Articles & Publications

Ilizarov Method for Wound Closure and Bony Union of an Open Grade IIIB Tibia Fracture

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Abstract

A grade IIIB open tibia fracture was treated with an Ilizarov external fixator. Wound debridement, removal of loose bone fragments and gradual compression across the fracture site led to bony shortening and union. Soft tissue compression led to secondary wound closure. An excellent anatomic and functional outcome resulted. This technique may prove useful in the treatment of tibia fractures with difficult to close wounds or for patients who are not candidates for flap coverage.

Introduction

Open fractures of the tibial shaft are both common and may be fraught with complications. Malunion, delayed union, nonunion, and infection are all seen regularly after open tibia fractures.[3,10,17-19] The subcutaneous location of the tibia places the leg at risk for skin loss at the time of fracture. Delay in closure of open tibia wounds has been associated with an increased prevalence of late infection.[5] With any exposed tendon or bone, wound coverage becomes a necessity. Soft tissue flaps are the most commonly employed method of obtaining wound coverage. Flap coverage can be performed with a local rotational muscle flap, a free vascularized muscle flap or a local fasciocutaneous flap.[15] The type of flap used is based on the location of the wound. In the proximal third of the tibia, a gastrocnemius rotational flap is used. In the middle third, soleus, medial gastrocnemius, and tibialis anterior rotational flaps have all been advocated, while for wounds in the distal third of the tibia, a free vascularized muscle flap is required.[4]

Open fractures of the tibia, with associated vascular injuries, have historically had a very poor outcome.[1] This poor prognosis has prompted some to call for early amputation in select cases.[9]

Ilizarov external fixation has also proven to be a valuable method for treating open tibia fractures. The ability of the frame to stabilize a fracture, provide compression at the fracture site, and allow access to the soft tissues makes it an integral tool in the management of severe tibia fractures. Metaphyseal fractures with significant shaft extension and fractures with short periarticular fragments are examples of situations in which an Ilizarov frame is frequently employed.[11]

Recently, the Ilizarov technique has been used to close chronic soft tissue defects of the tibia. Soft tissue has been transported along with bone to close large defects.[16] Skin traction employing hooks and an Ilizarov frame has also been used with success to close tibial wounds.[12] This case report will discuss the closure of a 4 x 4.5 centimeter (cm) distal leg wound over the subcutaneous surface of [8] the tibia that resulted from an open grade IIIB tibia fracture. The wound was closed with an Ilizarov frame utilizing gradual compression across the segmental fracture site and wound. This technique using closure, rather than coverage, may provide an answer for difficult tibia wounds.

Case Report:
The patient is a 49-year-old man who was struck by a car while riding a motorcycle. The patient sustained a right intertrochanteric hip fracture, a right femoral shaft fracture, a right tibial plateau fracture, a right grade IIIB open tibial shaft fracture of the distal one-third of the tibia, a right calcaneocubiod fracture dislocation, a right Lis Franc fracture dislocation and multiple right metatarsal fractures (Figure 1).

During the patient's trauma work-up he was noted to have an absent dorsalis pedis pulse and first web space numbness. Angiography was done and showed disruption of the anterior tibial artery at the level of the tibial shaft fracture. Other than a scalp laceration the remainder of the trauma work-up was negative.

The patient was brought to the operating room and underwent an open reduction and internal fixation of his right hip, a retrograde nailing of his right femur, an open reduction and internal fixation of his tibial plateau fracture and placement of a hybrid external fixator on his right tibia. The distal tibia fracture was severely comminuted with a large segmental fragment and significant medial bone loss (Figure 1). At the time of admission, the distal tibial wound was approximately 3cm in length with exposed bone that had been stripped of its periosteum. The surrounding tissue was thin and poorly vascularized and would experience breakdown during the postoperative period. Over the next month the patient was brought back to the operating room for repeat debridements of his right tibia, as well as fixation of his right foot fractures, and a resection of his right first ray. After this time the patient was left with a 4.5 x 4cm open wound on the anteromedial portion of his right distal tibia with exposed fragments of comminuted bone in the wound. Different treatment options were considered to achieve wound closure and bony union, and a novel approach was selected.

The patient was brought back to the operating room and his right tibia wound was once again debrided. All loose, exposed, and desiccated bone was removed from the wound, the hybrid external fixator was removed, and an Ilizarov external fixator was placed on the tibia. Gradual compression of 1-2 millimeter (mm)/day was started at the wound/fracture site and over the next two months complete wound healing occurred (Figures 2,3,4A, 4B). One inch of shortening occurred as a result of the initial debridement of desiccated bone fragments and compression of the comminuted fracture. The fracture was fully healed and the frame removed at five months (Figures 5, 6A, 6B). At one year follow-up the patient has right knee range of motion of 0° to 135°. He has 0° of dorsiflexion and 30° of plantarflexion of his right ankle. His right ankle dorsiflexion strength is four out of five and plantarflexion strength is five out of five. He has no complaints of hypersensitivity or cold intolerance. The patient is now full weight bearing without pain and is wearing a one-inch shoe lift to account for his leg length discrepancy.

Discussion

Open fractures of the tibia with associated vascular injury are a difficult problem to treat. Vascular injury impedes soft tissue healing and has been shown to double the rate of anastomotic thrombosis during free flap reconstruction.[13] Deep infection, malunion, delayed union, and nonunion have all been reported after these fractures.[3,10,17-19] Treatment options may be limited, especially with fractures of the distal third of the tibia. In this region, distally based muscle flaps and fasciocutaneous flaps have been used with varying amounts of success.[6,14] The primary option for coverage of the distal third of the tibia is a free flap. When a free flap is not possible or has failed, a cross-leg flap remains a useful option despite its significant morbidity.

With comminuted, open fractures of the distal third of the tibia open reduction internal fixation and intramedullary nailing may have a limited role. Bone grafting may used to fill bony defects but it has its own associated morbidity.[7] With these fractures Ilizarov external fixation may be used to achieve fracture union as well as wound closure. New methods employing the Ilizarov technique may provide distinct advantages regarding the soft tissues. These advantages may include fewer indications for rotational and free flap wound coverage, less need for amputation, fewer infections, and shorter treatment time. In addition the surgery is performed using percutaneous technique with limited exposure to minimize soft tissue trauma. Postoperatively the frame allows adjustability as well early weight bearing through axially dynamized stable fixation.[2]

Defects in the bone and soft tissue of the tibia may be treated with debridement followed by an acute or gradual approximation of the bone ends. Compression is then employed at the fracture site, which also provides closure of the soft tissue defect. This monofocal approach leads to some limb shortening as in the present case[11] (Figure 7).

Alternatively, a bifocal approach can be used[11] (Figure 8). The bone and soft tissue defect is treated with compression and shortening at the injury site with a synchronized distraction and lengthening at a level outside the zone of injury. This technique achieves union while simultaneously treating any preexisting or iatrogenic limb length discrepancy. A low energy percutaneous osteotomy is performed in the proximal metaphysis of the tibia. Compression and shortening are employed at the fracture/wound while simultaneous distraction and lengthening of the osteotomy occurs. The tibial wound may be closed acutely or subacutely with the aid of the compression that is occurring at the fracture site.

In the present case, the goal was to obtain wound closure and fracture healing. The concept of the previously mentioned techniques was used, but simultaneous proximal tibia lengthening was precluded because of an associated tibial plateau fracture and the presence of a plate. It was decided that lengthening, if necessary, would be performed after all healing had occurred.

Our experience is limited, but this may serve as an additional tool in the treatment of open tibia fractures. As far as we can determine this technique has not been previously published.

Conclusion

The Ilizarov external fixator has long been established as an effective tool for treating difficult tibia fractures and it may prove to equally effective in dealing with the soft tissue aspect of these injuries. Utilizing compression at the fracture site will not only promote bone healing, but may allow closure of wounds that previously required flap coverage or amputation.

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Legend of Figures:
Figure 1. Injury anteroposterior (AP) radiograph of tibia and fibula
Figure 2. Leg wound at the time of Ilizarov frame application
Figure 3. Leg wound one month after Ilizarov frame application
Figures 4A and 4B. Leg wound two months after Ilizarov frame application
Figure 5. AP radiograph of distal tibia and fibula after union
Figures 6A and 6B. Lateral radiograph of the distal tibia and fibula after union
Figure 7. Bone and soft tissue defect treated with monofocal method
Figure 8. Bone and soft tissue defect treated with bifocal method