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Negative pressure wound therapy: A salvage solution for wound treatment with exposed bone tissue

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Abstract
Negative pressure wound therapy (NPWT) is a well-known and proven treatment for wound care. However, its use on bone tissue hasn't been described so far. Wounds with visible bone tissue are difficult to manage and the results are often disappointing. We describe the case of a 75-year-old man, with cutaneous necrosis and underlying exposed hardware 7 weeks after a tibial shaft fracture treated by open reduction and internal fixation. After hardware removal, and because of the impossibility to close the soft tissue, a NPWT was directly applied to the bone. The results were encouraging, and a simple skin graft was sufficient after NPWT treatment. Through this case and after a review of the literature, it seems appropriate to extend the indications of NPWT as a salvage solution for exposed bone wound. Further studies are needed to determine the limits of this therapeutic option and to compare it with the already existing treatments.

Keywords: Exposed bone, pressure therapy, skin graft

Introduction
Negative pressure therapy has proven successful in the care of both acute and chronic wounds [1]. It can also be used in addition to various surgical reconstruction techniques [2]. It has proven to be a major tool in the healing process of complex wounds. However, it is not currently recommended to use it directly on bone tissue but rather to have a prior soft tissue interposition [3]. Through a clinical case and a review of the literature, this paper proposes to evaluate the effectiveness of its use in direct application on bone tissue as a salvage solution in specific cases.

Case Report
A 75-year-old male, presented to our emergency department after a low velocity motorcycle accident. The patient is a heavy smoker and had a previous medical history of an open right tibia-fibula fracture in his adolescence. Radiographic examination demonstrated a comminuted spiroid fracture of the right tibia. The latter was treated using open reduction and internal fixation through an anteromedial approach (Figure 1). The immediate postoperative period was uneventful. However, 7 weeks after the surgery, the patient developed mid-diaphyseal tibial skin necrosis exposing the internal fixation hardware (Figure 2). The patient was asymptomatic. Laboratory results show a C-reactive protein at 32.2 mg/L and 8.800 white blood cells/mm^3. Hardware removal and debridement was performed on the same day in the operating room. Because of the residual fracture mobility after hardware removal, an external fixator was implanted (Figure 3). 10 cm^2 of bone were left exposed at the end of the surgery. The latter was covered using a negative pressure therapy to accommodate a graft once the infection is resolved. The device used was the RENASYS GO™ - Smith and Nephew with a constant pressure suction of -100 mm Hg. The device was changed every 48 or 72 hours by the surgeon. Wound control was performed with the plastic surgery team and it was decided to perform a muscle flap once the wound will be infection-free. Intraoperative bacteriological samples demonstrated a multi-sensitive Staphylococcus Aureus for which an antibiotic treatment, consisting of 2 weeks of intravenous Flucloxacillin 2gr 4x / day followed by 3 months of oral rifampicin 600 mg 1x / day and doxycycline 100 mg 2x / day was initiated. After 25 days of NPWT the granulation tissue was found to have covered the entire previously uncovered bone area.

The initial plan of muscle flap surgery was dropped, and a simple skin graft was performed (Figure 3). The dressing was left in place for 6 days after which daily care was carried out with a satisfactory result at 10 days postoperative (Figure 4). The patient was discharged 5 weeks after the removal of the material and 10 days after the skin graft. Progressive weight bearing was authorized 3 months after the external fixator was implanted. The radiographs demonstrated signs of bone healing, the reason why the external fixator was removed 4 months after the surgery. Follow-up at 6 months of hardware removal showed a satisfactory skin appearance (Figure 4) with no pain in full weight bearing and normal laboratory tests.

Fig 1: Initial fracture (a) and the osteosynthesis (b) front view

Fig 2: Cutaneous necrosis with osteosynthesis hardware (arrow).

Fig 3: After removal (a). After 7 days (b) and 21 days (c) of NPWT. Skin graft in the operative room (d).

Fig 4: Skin graft after 10 days and after 6 months

Discussion

Managing wounds with exposed bone tissue are proving to be a challenge. Their healing is uncertain and, in general, very slow. At present, there are 2 types of therapy available, either flap coverage or conventional daily local care [4]. In this case, as the covering defect was in the middle third of the leg, a soleus flap or a propeller flap could have been chosen [5]. In case of a more extensive defect, a free flap can always be performed taking into account the potential complications and the vascular status of the patient [6]. On an infected site and in the presence of a doubtful vascular status, a NPWT was placed rather than performing a flap. The increasingly widespread use of NPWT leads us to consider its application on all types of tissue, especially bone. Chen *et al*. described the placement of NPWT on wounds with exposed bone on rabbits and demonstrated its effectiveness and superiority over conventional local care [7]. These results are explained by the increase and organization of the collagen frame, the increase in vascular density while reducing the infiltration of inflammatory cells and the rate of infection. Pelham *et al*. described the installation of NPWT on exposed osteosynthesis material with very encouraging results [8], which could have been an option in our case. On a septic area, it is contraindicated to carry out a flap as the first intention procedure but moreover, it is not recommended to leave bone tissue uncovered either (9). To make the area as suitable as possible for receiving a flap, a NPWT was placed. This option has already been carried out by various teams in the context of salvaging major traumatic musculoskeletal injuries with encouraging results [3]. The fast and surprising results encountered in our patient made it possible to perform a simple skin graft and it, therefore, seems appropriate to keep in mind that this type of therapy can be used in delicate situations as a salvage solution. In the absence of a team comfortable with flaps this can also be a solution. Indications for NPWT should now include direct placement on bone tissue when it is not recoverable directly and in selected cases. However, the limits of this indication still need to be determined, in particular the size of the tolerated bone surface, and to compare it to flap placement.

Conclusion

The management of wounds with exposed bone tissue remains a challenge. In selected cases, NPWT is a realistic salvage solution. However, this treatment still requires comparison with existing therapies and its limitations need to be determined.

Conflict of Interest
Nill

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