Use of a Continuous External Tissue Expander in the Conversion of a Type IIIB Fracture to a Type IIIA Fracture

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**Abstract**

Various methods have been used for soft tissue coverage of Gustilo-Anderson type IIIB open fractures. These injuries are often contaminated and, by definition, are associated with extensive periosteal stripping and inadequate soft tissue coverage. These characteristics predispose the patient to infection, delayed union, nonunion, and the likelihood of multiple surgeries to achieve durable soft tissue coverage. Although free tissue transfer and rotational flap coverage are the mainstay of treatment for Gustilo-Anderson type IIIB fractures, these procedures typically require additional modalities, such as local wound care, negative-pressure wound therapy, and skin grafting, to expedite wound coverage. Numerous undesirable aspects of these tissue coverage techniques exist, including the requirement for repeated application, potential anesthesia complications, near-constant surveillance, patient compliance, graft failure, and cost. External tissue expanders offer the surgeon a device that can rapidly facilitate closure of full-thickness soft tissue defects. This technique offers the benefit of a 1-time application that is easy to apply and cost-effective and can significantly improve fracture coverage options with a cosmetically acceptable result. Although this technique has been previously described for fasciotomy and ulcer coverage, to the authors’ knowledge, continuous external expansion has never been reported in open fracture wound management, specifically in converting type IIIB to type IIIA open fractures. The authors’ early success with this method indicates that it may be a valuable tool in the management of Gustilo-Anderson type IIIB open fractures.

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Various soft tissue coverage methods have been used for Gustilo and Anderson Type III B open fractures. These injuries are often contaminated and, by definition, are associated with extensive periosteal stripping and inadequate soft tissue coverage. These characteristics predispose patients to infection, delayed union, nonunion, and the likelihood of multiple surgeries to achieve durable soft tissue coverage.

Although free tissue transfer and rotational flap coverage are the mainstay of treatment for Gustilo and Anderson Type III B fractures, these procedures typically require additional modalities, such as local wound care, negative-pressure wound therapy, and skin grafting, to expedite wound coverage in these at-risk fractures. Numerous aspects of the aforementioned tissue coverage techniques are undesirable, including the requirement for repeated application, potential anesthesia complications, near-constant surveillance, patient compliance, graft failure, and cost.

The use of an external tissue expander in the coverage of soft tissue defects has been described in the plastic surgery, podiatry, and orthopedic surgery literature. However, to the current authors’ knowledge, this is the first report of the use of an external tissue expander in the coverage of a Type III B open fracture, effectively converting the injury to a Type III A fracture.

Case Report

A 32-year-old man serving in the armed forces sustained severe injuries to his right lower extremity, including an open Gustilo-Anderson type III B tibia and fibula fracture (Figure 1) and closed, comminuted fractures of the right calcaneus, talus, and navicular resulting from the blast of an improvised explosive device. He underwent multiple procedures over the following 5 days, including serial irrigation and debridement, negative-pressure wound therapy (VAC; KCI International, San Antonio, Texas), and open reduction of the tibia with external fixator placement, while en route back to the United States for definitive care.

On initial presentation at the authors’ facility, the patient had a large full-thickness soft tissue injury over the anteromedial lower leg (Figure 2). He was taken to the operating room the following day for repeat irrigation, debridement, and partial wound closure. These procedures were followed by application of a continuous external tissue expander (DermaClose RC; Wound Care Technologies, Inc, Chanhassen, Minnesota) to the remaining open wound, which was directly overlying bone.

He returned to the operating room 2 days later, where it was noted that the device had significantly increased the available soft tissue, allowing tensionless wound approximation (Figure 3). Interval wound checks were performed, demonstrating adequate wound healing without complication. The patient’s fracture was managed in a circular external fixator, with serial radiographs showing fracture healing 10 months after frame placement (Figure 4).
**DISCUSSION**

The current conflicts in Iraq and Afghanistan have resulted in a large number of open extremity fractures, accounting for 82% of all fractures in 1 study. Because of the high number of patients with open extremity fractures, a compelling need exists for prompt coverage of these wounds to reduce nosocomial infection, malunion, nonunion, and other negative outcomes that can potentially occur with delayed osseous coverage. To minimize the morbidity associated with tissue transfer procedures, current wound coverage techniques include releasing incisions with delayed primary wound closure, intentional shortening and angulation of the fracture site (with application of a circular fixator for gradual lengthening), and prolonged negative-pressure wound therapy treatment. These options can be expensive and time consuming to the wound care surgeon and supporting staff.

Mechanical manipulation of skin, first introduced in the 1950s, has been a valuable tool in reconstructive surgery because of excellent cosmesis, ease of use, and lack of rejection. Human skin can be stretched beyond its physiological limit, activating a variety of transmembrane mechanosensors that invoke a series of extracellular and intracellular events leading to increased mitotic activity and collagen synthesis. This sequence of events ultimately results in increased skin surface area, which is phenotypically similar to its initial state.

External tissue expanders offer surgeons a device that can rapidly facilitate closure of full-thickness soft tissue defects and associated periosteal stripping by applying continuous tension through a monofilament nylon line attached in a radial or shoelace pattern to stainless steel anchors placed in the skin and subcutaneous tissues approximately 1.5 cm from the edge of the wound and held in place with standard skin staples. A tension controller maintains a constant tensile force of 1.2 kg on the nylon line. The tension controller device is rotated until a clutch mechanism provides an audible indication that full tension has been achieved. Constant tension expands the skin and subcutaneous tissue around the wound until the edges of the wound are amendable to delayed primary closure. The current authors’ experience has shown that padding should be placed between the tension controller and the skin to prevent skin breakdown.

This technique offers the benefit of a 1-time application, which is easy to apply, is cost-effective, and can significantly improve fracture coverage options with a cosmetically acceptable result. Although this technique has been previously described for fasciotomy and ulcer coverage, to the authors’ knowledge, continuous external expansion has never been reported in open fracture wound management, specifically in converting Gustilo-Anderson type IIIB to type IIIA open fractures. Further studies are needed to determine optimal applications for this new technique, although the authors’ early success with this method indicates that it may be a valuable tool in the management of Gustilo-Anderson type IIIB open fractures.

**REFERENCES**