Treatment of chronic heel osteomyelitis in vasculopathic patients. Can the combined use of Integra®, skin graft and negative pressure wound therapy be considered a valid therapeutic approach after partial tangential calcanectomy?

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INTRODUCTION

Osteomyelitis of the calcaneus is a difficult problem to manage. The goal of the treatment is the eradication of the infected bone, preserving the weight-bearing function of the foot (1).

Moreover, patients affected by osteomyelitis of the calcaneus often have recalcitrant ulcerations of the heel and other significant medical and/or chronic venous insufficiency (1). These patients, thus, often have a below-the-knee amputation (2). The proper management of each of the listed comorbidities is mandatory, in order to obtain the healing of the ulcers and to minimise the risk of their recurrence.

Partial calcaneectomy is a common procedure for the treatment of chronic heel ulcers with limited calcaneal involvement (2–6), but in the cases of large ulcerations and vascular problems, it is not possible to approximate the adjacent healthy soft tissue and close primary skin; moreover in our opinion, the employment of pedicle or free flap should be reserved for selected patients without many comorbidities (7,8).

In this article, we present seven cases of heel ulcerations with osteomyelitis treated with Integra® Dermal Regeneration Template, skin graft and negative pressure wound therapy, after partial tangential calcaneectomy, discussing the surgical and functional results of our casuistic.

MATERIALS AND METHODS

A retrospective study was performed in the department of Reconstructive and Aesthetic Plastic Surgery at the University Hospital San Giovanni Battista of Turin during the period from May 2007 to December 2010. We identified seven patients with large ulceration of the heel (Table 1; Figure 1), managed with a partial calcaneectomy, temporary coverage with Integra® Dermal Regeneration Template and definitive coverage with a split thickness skin graft.

Inclusion criteria

Patients with chronic calcaneal osteomyelitis with partial involvement (limited to calcaneal tuberosity, under the insertion of the Achilles tendon) affected by peripheral vascular disease and diabetes, presenting ulceration of the heel, larger than 60 cm², with exposure of the cortex of the calcaneal tuberosity, not healing after 6 months of ambulatory care, were included.

Exclusion criteria

Patients with chronic calcaneal osteomyelitis presenting heel ulceration with either total calcaneal involvement or signs of peri-lesional soft tissues infection were excluded and also those who were unable to provide written informed consent and/or under 18 years of age.

The primary diagnosis was peripheral vascular disease in four patients, diabetes in two patients, pressure ulcers in one patient. All patients had documented vascular disease: four patients (IV stage according to Fontaine Leriche) had previously undergone a femoropopliteal bypass; three patients (I stage according to Fontaine Leriche) had documented vascular disease without surgical indications.

Prior procedures included irrigation, debridement and application of different kinds of advanced dressing. The patients ranged in age from 60 to 87 years (average age: 74 years). There were five men and two women. Ulcers were present for more than 6 months (9). Patients were followed for a range of 6–36 months (average: 22 months). The clinical diagnosis of osteomyelitis of the calcaneus was confirmed in all patients by radiography (Figure 2). Intraoperative bone cultures on fragments of the removed portion of the calcaneus were made in all patients.

After spinal anaesthesia in five patients, and general anaesthesia in two patients, the plastic surgeon excised the necrotic margins of the ulcers. The posterior portion of the
Table 1  Patients’ baseline characteristics

<table>
<thead>
<tr>
<th>No.</th>
<th>Age</th>
<th>Sex</th>
<th>Diagnosis</th>
<th>Wound area (cm²)</th>
<th>Comorbidity</th>
<th>Rate of engraftment of Integra® (%</th>
<th>Rate of engraftment of skin graft (%)</th>
<th>Type of NPWT</th>
<th>Wound healing</th>
<th>Follow-up (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>60</td>
<td>M</td>
<td>Diabetic foot</td>
<td>70</td>
<td>Ischemic vascular disease, hypertension, COPD, chronic renal failure, chronic heart failure</td>
<td>100</td>
<td>90</td>
<td>Foam</td>
<td>Yes</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>65</td>
<td>M</td>
<td>Diabetic foot</td>
<td>60</td>
<td>Ischemic vascular disease, ischemic cerebrovascular disease</td>
<td>95</td>
<td>100</td>
<td>Gauze</td>
<td>Yes</td>
<td>13</td>
</tr>
<tr>
<td>3</td>
<td>85</td>
<td>M</td>
<td>Pressure ulcer</td>
<td>85</td>
<td>Ischemic vascular disease, psoriatic arthritis, chronic heart failure</td>
<td>100</td>
<td>100</td>
<td>Gauze</td>
<td>Yes</td>
<td>15</td>
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<tr>
<td>4</td>
<td>87</td>
<td>F</td>
<td>Vascular ulcer</td>
<td>80</td>
<td>Ischemic vascular disease, hypertension</td>
<td>100</td>
<td>100</td>
<td>Foam</td>
<td>Yes</td>
<td>24</td>
</tr>
<tr>
<td>5</td>
<td>74</td>
<td>M</td>
<td>Vascular ulcer</td>
<td>90</td>
<td>Ischemic vascular disease</td>
<td>90</td>
<td>100</td>
<td>Gauze</td>
<td>Yes</td>
<td>28</td>
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<tr>
<td>6</td>
<td>72</td>
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<td>Vascular ulcer</td>
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<td>Foam</td>
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<tr>
<td>7</td>
<td>74</td>
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<td>Vascular ulcer</td>
<td>100</td>
<td>Ischemic vascular disease, hypertension, chronic renal failure</td>
<td>100</td>
<td>100</td>
<td>Foam</td>
<td>Yes</td>
<td>36</td>
</tr>
</tbody>
</table>

COPD, chronic obstructive pulmonary disease; F, female; M, male; NPWT, negative pressure wound therapy.

Figure 1. The necrotic wound bed of a large ulceration of the heel, not healing after 6 months of ambulatory care (patient 2 in Table 1).

calcaneus was resected (Figures 3 and 4) with a wide thin osteotome by the orthopaedic surgeon. The calcaneus is cut through on a line beginning just below the inferior tip of the calcaneocuboid joint, backward and slightly upward, ending just below the insertion of the Achilles tendon.

Then Integra® Dermal Regeneration Template was applied on the viable tissues by the plastic surgeon. We used Integra® double layer (measures 10 × 12.5 cm) that was meshed in all the cases (Figure 5). In six cases we also used Integra® Dermal Regeneration Template single layer (measures 4 × 5 cm) under the Integra® Dermal Regeneration Template double layer (Integra LifeScience Corporation, Plainsboro, NJ).

After a period of 14 days of negative pressure wound therapy (Figure 6), the superficial silicone outer layer of Integra® was removed and a split thickness skin graft was used to cover the regenerated dermis (Figures 7 and 8). Also after the application of the skin graft, a continuous negative pressure wound therapy was applied for 5 days.
In four patients we used the V.A.C. device (V.A.C. KCI, San Antonio, TX) with a negative pressure of 100 mmHg transduced by a polyurethane foam. In three patients we used the Renasys® system (Smith & Nephew, London, UK) using the polyhexamethylene biguanide pre-impregnated gauze, with a level of negative pressure of 80 mmHg (10).

After both surgical procedures, postoperative antibiotics were used in all patients following the antibiotics protocol of our department (intravenous administration of amoxicillin/clavulanic acid 1000/200 mg two times a day for 7 days from the day of surgery).

After calcanectomy, another antibiotic was administered on the basis of the antibiograms analysis of the intraoperative bone cultures. Regarding the reports of bacteriological analysis, in four patients *Staphylococcus aureus* (all patients were treated with intravenous administration of trimethoprim–sulfamethoxazole) was found, in two patients *Pseudomonas aeruginosa* (both patients were treated with intravenous administration of Vancomycin) was found and in one patient *Escherichia coli* (the patient was treated with intravenous administration of Meropenem) was found. Above-mentioned antibiotics were administered for a variable period (range 1–3 weeks).

In this regard we want to emphasise that antibiotic therapy was administered in order to limit bacterial growth under the silicone layer of...
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Figure 7. The skin graft applied on the regenerated dermis (patient 1 in Table 1).

Integra® although this was applied on viable and aseptic bone.

The period of discharge after the calcanectomy and coverage with Integra® ranged from 3 to 7 days (average 4 days). The change of the dressing of the negative pressure wound therapy was performed every 7 days. The engraftment of Integra® was evaluated after removing the silicone layer in all the cases, during the second surgical procedure. The engraftment of the skin graft was evaluated on the fifth postoperative day in all the cases. All the patients were discharged the same day.

RESULTS

All wounds healed after skin grating of the neodermis generated by Integra®, with no patient requiring a below-knee amputation. The rate of the formation of neodermis and the coverage of the calcaneal bone was evaluated after removing the silicone layer of Integra® and was over 90%. In two cases we did not obtain the complete coverage of the bone (Table 1; Figure 8) so we applied a second sheet of Integra® double layer (measures 5 × 5 cm) that allowed, in both cases, the complete coverage of the small remaining portion of the exposed bone (under 10%).

Successful skin engraftment rates were generally over 80% (Figure 8). In the cases of partial engraftment of the skin graft, wounds healed by secondary intention.

Follow-up was ranged for a period between 6 and 36 months. One patient died after 22 months and one patient had a stroke after 31 months.

All the patients were able to walk once completely healed using orthopaedic shoes, and they were able to maintain their preoperative level of mobility without the use of orthosis. None of the patients had calcaneal or varus deformity of the hindfoot.

DISCUSSION

Ulcers of the heel are a major and growing health-care problem (3). Although prevention and local wound care, recalcitrant wounds, with or without osteomyelitis, may require surgical intervention (3).

Surgical management of chronic osteomyelitis of a portion of the calcaneus has included local curettage (11,12) or partial calcanectomy (1,2,13–18).

In the cases of extensive calcaneal involvement, below-knee amputation has been recommended (1,2,18) because durable soft tissue coverage cannot be obtained over the calcaneus.

Partial calcanectomy is a common procedure for the treatment of chronic heel ulcers with limited involvement of the calcaneus (2–6) but in the cases of large ulcerations, it is not possible to approximate the adjacent healthy soft tissue and close primary skin. Split thickness skin graft is not a good choice in a weight-bearing zone because skin
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graft usually cannot withstand the shear forces and pressure peaks, particularly when walking. Furthermore, patients affected by chronic ulcers of the lower extremities are often poor candidates for other reconstructive procedures (7,8) because of their morbidity and vascular disease (2). In our opinion, the employment of pedicle or free flap should be reserved only for selected patients (7,8). So we decided to treat recalcitrant and large heel wounds by using Integra® Dermal Regeneration Template double layer (Integra LifeScience) on the wound bed after partial tangential calcanectomy. In six cases we also used Integra® Dermal Regeneration Template single layer in combination with Integra® Dermal Regeneration Template double layer, to improve dermal layer.

After the excision of necrotic tissues, the posterior portion of the calcaneus was resected. The calcaneus is cut as previously described, according to an oblique line tangential to the heel.

In our opinion, this kind of surgical approach that saves the Achilles tendon allows the maintenance of a large bearing surface; this is very important for functional recovery (active early physiotherapy). Moreover, the patients do not require any postoperative orthosis. Anyway, we recommend the use of orthosis in patients with severe equinism of the foot.

Integra® Dermal Regeneration Template double layer is a skin regeneration system. The outer layer is made of a thin silicone film. It protects the wound from infection and controls both heat and moisture loss.

The inner layer is constructed of a complex matrix of cross-linked fibres. This porous material acts as a scaffold for regenerating dermal skin cells, which enables the re-growth of a functional dermal layer of skin (19). We always meshed it with the aim to allow drainage of wound exudates and to prevent the haematoma formation under the outer silicone layer after surgery. In this way, the meshed two-layer skin regeneration system may be used in conjunction with negative pressure wound therapy.

Integra® Dermal Regeneration Template single layer (without silicone layer) consists of a single layer of collagen and glycosaminoglycans; it is used to add extra thickness to the dermal regeneration layer, when deep wounds are to be treated. We used it in the deepest areas of the wounds after excision of the necrotic bone, in combination with Integra® Dermal Regeneration Template double layer, with the aim to obtain a thicker layer of neodermis (20).

Negative pressure wound therapy that works through different mechanisms that include fluid removal, moist wound healing, decrease of the bacterial burden, increase of blood flow and by stimulating proliferation of fibroblasts and endothelial cells (10,21), applied on the calcaneus after calcanectomy and application of the meshed Integra® Dermal Regeneration Template, promotes and reduces the time of coverage of the bone by the neodermis. Meshing Integra® Dermal Regeneration Template double layer moreover helps the egress of fluids and allows antimicrobial agents to reach the wound bed. The removal of the outer silicone layer occurs generally in 3 weeks. Negative pressure wound therapy also shortens the time to remove it in 2 weeks.

In this casuistic of patients, we used the polyurethane foam of V.A.C. device (V.A.C. KCI) with a subatmospheric pressure of 100 mmHg in four patients and the gauze of Renasys® system (Smith & Nephew) in three patients using a negative pressure of 80 mmHg, obtaining the complete coverage of the calcaneal residual bone. Negative pressure wound therapy was also used with the same devices and levels of subatmospheric pressure after the coverage of the neodermis of the Integra® with a split thickness meshed skin graft. In 5 days we obtained a good rate of skin engraftment (over 80%).

In conclusion, despite the small casuistic, we can assert that, in selected patients, the partial tangential calcanectomy is a good alternative to the below-knee amputation. Moreover, the combined use of Integra® Dermal Regeneration Template, negative pressure wound therapy and skin graft can be, in our opinion, a valid therapeutic approach in the treatment of chronic heel osteomyelitis. In this casuistic it has allowed to obtain a good coverage of the bone and a complete and lasting wound healing.

ACKNOWLEDGEMENTS
All authors disclose any financial and personal relationships with other people or organisations that could influence this work.
REFERENCES


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