Provisional Plating of Type III Open Tibia Fractures Prior to Intramedullary Nailing

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Summary: Intramedullary nailing of tibial shaft fractures is the preferred treatment of most displaced, unstable tibial shaft fractures. In open tibia fractures, direct exposure of the fracture segments for irrigation and debridement is required prior to fracture stabilization. We propose a method of provisional stabilization using commonly available implants placed through the associated traumatic open wound prior to intramedullary nailing. This technique, particularly helpful to surgeons operating with limited assistance, employs a temporarily applied 3.5-mm dynamic compression plate or limited contact dynamic compression plate implant secured with unicortical screws, allowing reaming and intramedullary nailing of a reduced, stabilized tibia fracture.

Key Words: provisional plating, tibial plating, intramedullary nailing, open tibia fracture

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Intramedullary nailing is the treatment of choice for most displaced and unstable tibial shaft fractures. This technique has been shown to effect improved alignment, faster healing, a higher rate of union, and a faster return to work than casting or external fixation.[1–5] With intramedullary nailing, incisions for the insertion of intramedullary devices are typically remote to the fracture site, and indirect reduction techniques are commonly employed.

Many tibial shaft fractures have varying degrees of comminution that may make maintenance of reduction during nailing difficult, particularly when limited surgical assistance is available. Recommended techniques to help maintain reduction during nailing include using manual manipulations, sustained traction via a fracture table, a femoral distractor or external fixation, or simple clamp applications.[6] Techniques more specific to the nailing of proximal one-third tibial shaft fractures include adjusting the proximal starting point, nailing in a semiextended position, using adjunctive plates, and the placement of blocking screws prior to nailing.[7–10] Particularly in the setting of segmental fractures, a Schanz pin may be inserted to control the intercalary segment. Common to these techniques is minimization of further soft-tissue injury through provisional stabilization of the fracture fragments.

In the setting of many type III open tibial shaft fractures, the bone is already exposed and a thorough and appropriate irrigation and debridement is undertaken prior to intramedullary nailing. A small fragment dynamic compression plate (DCP) or limited contact dynamic compression plate (LC-DCP) (Synthes, Paoli, PA) may be meticulously applied through the open wound to hold provisional fixation. This is preferentially performed without further soft tissue dissection, leaving any attached periosteum and fascia undisturbed. These implants can be placed with unicortical screws, which avoid interference with medullary nailing, yet provide adequate stability to allow manipulation of the leg during the procedure to facilitate optimal imaging and nail insertion. Such plating can be performed quickly and tends to reduce time during reaming and nailing as no further reduction maneuvers are required, minimizing imaging and radiation exposure. This article describes the rationale, technique, and experience with provisional plate fixation for intramedullary nailing of open tibial shaft fractures.

TECHNIQUE

The patient is typically placed supine on a radiolucent operative table with a small bump under the ipsilateral buttock to avoid external rotation of the limb. The traumatic wounds are typically extended to allow visualization of the entire zone of injury. A thorough debridement and irrigation of the fracture is then performed. The fracture is reduced under direct visualization, using all available cortical interdigitations, with consideration given to using denuded bony fragments to recreate appropriate length, rotation, and alignment. If used, these devitalized fragments are removed after fixation. A 3.5-mm DCP or LC-DCP plate is applied to the exposed bony surface. Short oblique and transverse fractures typically require a short (5 or 6 hole) plate, whereas more unstable fracture patterns may require the greater stability afforded by longer plates.[11] As the open wound in tibial shaft fractures is commonly medial, the most common sites of temporary plate application include the anterior, the anteromedial, and the posteromedial tibial surface. However, to minimize further injury to the extraosseous vascularity, plates are preferentially applied to those areas immediately surrounding the fracture that are stripped, or devoid, of periosteum. Drilling is done

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FIGURE 1. Plated open tibial shaft fracture prior to intramedullary nailing.

with irrigation to avoid thermal necrosis. Similarly, to minimize interference with subsequent reaming (if used) and/or nail passage, screws are strategically placed to avoid significant penetration into the medullary canal. Ten or 12-mm length 3.5-mm screws are commonly employed and can be varied depending on the local anatomy.

As these plates are to be used as temporary measures only, gaining sufficient stability to permit intramedullary nailing is preferable to further soft tissue stripping to gain more substantial plate stability. Generally, 2 unicortical screws on either side of the fracture suffice. More unstable fracture patterns may require additional screws and increased plate length. After nail insertion and interlocking, the plate and screws are removed. A final inspection, irrigation, and debridement is performed, with wound care individualized.

PATIENTS

After obtaining Institutional Review Board (IRB) approval, review of our trauma database revealed 290 patients with 301 tibial shaft fractures treated in the 30-month period between January 1, 2000 and June 30, 2002 with intramedullary nailing. A total of 156 of these fractures were open and 145 fractures were closed. There were 30 Gustilo type I fractures, 19 type II fractures, 83 type IIIA fractures, 21 type IIIB fractures, and 3 type IIIC fractures.[12] Of these cases, 31 patients with 32 type III open tibial shaft fractures (AO/OTA classification 42A, B, or C) underwent provisional plating of their tibia fracture prior to intramedullary nailing.[13] All fractures were Gustilo type III open fractures (19 Gustilo type IIIA, 12 Gustilo type IIIB, 1 Gustilo type IIIC).[12] Provisional plating was used when limited assistance was available, when a segmentally comminuted fracture required stabilization of the intercalary segment, and at the discretion of the attending surgeon. The average age of the patients was 39 years (range 16–81 years). There were 23 males and 8 females. The mechanisms of injury included 9 motor vehicle collisions, 10 pedestrian injuries, 10 motorcycle collisions, and 2 falls from

FIGURE 2. Lateral radiograph of provisionally plated open tibial shaft fracture, after intramedullary nailing, prior to plate removal.

height. Four fractures (11.8%) were associated with compartment syndrome and treated with fasciotomies. Plates and screws were removed after intramedullary nailing in all cases. Two patients underwent early transtibial amputation (1 type IIIB and 1 type IIIC) who were not candidates for subsequent soft-tissue coverage procedure. The remaining 30 patients incurred 9 complications. Four patients developed deep infections (13.3%). Five patients developed nonunions (16.7%), which required further surgery to obtain union. Radiographic alignment was anatomic in the sagittal, coronal, and longitudinal planes in 18 fractures, and there was deformity of less than 3 degrees in the remaining fractures.

DISCUSSION

Adjuncts to facilitate fracture reduction and nail passage include indirect manipulative reductions, percutaneously or directly applied clamps or Schanz pins, traction using a fracture table, femoral distractor application, the use of adjunctive plates and screws, and fibular fixation. These methods, of proven utility, may have certain drawbacks. Fracture reduction clamps may require further stripping, may be impractical due to fracture morphology, or may simply become dislodged during the intramedullary nailing process. Indirect reduction maneuvers may not adequately control segmentally comminuted fragments. Not every surgeon has access to or familiarity with the femoral distractor. Fixation of the fibula well proximal to the ankle to facilitate tibial reduction is controversial. Mast et al described using a semitubular plate held by Verbrugge clamps to effect and provisionally maintain reduction during femoral intramedullary nailing.[14] Replacing the Verbrugge clamps with unicortical screws in an already open wound provides further stability with less soft-tissue stripping than clamp placement. Unicortical provisional plating of the open tibia fracture prior to intramedullary nailing is a simple technique utilizing implants familiar to all orthopaedic surgeons.

It may be argued that if a plate is already being applied, the screws may simply be placed bicortically, and the patient treated definitively with plate fixation. These are short, small fragment plates applied through the traumatic wound. The size and length of plate for adequate fixation would typically require further dissection for application. We believe this may be advantageous only in the extreme case in which the tibia is already effectively denuded and the disruption of the endosteal blood supply caused by intramedullary nailing is not considered prudent. Most wounds we have encountered would not accommodate the length of plate necessary for such definitive fixation. The benefits of intramedullary fixation over plate fixation in tibial shaft fractures have been clearly demonstrated.[1,5]

Type III open tibial shaft fractures have been shown to be at higher risk for infection and impaired healing compared to closed and lower grade open injuries. Our results are comparable to those reported.[12,15–17] We do not promote further soft-tissue disruption in these injuries. However, the small injury to the periosteum through which the screws pass, as well as the compression of this periosteum under the temporary plate, should be considered. The surgeon must decide whether the significant stability afforded by this technique, which facilitates the rest of the nailing and the intimate cortical contact obtained, outweighs these considerations. Such cortical contact has been associated with a decreased need for further surgery.[15] Finally, the cost of these implants as well as the time taken to insert and remove them should be considered.

Surgeons treating tibia fractures should desire techniques that are safe, reliable, and efficient. Provisional plating provides stability and maintains the easily obtained accurate reduction during reaming and insertion of an intramedullary nail. This obviates the need for repeated reduction maneuvers, frees the surgeon's hands, and eliminates multiple bulky clamps. This technique may be particularly useful in remote or austere areas where a fracture table, a femoral distractor, or other reductive adjuvants are not available, whereas small fragment plate and screws are widely available and familiar to all orthopaedic surgeons.

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