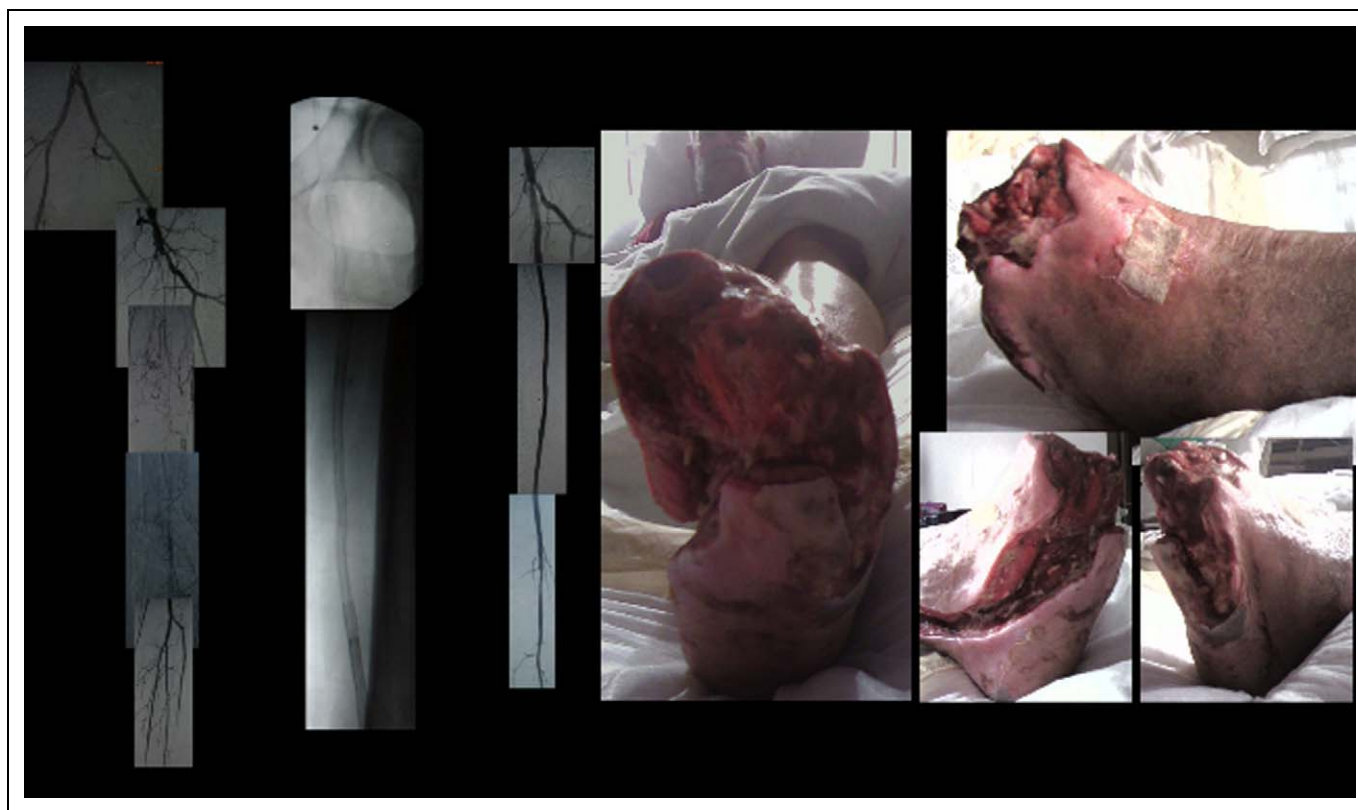


Figure 1. Angiographic images of the left lower extremity showing a complete left superficial femoral artery (SFA) chronic atherosclerotic occlusion with reconstitution of the popliteal artery at the knee level and a 3-vessel runoff. Stents were placed from the SFA origin down to the popliteal artery at the above-the-knee level, with restoration of in-line flow to the foot and palpable pedal pulses. To the right of the Figure, 4 images are shown, depicting the extent of necrosis and devitalized tissues seen after the first few debridement procedures.

ABI of 0.37. He underwent emergent left superficial femoral artery angioplasty and stenting, followed by wide left-foot debridement and open ray fourth and fifth toe open amputations on November 17, 2009 (Figure 1, left panel). This intervention restored palpable pedal pulses. His BUN and creatinine worsened and reached maximum values of 50 and 5.3 mg/dL, respectively, on November 20, presumably due to sepsis. Similarly, his WBC reached a maximum of 33 300 cells/ μ L on November 18. On November 21, reresection with debridement of skin, subcutaneous tissue, and bone including the left fourth and fifth metatarsal heads were performed, and a vacuum-assisted closure (VAC, KCI Incorporated, San Antonio, Texas) therapy was also applied. On November 25, left foot wide debridement and wound VAC application was done. On December 1, additional operative foot-wide debridement down to bone was required. On December 3, a wide debridement of the left foot down to bone and a transmetatarsal amputation was performed. Multiple foot cultures revealed *Pseudomonas aeruginosa*, *Staphylococcus aureus*, coagulase-positive, beta-hemolytic streptococcus group B, coagulase-negative *Staphylococcus aureus*, diphtheroids, *Trichophyton rubrum*, and streptococcus species. After Infectious Disease consultation was obtained, intravenous Vancomycin and Piperacillin/Tazobactam were given all

throughout his hospital stay through a peripherally inserted central catheter (PICC line).

On December 6, an orthopedic consultation was obtained. On their assessment, the orthopedic surgeon documented a palpable popliteal pulse, as well as an open wound extending proximal to the medial malleolus and then extending down into the plantar aspect of the foot. Exposed metatarsal bones are seen, as well as exposed bone at the base of the fifth metatarsal tuberosity. Superficial ulcerations over the mid-foot were also seen (Figure 1, right panel). Based on those findings, the orthopedic surgeon explained to the patient and his wife that coverage of the exposed area would be quite problematic and that he was unsure of the potential to salvage an amputation at the transmetatarsal level. He had the patient consider a below-knee amputation (BKA) so that the predictability of healing and extremity function is improved. He thought that this was a more attractive option than a Syme-type amputation or additional surgeries to try and salvage the transmetatarsal level. The patient was then receptive to a BKA and favored that rather than the uncertainty of a prolonged attempt to heal the foot at the current level. The orthopedic surgeon did not see any other orthopedic reconstructive options to consider at that point in time.



Figure 2. The Integra system is seen applied to the left foot wound, achieving complete coverage of the area of tissue loss. Superficial skin lesions and delayed primary closure of the uppermost area of the wound at the medial ankle region with staples can be also seen on the left and right images, respectively.



Figure 3. Follow-up images of the left foot wounds with the Integra system in place, showing granulation tissue growing under the silicone external layer and for the most part, viable tissues underneath the matrix.

On further discussion with his treating physicians, it was decided to continue limb salvage attempts, and therefore, on December 8, further wide-wound debridement down to bone and application of the Integra Bilayer Matrix wound dressing (Integra LifeScience Corp., Plainsboro, New Jersey) for a total area of 284 cm² approximately, together with a VAC application was done (Figure 2). Partial closure of the uppermost region of the left foot wound in delayed primary manner was also done. His WBC, BUN, and creatinine steadily decreased

after multiple surgical interventions and were 9300 cells/ μ L, 15, and 1.4 mg/dL upon discharge on December 9. From here on, outpatient therapy was instituted (Figure 3). Unfortunately, in addition to his large forefoot wounds, he developed a deep pressure heel ulcer that, on January 13, 2010, required a wide debridement of the left heel, down to bone, and Integra application for an area of 25 cm², as well as wound VAC application. Coagulase-negative *Staphylococcus aureus* and *Candida glabrata* grew on culture specimens obtained from the left heel



Figure 4. Contrasting images taken 2 months apart showing a large amount of devitalized tissue and large areas of exposed tendon and bones on the left panel, and the granulation tissue achieved after 7 weeks of Integra system and wound vacuum-assisted closure (VAC) application.

wound. On February 4, wide debridement of left heel and forefoot wounds, with split-thickness skin graft application to both areas, and wound VAC application over the skin graft were done (Figures 4 and 5). On March 3, all staples were removed and patient was cleared on March 17 to start using a custom-made shoe for ambulation (Figure 6). Duplex ultrasound was done on the same day, showing widely patent stents without evidence of restenosis. At this point, new skin is seen in most of the foot, with small open areas with healthy-appearing granulation tissue, now easily managed with local wound control.

Discussion

The presentation and outcome of this patient precisely depicts a common scenario that vascular surgeons encounter on a daily basis in a typical clinical practice. When facing a severe diabetic foot infection in a relatively young diabetic patient, fully functional prior to the onset of the infectious event, the treating physician must decide between a primary amputation versus aggressive attempts for limb salvage. The benefits of the former strategy include a presumed high potential for rehabilitation of a relatively young patient and also the presumably shortest time that would take from presentation until regaining ambulatory status, with the (presumably) minimum number of surgical interventions needed to achieve successful ambulation. Patients with high premorbid functional levels afflicted with comorbidities that did not limit their functionality could be best served by an amputation because their potential for rehabilitation with a prosthetic limb is certainly higher than that of a medically ill patient.

However, it needs to be considered that limb loss due to severe lower extremity ischemia is often sudden and is considered for most people a devastating event. The ensuing disability makes life changes necessary to adjust to a world where physical ability is the rule. The patients' acceptance of limb loss and their state of psychological recovery are thought to be greatly influenced by the individual's resilience levels, social support, medical care, economic situation, and societal attitudes toward people with disabilities. Therefore, potential downsides of this approach include the immediate negative psychological reaction to amputation (anxiety, depression, body image problems with development of a changed sense of self and identity, vulnerability feelings, grief); the adjustment during and shortly after the rehabilitation period; local socket problems (pain, heat, or sweating; sores or skin irritation; inability to walk in woods and fields or to walk quickly); back or phantom limb pain, back or contralateral limb pain; and social support changes.¹ Additionally, it has been shown that in most patients, their functional ability decreases after lower limb amputation.² Finally, life expectancy following high-level amputation is worse than most forms of cancer, including breast, prostate, and colon neoplasms.³ Five-year mortality rates of up to 74% for diabetic patients with lower extremity amputations have been reported.⁴

Traditional management dogmas have assumed that there are patients with such severe medical comorbidities, which include impaired ambulatory ability at presentation that the benefits of revascularization seem to be insignificant. As our patient population ages and our health care system continues to face financial challenges, economic rationing motivated by lack of evidence-based data to the contrary may dictate that



Figure 5. Intraoperative images of the split-thickness skin graft procedure that ultimately achieve full-wound autologous coverage and limb salvage.

these patients are best served by primary limb amputation. Our patient has been through a prolonged period of therapy, not only due to his current issues affecting the left lower extremity but also during the therapy for the ulcers affecting the right limb, which apparently required a prolonged time of therapy to achieve healing. He had considered the benefits of an amputation previous to his last hospital admission and at many times during his hospital stay, strongly questioned our efforts to achieve limb salvage, encouraged by the opinion of consultants along the way (for instance, the opinion of the orthopedic surgery service) who, despite a short interaction with the patient, did not hesitate in considering further attempts for limb salvage, futile.

There are highly controversial issues present in this patient's management. It has been shown that in diabetic patients with critical limb ischemia, revascularization is feasible in most cases and allows a low rate of early major amputation.⁵ To achieve this benefit, multiple revascularization procedures may be required, and close surveillance is therefore mandatory.⁶

The need for revascularization therefore has not been questioned but the type of revascularization performed has.⁶ Some questioned the longevity of performing a "full-metal jacket" stenting of the superficial femoral artery, stating that it would have been better to perform a traditional vein graft femoropopliteal bypass, to ensure a more long-lasting revascularization method. The optimal revascularization strategy in diabetic patients with chronic critical limb ischemia is unclear. We consider these concerns regarding the long-term patency of arterial stenting appropriate. It has been shown that the choice of initial revascularization modality seems not to influence clinical success.⁶ Furthermore, at the moment of presentation, the severity and extent of his infection made us believe that a more rapid, less invasive way to revascularize his extremity would serve him best, in case we would not have been able to control the infectious process. We believe that, if stent thrombosis may now occur, the patient's level of awareness that will allow him to recognize it and to seek medical attention is high and if that would occur, a vein bypass would be performed.



Figure 6. Ultimate appearance of the foot after skin staples were removed and patient was cleared from the vascular surgery standpoint to restart ambulation.

Another controversial issue was the amount of exposed tendons and bone when the infection was finally controlled. This fact made the wound not amenable to traditional skin grafting and led many to consider that our patient's wound was nonreconstructible. Vascularized flaps, which represent the most appropriate treatment for the treatment of lower extremity wounds with exposed bone, tendons, or joint, were not suited for this particular problem in a disvascular limb. The Integra is a bilaminated dermal replacement matrix, composed of bovine collagen and shark chondroitin-6-sulfate (cell-free). The epidermal component is a thin layer of silicone. This matrix serves as scaffolding for the ingrowth of fibroblasts and endothelial cells. This matrix becomes vascularized in 2 to 4 weeks and eventually becomes remodeled into a dermal equivalent. It additionally allowed elimination of dead space, surface adherence, control of bacterial invasion. We use negative-pressure therapy with the VAC system to aid in skin grafting procedures, and now we are using it in combination with Integra. After successful matrix engraftment, the silicone

layer can be removed and replaced with a thin split-thickness skin graft. Most of the experience gained with this product has been reported in burn wounds. Not much has been published in the management of wounds due to peripheral arterial disease, which has become our next project.

The final outcome of this patient was that of limb salvage with ensuing ambulation. However, the status of his foot on admission and during the first 2 weeks after therapy was almost unsalvageable and, in fact, considered by many as such. We therefore acknowledge that the outcome could have easily been that of a very prolonged, very expensive, and unsuccessful attempt for limb salvage, which represented our fear all along this patient's treatment period. Evidence has also suggested that from the patient's perspective on undergoing multiple procedures for limb salvage that ultimately result in major lower extremity amputation, and certainly from our particular patient's perspective, they are most often willing to undergo multiple revascularizations percutaneous or open to attempt limb salvage even if the eventual result is major limb loss.⁷

Would it have been more appropriate to perform a single intervention in the means of a high-level amputation versus the 8 surgical interventions, 108 days of intensive therapy and intravenous antibiotics, multiple outpatient visits (with the corresponding co-payment fees, traveling, time, and home-health expenses), for close follow-up, ultimately required for limb salvage? The answer to this question is nebulous and will remain a matter of personal points of view—both by the patient and the patient's family and his or her clinical team. We believe that the ultimate decision should be determined after a prolonged discussion of the benefits and risks of both approaches, that is, a major amputation as definitive therapy versus attempts to revascularize and reconstruct a lower limb, including nontraditional methods. Also as important to consider is the economic situation of the patient and the country or the hospital caring for the patient, which obviously in some cases would prohibit the use of such expensive tools. Frequent reevaluations are a must along the therapeutic path, to ensure that the patients and their families are aware of the clinical status, possible outcomes, and that they are given the option to change their preference as to continue with limb salvage strategies versus choosing an amputation instead.

Declaration of Conflicting Interests

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