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CASE REPORT

Successful Treatment of Severe Soft Tissue Loss in Open Fracture (Gustilo-Anderson IIIb) with Ovine-Derived Xenograft: A Case Report

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Abstract

Background: Open fractures with extensive tissue loss present unique clinical challenges. Exposed bone often results in periosteal damage, which is associated with a loss of blood and nutrient supply, and a higher susceptibility to infection. Common surgical interventions to provide rapid bone coverage include various types of flap reconstructions; however, these may not be universally optimal, depending on patient candidacy and institutional resources.

Methods: Here, we present a case of an open, comminuted fracture of the right tibia and fibula with severe soft tissue loss and contamination secondary to a motor vehicle accident that underwent staged soft tissue reconstruction with ovine forestomach matrix graft and particulate.

Results: Robust granulation tissue formed by post-operative day 10, which resulted in complete epithelization 1 month post-operatively via split-thickness skin graft. The patient's soft tissue remained healed without complications or pain at the 6-month follow-up.

Conclusion: This case report highlights the utility of an OFM grafts as part of the modern reconstructive ladder to facilitate rapid soft tissue coverage and regeneration in open fractures.

Keywords

Soft tissue loss, Ovine forestomach matrix, Extracellular matrix, Open fracture

Abbreviations

OFM: Ovine Forestomach Matrix; MVA: Motor Vehicle Accident; NPWT: Negative Pressure Wound Therapy; STSG: Split-Thickness Skin-Grafting

Introduction

Managing open fractures, and the associated soft tissue loss, remains a prominent clinical challenge. Such injuries are often a consequence of high-energy trauma and are associated with a damaged periosteum, which leads to a loss of blood and nutrient supply, and an elevated risk of infection [1]. Fracture-related infection is the most common complication that arises due to the often contaminated nature of the open fracture, the addition of orthopaedic hardware, and patient comorbidities [2]. Further, the risk of infection of open fractures is proportional to the extent of tissue loss, where extensive tissue loss places the open fracture at a greater risk of infectious complications [3]. With severe tissue loss, some studies have reported infection rates as high as 52% [4].

The reconstructive approach to open fractures can also impact the wound healing trajectory. Following irrigation, debridement and fracture stabilization, reconstruction may proceed in a variety of ways. Common bone coverage options include the use of free-flaps, fasciocutaneous or muscle flaps. However, these reconstructive interventions have limitations including donor site morbidity, availability of tissue, patient candidacy, flap failure, length of hospital stay, procedural costs and the requirement of complex microsurgical techniques [3,5]. Furthermore, if resources are lacking and/or patients require a transfer

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for flap reconstruction to be completed, wound coverage may be further delayed. This can directly contribute to increased complication rates, since fracture coverage ideally should be performed within 72 hours of exposure to minimize the risk of deep infection and nonunion [6].

To overcome some of these challenges, xenogeneic bioscaffolds like ovine forestomach matrix (OFM) can be integrated into the reconstructive ladder. OFM, in particular, is a cost-effective bioscaffold that can be easily and rapidly applied to traumatic defects to promote tissue regeneration [7]. Here, we present a case of tissue coverage using OFM graft to a lower leg open fracture in a patient that was involved in a motor vehicle accident (MVA).

Case Description

A 39-year-old male patient presented to the emergency department with a bilateral, open, comminute Gustilo-Anderson IIIb fracture of the tibia and fibula with severe soft tissue loss and contamination secondary to an MVA (Figure 1A). The injury to the left lower leg was catastrophic and warranted below knee amputation. On the lower right leg, the orthopedic surgeon performed fracture stabilization and anatomic reduction with external fixation the day of presentation (Figure 1A). On the same day, the large soft tissue defect was sharply debrided of nonviable tissue and debris. After the initial debridement, the index soft tissue defect measured 25 cm x 25 cm (625 cm^2) with significant undermining noted (indicated in Figure 1A). Three days after, the wound was sharply debrided again, and bone coverage was partially accomplished with a hemisoleus muscle flap. Additionally, OFM particulate (Myriad Morcells™, 2000 mg, Aroa Biosurgery Limited, Auckland, New Zealand) was added to irregular areas (Figure 1B), followed by an OFM graft (Myriad Matrix™, 5-layer, 10 x 10 cm) (not shown) secured with absorbable sutures in areas with minimal bone coverage and with dead space. The defect was dressed with a non-adherent dressing, and negative pressure wound therapy (NPWT) (125 mmHg). Dressing changes took place every 3-5 days at the discretion of the practicing physician. During the immediate post-operative period, the patient was strictly offloaded and utilized a wheelchair for mobility due to amputation of contralateral limb. On post-operative day 3, the patient was re-evaluated and the OFM was integrating and vascularized tissue forming within the defect. At that time, the patient returned to the operating room for a debridement and second application of OFM particulate (500 mg) for additional depth fill (Figure 1C). NPWT was re-applied at 125 mmHg. On post-operative day 10, (Figure 1D), granulation tissue had eradicated the wound depth and the surgical team elected for definitive closure via a split-thickness skin-grafting (STSG) (0.0018 inch), which was performed at post-operative day 15 (Figure 1E). After this, the patient continued non-weight bearing precautions for fracture healing. There was approximately 95% take of the STSG at post-operative day 22 (one week post grafting), with complete epithelization noted at the one-month follow-up appointment (Figure 1F). The patient's soft tissue remained healed without complications or pain for 6 months post-operatively. Moreover, functional improvement was achieved with physical therapy.

Discussion

Open fractures, especially of the lower extremity, can be catastrophic for patients and offer multi-factorial complexity leading to higher risk of infection and poor outcomes such amputation [8]. Therefore, immediately addressing soft tissue loss can mitigate post-operative complications and improve overall wound and fracture healing results. As a temporary cover for exposed bone,

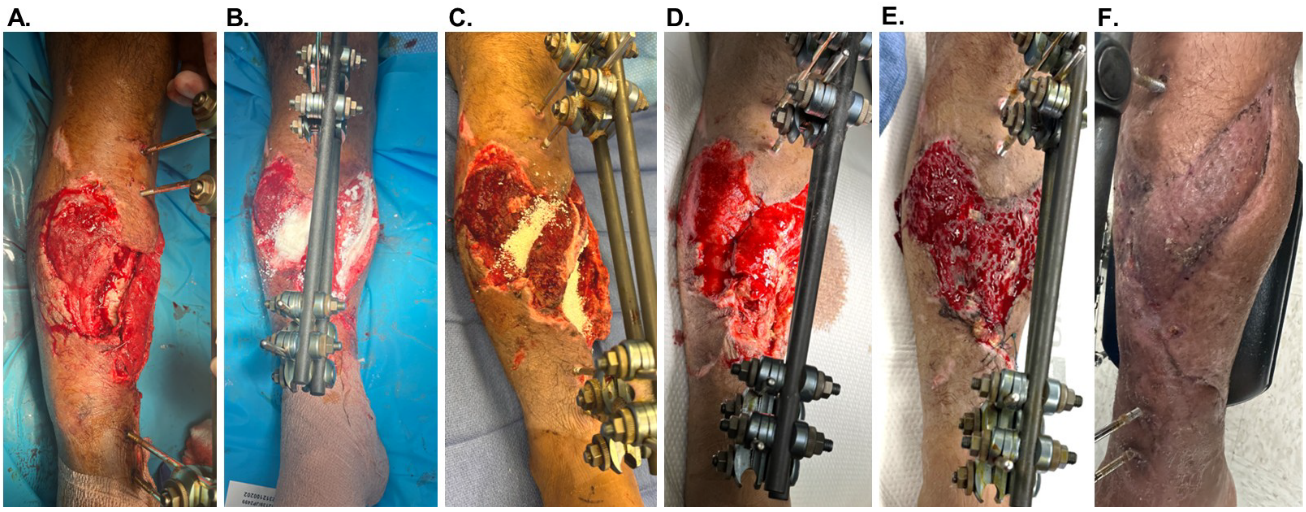

Figure 1: Application of OFM graft and particulate in an open fracture. (A) Initial wound presentation, after debridement, with undermining noted (star); (B) Post-operative day 0, with matrix and first particulate application; (C) Post-operative day 3, with second application of particulate; (D) Post-operative day 10, deemed ready for STSG; (E) Post-operative day 15, day of STSG; (F) One month follow-up, full closure of the wound site.

NPWT and antibiotic bead pouches are commonly used to fill dead space [9]. Long-term open fracture coverage, however, is usually addressed through flap reconstruction, or application of a STSG after vascular bed formation is achieved, often through the use of a bioscaffold [2,10]. While popular, flap reconstruction can be technically challenging, may lead to insensate tissue, donor site morbidity, and flap necrosis [11]. Additionally, revisional surgeries may be required to de-bulk the flap and improve functional and aesthetic outcomes [12].

To supplement the coverage achieved by flap reconstruction, we considered a staged approach using OFM, a xenogeneic bioscaffold, to facilitate regeneration of soft tissue in areas that the flap could not cover. OFM is a decellularized extracellular matrix that provides a scaffold to support host cell infiltration, adhesion, and migration, as well as the formation of new local vascular networks [13,14]. OFM was developed for various applications in soft tissue regeneration, including staged reconstructions of full thickness defects with exposed structures [15-18]. OFM grafts are frequently used in contaminated settings, making the technology an appealing treatment for open fracture procedures, since these are typically at risk of post-operative infection. The ability of OFM to promote tissue regeneration in contaminated settings may be due to its natural antimicrobial properties, or due to the vascularization it triggers which enables the clearing of bacteria [13,19].

Interestingly, in this case study we observed complete bone coverage with granulation tissue by 10 days after the first application of OFM matrix and particulate. Our observed time to tissue coverage with OFM graft is consistent with larger prospective and retrospective studies [15-18].

Although products such as the OFM graft do not supersede or replace flap-based reconstructions, these devices represent an alternative option for the modern reconstructive ladder where flaps are not appropriate or possible due to anatomy, patient selection, potential for donor site morbidity, or surgical training. This case represents a successful reconstruction of a complex open fracture of the lower leg with significant soft tissue loss using OFM grafts. With this approach, soft tissue coverage and contour restoration were achieved as a less invasive and technically demanding alternative to a free flap reconstruction. The described approach of conservative staged surgical management of open fracture may offer surgeons another option for improved functional and cosmetic outcomes while minimizing the risk of complications associated with free flaps and open fractures.

Conclusions

In conclusion, this case report highlights the utility of an OFM grafts as part of the modern reconstructive ladder to facilitate rapid soft tissue coverage and regeneration in open fractures. Further studies are warranted to explore the impact of OFM grafts with respect to post-operative complications, expediating time to definitive closure, and functional outcomes.

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Authors' Contribution

A.N.D and A.K. contributed conceptualization of the case, data collection, and analysis, T.F. contributed to manuscript development and figure preparation. All authors revised and approved the final version for submission.

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