Injury to the Anterior Tibial System During Percutaneous Plating of a Proximal Tibial Fracture

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abstract

Minimally invasive osteosynthesis of proximal tibial fractures has grown in popularity in recent years. This article describes a patient with a Schatzker type VI proximal tibial fracture (AO/OTA type 41.C3) and previous compartment syndrome treated with definitive fixation 8 weeks after initial injury with a precontoured proximal tibial plate and a distal targeting device. Brisk bleeding occurred during percutaneous insertion of a cortical screw at the midshaft of the tibia. Surgical exploration revealed sidewall tearing of the anterior tibial artery and vein, which were clipped at the screw insertion site. After the bleeding was controlled, the patient had a strong palpable posterior tibial pulse with no palpable dorsalis pedis pulse, and the foot remained well perfused. Function of the deep peroneal nerve was normal postoperatively.

Previous concerns regarding the percutaneous treatment of proximal tibial fractures have focused on the risks of damage to the superficial peroneal nerve from distal screws. Based on cadaveric studies, percutaneously and laterally based screw placement in the distal tibial metaphysis threatens injury to the anterior tibial system. However, with alterations to the normal anatomy caused by severe trauma, previously described safe zones may be changed and neurovascular structures may be exposed to risk in locations that were previously thought safe.
Minimally invasive plate osteosynthesis has gained popularity in recent years in the treatment of periarticular and long-bone fractures. Several precontoured plates have been designed with targeting devices to assist with the percutaneous insertion of screws and minimally invasive fixation. In patients with severe soft tissue injury, limiting soft tissue dissection may provide lower complication rates and less disruption of periosteal blood supply. However, the percutaneous insertion of screws risks damage to neurovascular structures because open exposure is not routinely performed. This article describes a patient with a bicondylar proximal tibial fracture and compartment syndrome treated with delayed definitive fixation. The patient sustained an injury to the anterior tibial system with percutaneous insertion of a cortical screw near the midshaft of the tibia. This article illustrates a risk not previously described being associated with this minimally invasive technique.

**Case Report**

A 40-year-old man was transferred to the authors’ institution 4 days after a motorcycle collision. He had sustained a Schatzker type VI tibial plateau fracture (AO/OTA type 41.C3) with associated compartment syndrome. Initial management at another facility consisted of knee-bridging external fixation and anterior compartment fasciotomy.

Physical examination revealed normal neurovascular function in the extremity and no evidence of ongoing compartment syndrome. The dorsalis pedis and posterior tibial pulses were palpable. Severe soft tissue injury existed with extensive formation of hemorrhagic fracture blisters on the medial aspect of the leg. An open fasciotomy wound on the anterolateral aspect of the leg had no necrotic muscle. Radiographs obtained at presentation at the authors’ institution revealed a bicondylar proximal tibial fracture with extension to the midshaft of the tibia and persistent shortening (Figure 1).

The patient subsequently underwent irrigation and debridement, lateral compartment fasciotomy and exploration for necrotic muscle, limited fixation of the articular block, and revision of the external fixator. This deviated from the authors’ normal protocol of performing 4 compartment fasciotomies using medial and lateral incisions when a diagnosis of compartment syndrome is made because the patient presented 4 days after initial management at another facility without evidence of ongoing compartment syndrome. The authors opened the lateral compartment to evaluate muscle viability in an open wound. Approximately 40 hours later, the patient developed increasing pain and signs of posterior compartment syndrome. He emergently underwent release of the posterior and deep posterior compartments. Open reduction and internal fixation of the tibial tubercle fragment and limited fixation of the shaft were also performed through the lateral fasciotomy wound (Figure 2). Medial fasciotomy closure and split-thickness skin grafting to the lateral wound were performed 2 days later.

Postoperatively, the patient was mobilized and received physical therapy while remaining nonweight bearing. Plans for definitive open reduction and internal fixation were delayed until maturation of the split-thickness skin graft and healing of the medial soft tissues.

Eight weeks after initial injury, the medial soft tissues had healed, and the lateral skin graft had matured (Figure 3). Neurovascular function of the extremity remained normal. Minimally invasive osteosynthesis was performed with a 14-hole precontoured proximal lateral tibial plate (Stryker, Mahwah, New Jersey) using a targeting device for distal screw placement. A nonsterile pneumatic tourniquet was initially applied but not inflated.

During insertion of a standard cortical screw at the tibial midshaft (10th hole, 190 mm from the top of the plate), brisk bleeding occurred from a 1-cm stab incision. The wound was packed, and fixation was completed. Fluoroscopy showed excellent fracture alignment and plate position. When the packing was removed, brisk bleeding persisted. The incision was extended proximally and distally to a length of 6 cm for exposure.

The tourniquet was inflated, and a side-wall injury to the anterior tibial artery and vein existed. Vascular clips were placed proximal and distal to the injury on the artery and vein. After deflation of the tourniquet, the foot was well perfused with a strong palpable posterior tibial pulse but nonpalpable dorsalis pedis pulse. Estimated total blood loss was 1100 mL. Postoperatively, motor and sensory functions of the...
superficial peroneal, deep peroneal, and tibial nerves were normal. Postoperative radiographs showed excellent fracture alignment (Figure 4).

DISCUSSION

Arterial injuries are rare complications of surgical treatment for tibial fractures and have occurred in association with open reduction and internal fixation, external fixation, and intramedullary nailing. Minimally invasive plating of fractures of the proximal and distal tibia has become a widely accepted technique. Cadaveric studies have shown less disruption of the peristeal blood supply when compared with traditional open techniques. However, minimally invasive techniques limit direct visualization and protection of neurovascular structures.

Risk of superficial peroneal nerve injury using the Less Invasive Stabilization System (Synthes, Paoli, Pennsylvania) for the proximal tibia has been previously studied. Open placement of distal screws has been recommended when using the 13-hole implant. The distance from the top of the plate to this zone for potential superficial peroneal nerve injury is 205 mm with the Less Invasive Stabilization System.

To the authors’ knowledge, no case reports have shown risk to the anterior tibial vessels and deep peroneal nerve exists with percutaneous plating of the distal tibia. Wolinski and Lee used cadavers to show that the neurovascular bundle crosses from posterior to anterior on the tibia between 40 and 110 mm proximal to the ankle joint. The authors advised against percutaneous screw placement in this zone.

To the authors’ knowledge, this is the first report of an injury to the anterior tibial vessels with percutaneous insertion of a proximal lateral tibial plate. The level of injury was more than 110 mm above the ankle joint level and was located in the middle-third of the tibia. Altered anatomy caused by previous fasciotomy and persistent swelling from compartment syndrome may have been contributing factors to the injury in this patient. The lack of tourniquet inflation at injury may have been a factor because flow within the vessels kept them engorged. However, the persistence of brisk bleeding from the small wound allowed prompt recognition of the injury. Several other case reports have reported pseudoaneurysm to be a delayed consequence of unrecognized arterial injury at the time of minimally invasive surgery. In the current case, the complication was recognized intraoperatively, and bleeding was controlled with vascular clips with maintenance of distal perfusion.

CONCLUSION

Minimally invasive plating of the proximal tibia provides less extensive surgical dissection and improved periosteal blood flow compared with traditional open approaches. However, the current article describes potential risk to the anterior tibial vessels and deep peroneal nerve with insertion of percutaneous screws in the middle-third of the tibia. Caution should be used with this technique to avoid potentially limb-threatening neurovascular injury.

REFERENCES

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