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

Giacomo Clerici, M. Caminiti, V. Curci, A. Quarantiello, and E. Faglia

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.

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...
Table 1. Demographic and Clinical Characteristics at Admission

<table>
<thead>
<tr>
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<th>Value</th>
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<tbody>
<tr>
<td>Diabetes duration (years)</td>
<td>12</td>
</tr>
<tr>
<td>Glucose (mg/dL)</td>
<td>240</td>
</tr>
<tr>
<td>Glycosylated hemoglobin (%HbA1c)</td>
<td>7.5</td>
</tr>
<tr>
<td>Sensory-motor neuropathy</td>
<td>Yes</td>
</tr>
<tr>
<td>AOCP</td>
<td>Yes</td>
</tr>
<tr>
<td>Creatinine (mg/dL)</td>
<td>0.85</td>
</tr>
<tr>
<td>Antihypertensive therapy</td>
<td>ACE inhibitor + β blocker</td>
</tr>
<tr>
<td>Cardiac disease</td>
<td>No</td>
</tr>
<tr>
<td>Polymerase chain reaction (mg/dL)</td>
<td>21.44</td>
</tr>
<tr>
<td>White cell count (×10^3/mm)</td>
<td>11.0</td>
</tr>
<tr>
<td>Microbiological cultural test</td>
<td>MRSA + Streptococcus Ag</td>
</tr>
</tbody>
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Abbreviations: ACE, angiotensin-converting enzyme; MRSA, Methicillin-resistant Staphylococcus aureus.

Figure 1.

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.
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.

**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. 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. 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.

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.\textsuperscript{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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**References**


