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Case Report

Post-Traumatic Free a Vascularized Fibular Graft Nonunion of the Tibia: Treatment with Trifocal TSF/Ilizarov Technique. A Case Report

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Received: March 13, 2017; **Published:** April 11, 2017

Abstract

The treatment of recalcitrant posttraumatic free fibular graft non-union can be very challenging. We report our experience in treating such difficult case with an alternative surgical option using combined TSF/ Ilizarov technique with trifocal bone transport in a leg. Outcomes were evaluated in term of union and guidelines of the Association for the Study of the Method of Ilizarov (ASAMI). At the final follow-up, the non-union sites were completely united and the patient had no clinical infection, skin defect, or limb-length discrepancy. The results were evaluated according to ASAMI criteria: excellent in terms of bony outcome; functional result was good. Combined Ilizarov/TSF trifocal techniques for the treatment of segmental tibial bone defects achieve union without mal-alignment of the mechanical axis and are a viable limb salvage option for refractory free fibular graft non-union.

Keywords: *Bone Transport; Tibial Nonunion; Bone Defect; Taylor Spatial Frame; Ilizarov Bone Transport; Docking Site; Taylor Spatial Frame; Ilizarov; Free A Vascularized Fibular Graft*

Introduction

Most open fractures due to motor-vehicle accidents are severe, and 65% to 75% of all open tibial fractures are Gustilo type III in severity, often associated with combined bony and soft-tissue defects that cannot be reconstructed with conventional methods [1]. The free vascularized fibular graft (FVFG) is a viable method for the reconstruction of tibial defects of more than 6 cm [2,3]. It can be transferred as a free bone, or with an accompanying fasciocutaneous and/or muscular flap based on the same pedicle [4,5]. Nonunion at one or both junctions of a vascularized fibula transfer is a challenging problem to orthopaedic surgeons. Gradual bone transport with Ilizarov technique uses the concept of compression–distraction while providing a large-diameter bone with intact blood supply to fill bony defects [6-9]. The Taylor Spatial Frame (TSF; Smith and Nephew, Inc.; Memphis, TN, USA) uses specialized struts and a computer program to calculate the position of imaginary ''hinges'' for simultaneous deformity correction in multiple planes [9,10]. We report the case of a patient with a recalcitrant posttraumatic FVFG nonunion.

Case Report

A thirty-eight-year female patient after a motorcycle accident presented to the emergency department of a distant hospital with a

42C3 Gustilo type-IIIB open fracture of the left tibia with bone loss. The wound was irrigated, debrided, and an external fixator was applied. An osteocutaneous free vascularised fibular graft (10 cm) was therefore raised from the opposite leg with a skin flap 12 cm by 6 cm. The fibular graft was inserted into the medullary cavity of the left tibia both proximally and distally and the graft revascularised, while the donor site was skin-grafted. Six months later the patient had a second surgery with debridement, autologus bone grafting, internal fixation and unilateral frame due to FVFG nonunion at distal junction. At the time of definitive treatment, the patient was walking with partial weight bearing and with support using two crutches, with discomfort and pain caused by persistent pseudarthrosis of the leg.

Operative Technique

The patient was positioned supine on the radiolucent operating table under general anesthesia. Non-union site and fibular graft were first treated with bone resection. Trifocal antegrade transport was used for ten centimetres of segmental defect [8]. Radical bony resection of all necrotic bone was performed until bleeding, viable, bony margins were visualized proximal and distal to the non-union site. TSF rings were placed on the proximal and distal fragments parallel to their respective joints, allowing adequate soft tissue clearance. The frame was mounted orthogonally to the mechanical axis of the tibia and fixed initially with a proximal and distal wire before fluoroscopic visualization. Additional wires and half pins were then inserted; in more proximal or distal tibial bony defect. The construct was extended to the foot to achieve maximum stability of the frame. One screw and one wire were used for each of the two bone transport segments (intermediate rings). We used conical, 6.0 mm, hydroxyapatite-coated half pins (Orthofix; Richardson, TX, USA) and conventional 1.8 mm-diameter Ilizarov bayonet wires for fixation. Two percutaneous tibial osteotomies were made using a Gigli saw. Initially, the conventional Ilizarov threaded rods were used for transport, and then we used TSF struts to allow for multiplanar correction of the limb axis after docking. The latency period before bone transports were fourteen days, and the rate of osteotomy site distraction was 0.75 mm per day per osteotomy site. After bone contact at the distal docking site was achieved, debridement and iliac crest bone-grafting was performed to promote healing. The patient had standard pin care with showering and application of dry gauze around the pins. Patient was encouraged to partial weight-bear with crutches beginning the third day after surgery, and isometric quadriceps and knee range-of-motion exercises were started. Radiographs were reviewed every two weeks during the distraction phase and monthly during the consolidation phase. Frame was removed under sedation when radiographs showed solid docking-site union and that the two regenerates had three complete cortices. After frame removal, patient was partial weight-bearing for four to six weeks. At the time of the three-year follow-up visit, the fracture sites were completely united and the patient had no clinical infection, skin defect, or limb-length discrepancy. Using the ASAMI outcome score, bony result was excellent and functional result was good. In addition, our patient had no significant residual deformities. At the time of final follow-up, we measured the medial proximal tibial angle, the lateral distal tibial angle, the posterior proximal tibial angle, the anterior distal tibial angle, and the mechanical axis deviation value. All of these measured values were within the normal range [11,12].

Discussion Section

There have been many reviews of the use of FVFG for the reconstruction of skeletal defects of more than 6 cm resulting from various conditions, such as trauma, tumor resection, and osteomyelitis and most have reported good results [3,13,14]. Free vascularized fibula grafting procedure has been associated with the risk of thrombosis of the anastomosed vessels, stress fracture, nonunion, infection, and variable donor-site morbidity [3]. De Boer reported an overall union rate of 93% in patients who underwent vascularized fibula transfer for a diagnosis of tumor or trauma, compared to a 59% union rate for those whose underlying diagnosis was osteomyelitis [15]. Nonunions are treated with secondary bone grafting procedures, which lead to eventual healing in most instances [15,16]. Minami presented a series of 33 FVFG due to bony defect or pseudoarthrosis after trauma in different recipient sites. Bony union was ultimately achieved in 32 cases, with primary union in 26 (79%) [17]. Nonunions are also more common in fibula grafts transferred to the lower extremity, as compared to the upper extremity [18]. Another interesting finding is the worse outcomes that have been observed in complication following FVFG. De Boer reported four amputations in sixty-two consecutive cases for different pathology in which an ultimate rate of tibial union was 75% [15]. Gradual bone transport with external fixators uses the concept of compression-distraction while providing a large-diameter bone with intact blood supply to fill bony defects [19]. During distraction osteogenesis the bone ends carry the surrounding soft tissue which helps in closure of the combined soft tissue and bony defect without the need of major plastic surgeon [11,19]. Sala assessed and compared ccombined TSF/Ilizarov trifocal and bifocal techniques for the treatment of twelve segmental tibial bone defects achieving union without mal-alignment of the mechanical axis [8]. In our case, FVFG was removed, because of critical cross-section size, allowing appropriate tibial cross-section for trifocal technique, with distraction osteogenesis at two osteotomy sites and compression at level of the pseudarthrosis. The presence of two osteotomies and two levels of bone regeneration accelerated the closure of the bone defect and relatively shortened the treatment time, which reduced the risk of the development of complications that are associated with prolonged transport time. We performed debridement of the docking sites and autogenous grafting to accelerate bone healing [6,7,10]. The combined TSF/Ilizarov technique was used in this case because of its many advantages [8]. TSF web based computer program is accurate in achieving for both multiplanar correction of the limb axis and further fine-tuning of the regenerate site after docking. The six struts were adjusted gradually by the patient, following the computer-generated daily adjustment schedule. In this case, there were no residual deformities or LDD at the end of treatment. The combined technique was used to take the advantages of the versatility of TSF and availability of Ilizarov parts in author's hospital [20]. Ilizarov was less cumbersome and lighter to the patient than multiple Taylor spatial frames stacked upon one another to perform double levels of lengthening plus compression at the nonunion site in the same limb. Ilizarov's four threaded rods permitted better radiographic evaluation of regenerate and docking site healing in comparison to TSF six struts.

Conclusion

FVFG has become one of the established procedures for the orthopedic surgeon in the reconstruction of extensive long bone defects following trauma associated with a number of well documented complications. The healing of recalcitrant FVFG nonunion of the lower extremity represents a true challenge for orthopedic surgeon. We have shown that distraction osteogenesis using combined TSF/Ilizarov technique is a viable limb salvage option for recalcitrant FVFG nonunion.

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Volume 5 Issue 6 April 2017