The Utility of Semi-Extended Tibial Nailing Utilizing the Suprapatellar Approach in the Treatment of an Open Proximal Tibial Fracture With Vascular Injury

Daniel N. Segina, MD and Ryan M. Wilson, PA-C, MPAS

Summary: Fractures of the proximal tibia are technically difficult to surgically repair noting a high incidence of complications, especially malalignment. This demonstrative case is of a 52-year-old woman involved in an auto versus motorcycle collision sustaining an isolated, open, proximal left tibia and fibula fracture. Extensive soft tissue stripping and exposed bone was noted at presentation. Plantar sensation was intact; however, the patient demonstrated no motor dorsiflexion function and pulses were undetectable. Imaging studies including angiography confirmed the clinical diagnosis of an open tibia fracture with vascular injury. Surgical debridement and temporary stabilization along with revascularization was urgently performed. Subsequent free tissue transfer and intramedullary stabilization using a suprapatellar entry portal for tibial nail insertion was performed in the semiextended position. Eventual infection and nonunion was successfully treated with hardware removal, revision nailing and autograft bone grafting. Bone healing without infection was able to be achieved with good clinical outcome. The case demonstrates the utility of the suprapatellar nailing technique in the semi-extended position, particularly with the avoidance of vascular graft disturbance and prevention of malalignment.

Key Words: semiextended, suprapatellar, tibia nailing, malalignment

INTRODUCTION

Proximal tibial fractures present a clinical and technical challenge because of the difficulty of obtaining and maintaining reduction until fracture union. Surgical adjuvants are commonly used to overcome these challenges. The suprapatellar nailing technique in the semiextended position can be a useful technique in the treatment of these difficult injuries.

PRESENTING CONCERNS

This case report concerns a 52-year-old woman motorcycle passenger injured after being struck by an automobile. She was transported from the accident scene as a designated trauma alert to our trauma center. Full ATLS protocol was initiated.

CLINICAL FINDINGS

This case report concerns a 52-year-old woman motorcycle passenger injured after being struck by an automobile. She was transported from the accident scene as a designated trauma alert to our trauma center. Full ATLS protocol was initiated.

The patient was awake and alert with a GCS of 15. She was hemodynamically stable with her only complaint of pain to her left lower extremity. The patient relayed no significant current medical problems, medical history, surgical history, or previous injury to her left leg. Her family history was negative for musculoskeletal disease, bleeding dyscrasias, or problems with anesthesia. The musculoskeletal assessment of her bilateral upper extremities, pelvis, spine, and right lower extremity was negative. An isolated injury to her left leg below the knee was noted with exposed muscle and bone. Detailed evaluation of the left lower extremity revealed intact plantar sensation. Plantar flexion of the ankle and toes was noted to be intact. Extensor function at the foot was absent along with no dorsal foot sensation. Vascular examination revealed absent dorsalis pedis and posterior tibialis pulses.

Accepted for publication January 5, 2016.

From the Holmes Regional Trauma Center, Melbourne, FL.

D.N. Segina is a consultant for Stryker, Breg, and Eli Lilly and an owner/shareholder of Genesis Medical LLC, Motion Devices LLC, and Breaking Away Consulting LLC. The remaining author reports no conflict of interest.

Reprints: Daniel N. Segina MD, Holmes Regional Trauma Center, 1350 Hickory St, Melbourne Florida 32901 (e-mail: Daniel.segina@healthfirst.org).

The views and opinions expressed in this case report are those of the authors and do not necessarily reflect the views of the editors of Journal of Orthopaedic Trauma or Stryker.

Copyright © 2016 Wolters Kluwer Health, Inc. All rights reserved.
DIAGNOSTIC FOCUS AND ASSESSMENT

Broad spectrum IV antibiotics for gram positive and gram negative organisms and tetanus toxoid were urgently administered. Radiologic evaluation confirmed the diagnosis of tibial and fibular fracture with a proximal, segmental fracture pattern. (Fig. 1) Additionally, acute angiography was performed demonstrating complete vascular compromise at the inferior margin of the popliteal artery. (Fig. 2) The final diagnosis was a type III C open proximal left tibia fracture.

THERAPEUTIC FOCUS AND ASSESSMENT

Emergent orthopaedic and vascular surgery intervention was undertaken. Surgical debridement with temporary skeletal stabilization using a small fragment plate and external fixation was rapidly accomplished. (Fig. 3) Revascularization using a reverse saphenous interposition graft successfully restored perfusion to the lower limb and foot. Serial debridements, every 48 hours, were undertaken over the ensuing week with no active infection appreciated. Definitive stabilization of the fracture was accomplished 6 days after injury with the placement of a reamed, locked, tibial intramedullary nail using the suprapatellar nailing technique in the semiextended position. The temporary small fragment plate was retained to assure proximal fracture reduction. (Figs. 4A–F) Free tissue transfer was accomplished at the same time using the ipsilateral gracilis muscle and split thickness skin graft.

FOLLOW-UP AND OUTCOMES

The patient was discharged to home at 14 days after injury. Initial follow-up occurred at 2 weeks after discharge noting no clinical signs of infection and nearly 100% take of her grafts. Sutures were removed and full range of motion was allowed. Follow-up occurred 8 weeks after discharge where the initial postoperative x-rays were obtained. Maintenance of reduction and early callous formation were noted. Progressive weight bearing as tolerated was allowed. Formalized physical therapy was also ordered. Bimonthly follow-up continued until 8 months after surgery. Radiographs at that time revealed interval callous formation and well-maintained alignment. (Figs. 5A, B) Knee range of motion was from 5 to 110 degrees. Passive ankle range of motion was from 0 to 25 degrees. No active range of motion of the ankle was noted. The patient continued follow-up with her local orthopaedic surgeon for the next 13 months (she lived 4 hours away). She did return 21 months after injury with complaints of increasing pain and active drainage from her proximal tibia. Diagnostic workup at that time included serologic studies; computed tomography and Indium-labeled white blood cell scan (Figs. 6, 7). Infected proximal tibial nonunion was diagnosed. Her distal diaphyseal fracture was noted to be healed. Staged surgical treatment was initiated beginning with hardware removal, deep cultures, antibiotic impregnated PMMA intramedullary nail, and IV antibiotics.

Copyright © 2016 Wolters Kluwer Health, Inc. All rights reserved.
The nail was removed through an infrapatellar entry portal (Figs. 8A, B). An infectious disease consultation was obtained with IV antibiotic therapy continued for 6 weeks. Serologic studies obtained after the conclusion of antibiotic therapy were noted to be normal. Surgical treatment at the time was performed including stabilization with a larger diameter tibial nail and autograft bone graft. Seven months later, final follow-up occurred with clinical and radiographic signs of fracture union (Figs. 9A, B). Additionally, serologic studies were normal. Final knee range of motion was 5–105 degrees. Final radiographs revealed anatomic coronal plane alignment with 5 degrees of procurvatum. She wears an AFO for lack of ankle and toe dorsiflexion function. She does have chronic pain issues managed with nonnarcotic pain medicine. She has returned to work. Her spouse is an above knee amputee from the same accident (Figs. 10A, B).

**DISCUSSION**

Fractures of the proximal tibia present a challenging problem particularly from a surgical reconstruction perspective. Options for surgical repair are divided between plating or nail fixation.
Bhandari conducted a meta-analysis of data published concerning proximal tibia fracture treatment. Although they graded the evidence as weak, they were able to demonstrate trends in surgical treatment options. Plate fixation was associated with a higher incidence of infection, whereas nails were associated with a higher incidence of malunion.\(^5\)

**FIGURE 5.** A and B, 8 months postoperative AP and lateral radiographs demonstrating posterior bridging callous.

**FIGURE 6.** Coronal computed tomographic image revealing persistent fracture line supporting the diagnosis of nonunion.

**FIGURE 7.** Indium-labeled white blood cell scan demonstrating significant uptake in the proximal tibia supporting the clinical diagnosis of infection.
Recent studies have demonstrated similar incidence of malreduction and malunion (8%–36%).\(^1\)–\(^4\) Additionally, these studies commented on the need for reduction aids when nail fixation is chosen for fracture repair to avoid malreduction.\(^1\)\(^2\) One of these aids revolves around the use of the suprapatellar nailing technique with the tibia in the semiextended position. This technique allows for the limb to be placed in a semiextended position that reduces the extension moment through the proximal tibia and thus reducing the potential for a procurvatum deformity. The technique also facilitates a more accurate entry portal, which assists in obtaining a more anatomic fracture alignment. Finally, this technique eliminates the need for limb repositioning that is needed using a traditional infrapatellar entry portal. Prospective studies recently published have demonstrated benefit of the suprapatellar nailing technique with

**FIGURE 8.** A and B, Intraoperative lateral fluoroscopic images demonstrating infrapatellar nail removal and temporary antibiotic nail placement.

**FIGURE 9.** A and B, AP and lateral radiographs, 7 months after revision nail fixation and bone grafting, demonstrating healed nonunion.

**FIGURE 10.** A and B, Final clinical photographs including the patient’s spouse with his AKA prosthesis.
excellent clinical and radiographic outcomes (Figs. 11A, B). A recent prospective randomized trial has demonstrated similar outcomes, with respect to pain and knee range of motion, comparing suprapatellar versus infrapatellar tibial nail insertion portals. Nail design has evolved to provide improved interlocking options with superior biomechanical stability as compared with traditional tibial nailing or plating. Multiple manufacturers have modified their tibial nail insertion apparatus to take advantage of the suprapatellar nailing technique using the suprapatellar nailing portal. Elongated insertion handles, trochlear groove protection sleeves, and extended reamers are now available.

Finally, this case study generates additional treatment challenges because of the open fracture with associated vascular injury requiring repair (Gustillo Anderson Type III C). Choosing limb salvage for this injury carries a significantly high complication rate, as experienced by this patient, and generates debate over preferred treatment options. Amputation, acute or delayed, must be considered a viable treatment option and is supported by prospective, peer reviewed data. That having been said, data gathered from the Lower Extremity Assessment Project study does not demonstrate a clear advantage to either treatment option when one considers long-term functional outcomes data. Decision making is multifactorial and should be individualized to each patient.

One of the confounding variables in formulating the treatment plan was the fact that this patient’s husband was also injured in the motorcycle collision. He sustained a traumatic above the knee amputation. Our patient categorically refused to consent to an amputation.

As with all case discussions, the information must be viewed with the understanding that a single case is only one piece of datum. It does not hold up to the scrutiny needed to make broad changes to one’s practice. It does provide the reader/surgeon an entry point into evaluating techniques, which may improve clinical outcome in certain patients. For this case specifically, obtaining anatomic alignment while avoiding potential disruption of an acute vascular repair are primary orthopaedic objectives. The utility of the semiextended tibial nailing using the suprapatellar approach is a valuable tool in achieving these objectives.

REFERENCES