Trauma Tips & Tricks: Cortical Replacing Screws for Reducing Proximal-Third Tibial Shaft Fractures

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Background

Extramedullary proximal tibial shaft fractures provide numerous challenges to orthopaedic surgeons with respect to appropriate reduction that re-establishes length, alignment, and rotation. This is due to numerous factors including thinner cortices, spongier metaphyseal bone, the proximal flared shape of the tibia, and soft-tissue deforming forces. Numerous intra-operative reduction and fixation techniques have been reported including external fixation, percutaneous plate fixation, open reduction internal fixation, intramedullary nails, and any combination of the above as an initial reduction and subsequent permanent fixation technique. Intramedullary nails provide an ideal fixation method due to their load-sharing ability, thereby allowing early mobilization. However, achieving coronal and sagittal alignment presents a challenge for otherwise-uncomplicated proximal third tibial shaft fractures due to the size mismatch of the wide metaphyseal proximal tibia and significantly smaller intramedullary nail diameter with reports of malreduction in 58 to 84% of fractures having undergone intramedullary nailing.[1,2] This often results in an apex anterior deformity due to the proximal and anterior pull of the extensor mechanism and valgus malalignment.

First described by Kretek et al, cortical replacing ("blocking") screws provide a supplementary technique to addressing malalignment.[3] Also known as "Poller" screws, referring to metal-shaped objects that are used to block or re-direct road-traffic,[4] they essentially serve the same purpose during placement of intramedullary nails for proximal tibial shaft fractures by re-directing the guidewire and subsequently the nail in such a manner that corrects the deforming forces. Additionally, when left in situ, they provide increased biomechanical construct stability and resistance to continued deforming forces post-operatively by providing a three-point internal mold.[5,6] Below, we review tips and tricks to implementing this technique in order to successfully reduce proximal tibial shaft fractures during intramedullary nail fixation.

Preoperative Assessment

As with any proximal tibia fracture, pre-operative assessment should start with good history taking, including prior injury or congenital deformity to the limb, and physical exam, including a high suspicion for developing compartment syndrome, sustaining a neurovascular injury due to the anatomic proximity of the peroneal artery and nerves, or presenting with an open fracture due to the subcutaneous position of the tibia anteriorly. Obtain appropriate orthogonal radiographs of the tibia (Figure 1A, 1B), knee, and ankle. Supplementary views can include the "twin peaks" and "flat plateau" views to better assess intra-articular extension. If there is concern for intra-articular extension and the appropriate resources, proceed with a CT scan.

Initial stabilization can occur with a short leg splint and knee immobilizer to ensure that neither the respective proximal or distal ends act as a fulcrum for further deformity. Alternatively, a long leg splint may be applied.

Intramedullary fixation may be contraindicated in Gustilo-Anderson type II or III open fractures due to need for repeat debridements and higher risks of development of osteomyelitis; an external fixation construct may be more appropriate initially in such cases.

Surgical Technique

The patient is placed supine on a radiolucent table with a bump under the ipsilateral hip so that the patella faces toward the ceiling. Cortical replacing screws can be used with any nail insertion technique. However, a suprapatellar approach with a radiolucent foam ramp placing the knee in 10-20 degrees of flexion provides among the easiest intra-operative set-ups as it reduces deforming forces by relaxing the extensor mechanism and removing gravity, and provides easier fluoroscopic assessment by positioning the limb parallel to the floor and elevating it from the contralateral limb for easier lateral views. For the purposes of this review, the blocking screw technique will be highlighted with a suprapatellar approach.

Mark the incision from one finger breadth above the superior pole of the patella to 2-3cm proximally. Incise down through the quadriceps tendon to bone in line with the fibers. Using blunt finger dissection, free up adhesions in the suprapatellar pouch and insert the soft-tissue guide. Confirm via fluoroscopy the starting

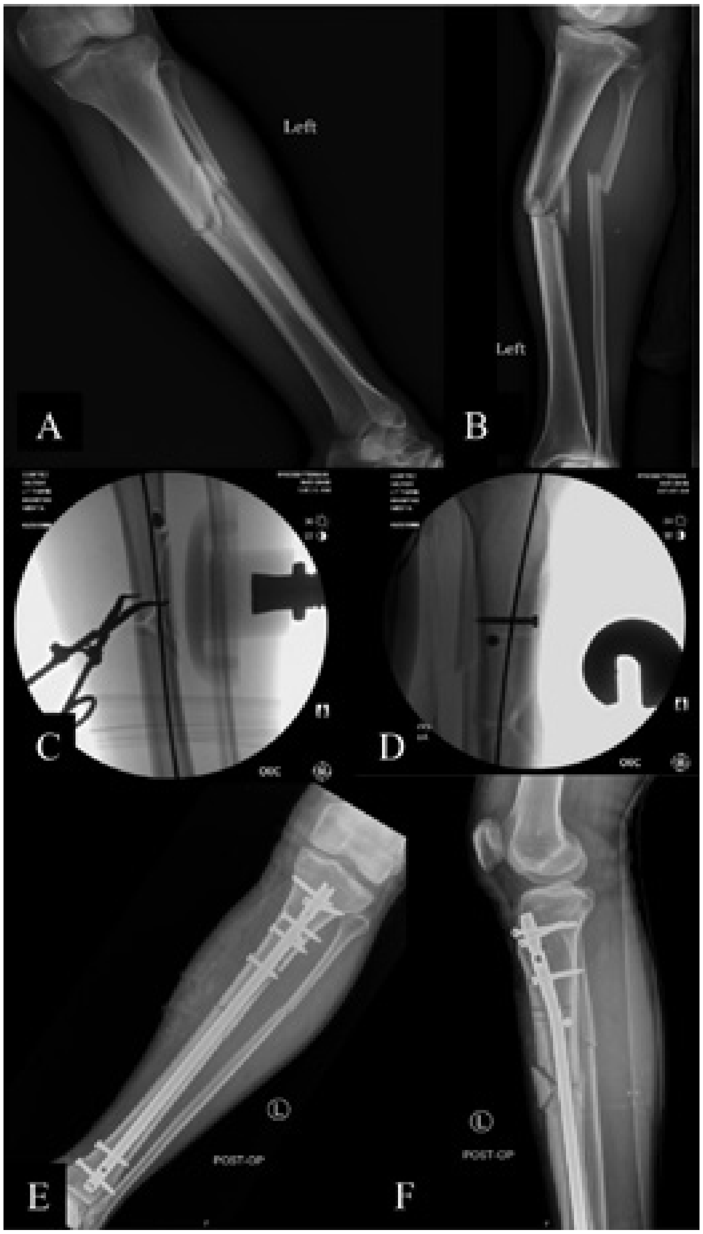

Figure 1. Radiographs demonstrating the use of cortical replacing screws for improving intra-operative reduction of a proximal- third tibial shaft fracture during insertion of an intramedullary nail. **(A)** AP radiograph of a proximal-third tibial shaft fracture with valgus mal-alignment; **(B)** Lateral radiograph of a proximal-third tibial shaft fracture with apex-anterior deformity; **(C)** Intra-operative fluoro with reduction of the fracture using clamps; **(D)** Intra-operative fluoro with a guidewire passing after placement of posterior and lateral cortical replacing screws; **(E)** Post-operative AP radiograph of a proximal-third tibial shaft fracture after intermedullary nailing using cortical replacing screws; **(F)** Post-operative lateral radiograph of a proximal-third tibial shaft fracture after intermedullary nailing using cortical replacing screws.

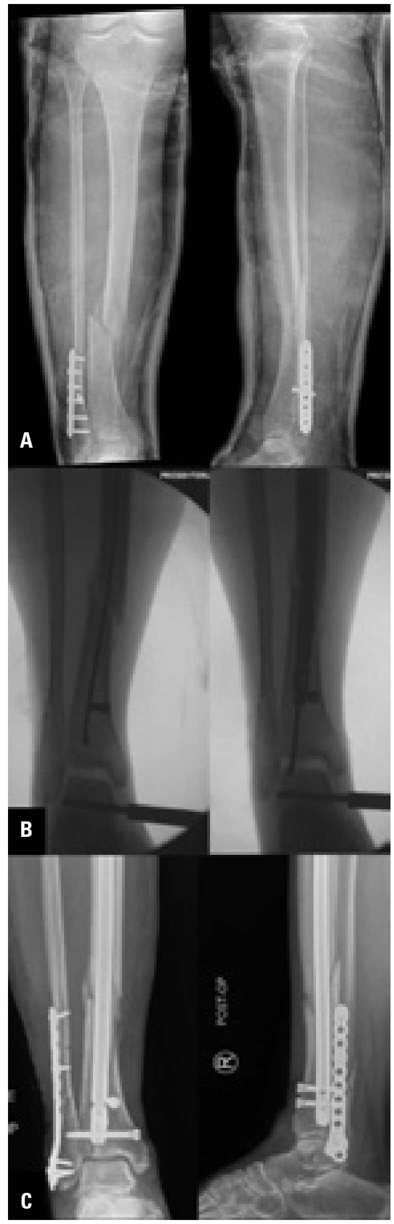

Figure 2. Radiographs demonstrating the use of cortical replacing screws for improving reduction of a distal-third tibial shaft fracture, another location of bone width-nail diameter mismatch. **(A)** AP and lateral radiographs of the initial distal-third tibial shaft fracture with lateral translation; **(B)** Intra-operative fluoros with a guidewire and nail passing after placement of a medial cortical replacing screw; **(C)** Post-operative AP and lateral radiographs of the distal-third tibial shaft fracture after intermedullary nailing using cortical replacing screws.

point as medial to the lateral tibial spine and at the junction between the anterior cortex and anterior articular surface of the tibia with a trajectory parallel to the anterior cortex. Place a guidewire within the soft-tissue guide and provisional advance past the level of the tibial tubercle to confirm appropriate placement. Secure the soft-tissue guide to the femur or tibia using a large-diameter wire to protect the patellofemoral joint. This will maintain the cannula allowing for easy passage of instruments. Use an opening reamer to open the proximal tibial cortex. Assess the deformity present at this time and make note of the concave sides on AP and lateral fluoroscopy as this will be where the cortical replacing screws should be placed. Reduce the fracture with closed or open techniques (Figure 1C). Insert a coronal and saggital blocking screw in the proximal fragment at least 1 cm away from the fracture line as needed. An interlocking screw or a large diameter screw ($\geq$ 4.5mm) is recommended as there have been reports of smaller screws bending or breaking with subsequent reaming. Alternatively, a Schantz pin may be initially placed during reaming to reduce deformity to the reamer and subsequently replaced with a screw just prior to final nail insertion (Figure 1D). Introduce a ball-tipped guidewire down the length of the tibia and reassess reduction. These steps may be repeated multiple times until the reduction is deemed satisfactory.

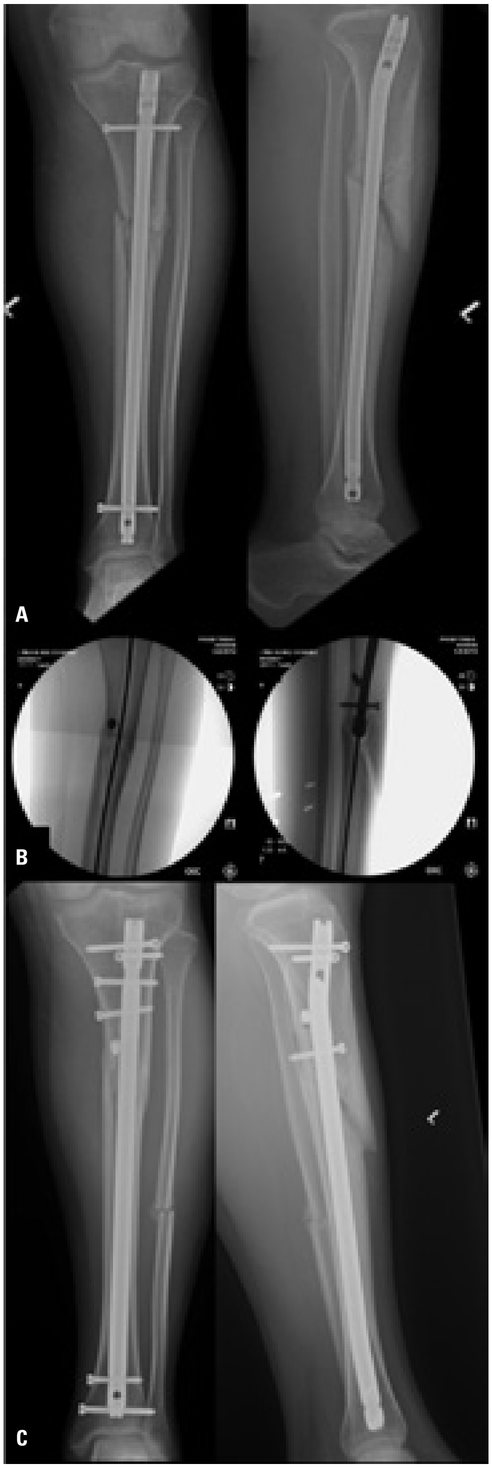

Figure 3. Radiographs demonstrating the use of cortical replacing screws for improving reduction of a proximal-third tibial shaft fracture non-union with varus mal-alignment. **(A)** AP and lateral radiographs at time of initial evaluation; **(B)** Intra-operative fluoros with a guidewire and reamer passing after placement of medial and posterior cortical replacing screws; **(C)** Post-operative AP and lateral radiographs three months post-operatively.

Proceed with sequential reaming and placement of the nail and its interlocking screws in a standard fashion (Figure 1E, 1F).

Post-Operative Care

The standard post-operative protocol can be followed after this reduction technique without modification including weight-bearing as tolerated and initiation of physical therapy post-operative day 1.

Final Considerations

In short, the use of cortical replacing screws as outlined above is meant to serve as one tool out of many available in the Orthopaedic surgeon's skillset for reducing proximal-third tibial shaft fractures. It can also be applied to other sites where intramedullary nails are used in the setting of a bone width-nail diameter mismatch (Figure 2) and in cases of mal-union and non-union corrections (Figure 3) at these sites.

From a technical standpoint, actual execution in the OR may not be as easy as outlined due to imperfect fluoroscopic views, pre-operatively unrecognized fracture comminution, or imperfect technical execution. Furthermore, other characteristics of the fracture may make it more amenable to a different reduction technique such as an existing external fixator or clamping through an open fracture site. Even in such cases, though, cortical replacing screws can be used to continue to hold the alignment after the fracture has already been reduced.

The use of cortical replacing screws as a way to obtain and maintain reduction is far better than accepting a mal-reduction of the tibia with significantly reported improvements from 59-84% incidence of tibial mal-union in cohorts reduced without cortical replacing screws to 1-6% incidence of tibial mal-union in separate study cohorts using this technique.[1,2,7,8]

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