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The Use of a Dermal Substitute (Integra) to Preserve Maximal Foot Length in a Diabetic Foot Wound With Bone and Tendon Exposure Following Urgent Surgical Debridement for an Acute Infection

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Abstract

In this report, the authors present the case of a 62-year-old female patient who was admitted to our hospital with an acute deep foot infection. The patient was taken immediately to the operating room where she underwent surgical debridement to completely remove all infected tissues; at the end of this first surgical step, all 5 metatarsal bones remained exposed dorsally. Once eradication of infection was completed, we had to decide whether to perform a transmetatarsal amputation at proximal levels, which would have allowed healing by first intention but would have left the patient with a smaller foot stump, or amputation at more distal levels followed by coverage of healthy tendon and bone tissues with a dermal regeneration template (Integra, Integra Life Sciences Corporation, Plainsboro, NJ), which would have preserved the foot stump length and allowed better walking. We opted for the second choice, and the use of a dermal template actually enabled our patient to maintain a considerable foot stump length, much longer than would have resulted from an amputation with immediate primary closure.

Keywords

diabetic foot infection, minor amputation, dermal substitute, foot length

Improvements in diagnostic and therapeutic techniques and the adoption of multidisciplinary approaches for managing diabetic foot disease have enhanced limb salvage rates.[1,2] Treatment for feet presenting with infection or widespread gangrene consists of surgical removal of the infected soft and nonvital bone tissues, which often means minor amputation even at proximal levels, that is, Chopart amputation. Following aggressive debridement, a lack of soft tissue available for covering exposed bones and healthy tendons may necessitate more proximal amputation to achieve immediate surgical wound closure by first intention, resulting in shortening of the foot stump. Preserving maximal residual foot length is an important goal when performing large debridement or minor amputation. This increases the patient's potential for rehabilitation and mobility.[3] Our report describes the case of a female diabetic patient in whom the proper surgical approach allowed preservation of maximum length of the foot stump, thus, providing improved gait.

Case Report

A 62-year-old female patient, who had been diagnosed with diabetes mellitus at the age of 50 years and treated with oral antidiabetic drugs was referred to our diabetic foot center on March 30, 2009, because of the worsening of an ulcer on the fifth toe of her right foot. The ulcer had developed 15 days previously and was being treated at another hospital. Table 1 shows the demographic characteristics and test results at admission.

At admission, the patient presented with wet and foul smelling gangrene of the fifth toe of her right foot, with

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Table 1. Demographic and Clinical Characteristics at Admission

Diabetes duration (years)	12
Glucose (mg/dL)	240
Glycosylated hemoglobin (%HbA_1c)	7.5
Sensory-motor neuropathy	Yes
AOCP	Yes
Creatinine (mg/dL)	0.85
Antihypertensive therapy	ACE inhibitor + β blocker
Cardiac disease	No
Polymerase chain reaction (mg/dL)	21.44
White cell count ($\times 10^3$/mm)	11.0
Microbiological cultural test	MRSA + *Streptococcus* Ag

Abbreviations: ACE, angiotensin-converting enzyme; MRSA, Methicillin-resistant *Staphylococcus aureus* **[AQ: 6]**

Figure 1.

forefoot phlegmone and crepitation on palpation of the dorsum of the foot (see Figure 1A). Ischemia caused by edema (compression) was detected on the third and fourth toes (see Figure 1B). **[AQ: 2]**

On admission, the patient was tested for the presence of diabetic neuropathy and chronic critical limb ischemia. Sensory-motor neuropathy was defined as a vibration perception threshold >25 V (biothesiometer), insensitivity in more than 5 of 9 foot points (Semmes-Weinstein 10 g filament), and absence of Achilles tendon reflex. Critical limb ischemia was defined as ankle-pressure <70 mm Hg when assessable (foot arteries absent or not compressible because of medial calcifications) and transcutaneous oxygen tension ($TcPO_2$) < 30 mm Hg; $TcPO_2$ measurements were taken at the dorsum of the foot with the patient resting in the supine position, in an air-conditioned room maintained at 22°C; the instrument used was a TCM 3 (Radiometer GMBH, Copenhagen, Denmark) equipped with a Clark electrode. The measuring site was cleaned carefully using saline solution. The transducer was fixed to the skin with double-sided adhesive rings and contact liquid supplied by

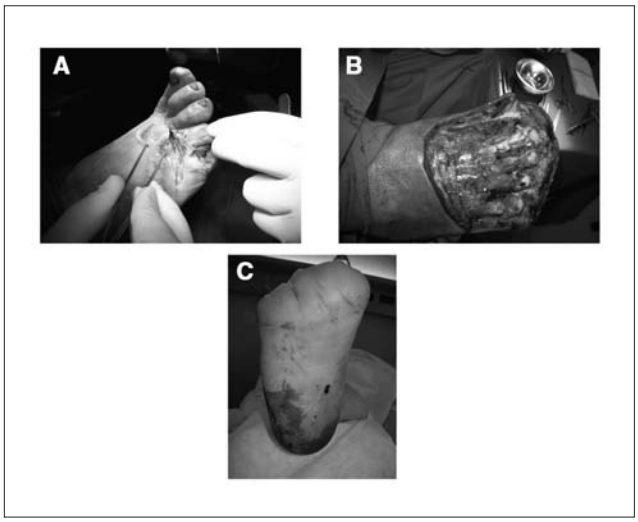

Figure 2.

the manufacturer. The calibration period was 10 minutes, and the $TcPO_2$ signal was continuously recorded on paper for 30 minutes.

Arterial duplex scan revealed the presence of tibial peripheral arterial disease, with stenosis of the anterior tibial artery and obstructions of the posterior tibial artery with distal rehabitation. **[AQ: 3]** $TcPO_2$ at the dorsum of the foot was 13 mm Hg, probably affected by the presence of foot edema and infection. Plantar foot $TcPO_2$ was 74 mm Hg. Ankle systolic pressure could not be assessed because the arteries were noncompressible as a result of Moenkeberg sclerosis. Foot radiography excluded the presence of osteomyelitis but revealed the presence of subcutaneous gas and arterial calcifications.

The patient was promptly treated with double intravenous antibiotic therapy (piperacillin/tazobactam and metronidazole); the oral antidiabetic therapy was interrupted, and a subcutaneous insulin therapy was started. In keeping with our clinical practice, the deep infected foot ulcer was managed on the day of admission with surgical incision (under locoregional anesthesia by combined sciatic and femoral nerve blocks) over the dorsal surface of the fifth toe. The incision allowed discharge of any purulent material and released any foul-smelling substances that infiltrated the dorsal and medial forefoot. Afterward, the lesional area was extensively debrided, toes were disarticulated, and the soft dorsal tissues were thoroughly cleansed until healthy tissue was reached in the healthy midfoot area (Figures 2A and 2B), with a gap between the soft tissue at the dorsum and at the plantar surface (Figure 2C). In keeping with our clinical practice, treatment of deep infected foot ulcers did not include an immediate wound closure during the first surgical session because of the high risk of surgical wound infection.

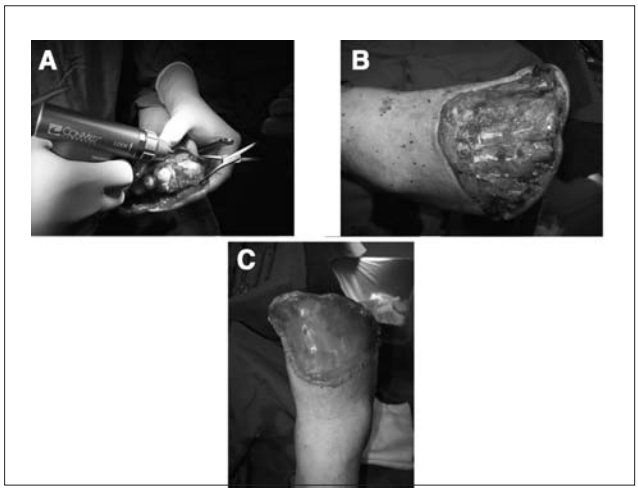

Figure 3.

During the surgical debridement, optimal bleeding was observed, and the next day $TcPO_2$ was 38 mm Hg. The day after surgery, the patient underwent negative pressure wound therapy with open-celled polyurethane foam (V.A.C. Vacuum Assisted Closure Therapy, Kinetic Concepts, Inc, KCI, San Antonio, TX) for 3 days at a continuous pressure of 125 mm Hg. By April 3, the infection had disappeared, and healthy granulation tissue was present on the wound surface; the patient then underwent distal metatarsal amputation (Figures 3A and 3B). A dermal regeneration template consisting of bovine collagen, Integra (Integra Life Sciences Corporation, Plainsboro, NJ), was used to compensate the loss of dorsal soft tissue for coverage of exposed tendon and bone tissues (Figure 3C). In this patient, wound closure by primary intention would have required a more proximal metatarsal amputation with the use of a plantar flap for the coverage of the dorsal defect; however, this approach would have considerably reduced the length of the foot stump (proximal transmetatarsal amputation).

The patient was discharged from hospital on April 4, 2009, and provided with a postoperative shoe (Optima PostOp, Molliter srl, Civitanova Marche, Italy) specifically designed to allow the patient to walk even in the presence of a large foot ulceration. The patient was then visited every 5 days for secondary dress changes (Mepitel, Mölnlycke Health Care, Goteborg, Sweden) by a trained assistant.

On April 29, patient was readmitted to our foot center; the silicon film was removed, and the newly formed granulation tissue was covered with a skin graft during the same surgical session. After discharge from hospital on May 1, the patient was visited every 5 days for secondary dressing changes (Mepitel). On June 4, the lesion had healed completely (Figures 4A and 4B); the patient was then provided with secondary prevention shoes, with rigid soles (rocker sole) and customized insole made of Alkafoam and PPT (Professional Protective Technology). Three months later, a radiographic examination revealed no stump complications, including osteomyelitis.

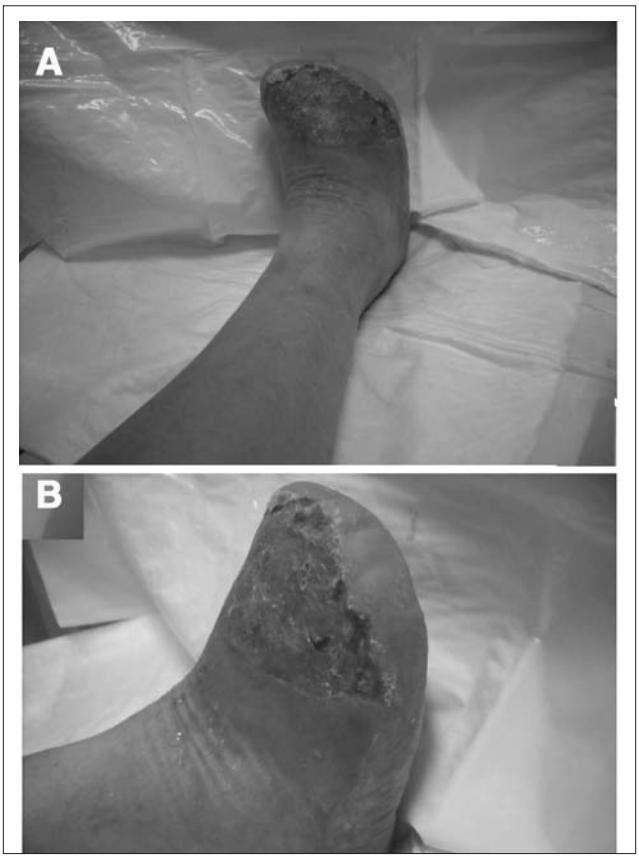

Figure 4.

Discussion

Despite improvements in the management of the diabetic foot, the presence of ischemia or infection, which are risk factors for amputation and mortality, remains a challenge for clinicians.[4,5] In our experience, these complications most often result from delayed treatment. Treatment delay can allow the rapid spread of infection and tissue necrosis, resulting in severe loss of substance.[6] In these cases, limb salvage requires aggressive debridement with or without minor amputation, frequently at very proximal levels. In such situations, the challenge is to preserve maximal residual stump length, thereby providing patients the greatest possibility of rehabilitation and continued mobility.[3]

The present clinical study evaluates the use of a dermal substitute for preserving maximal foot length in diabetic patients presenting with exposed healthy tendon and bone tissues. In comparison to techniques that use regional flaps

and free flaps, dermal substitutes offer unique advantages in terms of ease of use and lower invasiveness.

It may be speculated whether a similar result could have been achieved using advanced dressings or bioengineered skin substitutes. However, whether such dressings can cover the tendon and bone tissues adequately and how these types of dressings affect healing time are unanswered questions.[7-9]

In conclusion, the use of the dermal substitute Integra for treating exposed tendon and bone tissues following treatment for deep wound infections in diabetic patients allowed timely wound healing and preserved maximal foot length, improving walking ability in this patient. Such treatment should constitute part of the comprehensive management of diabetic wounds.

Authors' Note

Drafting of manuscript and revision: Clerici and Faglia; acquisition of data: Caminiti, Curci, and Quarantiello; final approval of the article: Clerici, Caminiti, Curci, Quarantiello, and Faglia.

Declaration of Conflicting Interests

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