Incarcerated Cortical Fragments in Intramedullary Nailing

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Abstract: In fractures with varying degrees of comminution, it is possible for cortical bone fragments to become entrapped within the intramedullary canal. There have been prior case reports on complications associated with incarcerated fragments; however, there has been no proposed solution. The current case shows how 2 cortical fragments in the distal segment of a comminuted femur fracture impeded passage of the intramedullary reamer and induced deformity at the fracture site during the reaming. The authors describe a simple method of retrieval without having to formally open the fracture site. Recognizing the presence of an incarcerated fragment and appropriately managing it intraoperatively allows for fracture fixation to occur uneventfully. [Orthopedics. 2016; 39(3):e582-e586.]

Intramedullary nailing has become the standard method of treatment for femoral and tibial shaft fractures. More recently, nailing has become increasingly popular in the treatment of humerus fractures. Indications have expanded to include extra-articular proximal and distal fractures of long bones, as well as some fractures with limited intra-articular involvement. The technique is not without complications, including malunion, nonunion, infection, heterotopic ossification, neurovascular injury, and pain at insertion and interlocking sites. Prior case reports have noted intraoperative complications of incarcerated cortical fragments in the medullary canal resulting in impassable guidewires and reamers, intra-articular penetration of the fragment, and intra-articular advancement of the guidewire. To the authors’ knowledge, a specific report on how to remove an incarcerated cortical fragment has not been presented in the orthopedic literature. Recognizing the presence of an incarcerated fragment and appropriately managing it intraoperatively allows for fracture fixation to occur uneventfully.

Case Example and Surgical Technique

A 22-year-old healthy man involved in a motor vehicle collision presented to a level 1 regional trauma center. Advanced Trauma Life Support protocol was followed and the patient was evaluated by the general surgery and orthopedic trauma surgery services. Physical and radiographic evaluation confirmed a closed right diaphyseal femur fracture with mild comminution, AO/OTA 32-B3 (Figure 1). Once the patient was cleared, he was brought to the operating room, where general endotracheal anesthesia was induced. He was placed onto a radiolucent operating table and positioned appropriately and standard preparation and draping was done. A piri-formis start site was obtained and the proximal femoral canal was opened. Passage of a ball-tipped guidewire down to the
fracture site was performed. Reduction occurred with a combination of longitudinal skeletal traction, towel bumps, external manipulation, and a shoulder hook placed through a 5-mm incision. Once reduced, a ball-tipped guidewire was placed into a center-center position in the distal femur.

When reaming commenced, 2 free cortical fragments were noted in the distal segment that induced a translational and apex posterior deformity at the fracture site on the lateral view (Figure 2). Attempts to ream through the fragment, as well as removal by backing up the reamer and ball-tipped guidewire, were unsuccessful. Before making a larger and formal open approach, a long, narrow endoscopic grasper (Encision, Boulder, Colorado) (Figure 3) was used for fragment extraction. The grasper was placed through the existing proximal start site incision into the proximal segment, across the fracture site, and into the distal segment. The fragments were successfully grasped and retracted proximal to the fracture (Figure 4). The fragments were unable to be completely extracted due to their size and irregular shape. The fracture was displaced with a ball-spike pusher through the prior percutaneous incision and the fragments were released into the soft tissues adjacent to the fracture site (Figure 5). With the fragments out of the way, the guidewire and reamers were passed without incident and the intramedullary nail was placed successfully without further issues (Figure 6; Video).

At 5 months postoperatively, the patient had healed clinically and radiographically (Figure 7). At 1 year postoperatively, he had no complaints, had fully returned to all leisure activities, and had resumed full-time employment.

**RESULTS**

After institutional review board approval was obtained, a retrospective search was conducted that showed that 82 diaphyseal femur fractures and 70 diaphyseal tibia fractures were treated at the authors’ institution between September 2012 and November 2013. Within this series, 3 patients sustained 2 diaphyseal femur fractures and 70 diaphyseal tibia fractures were treated at the authors’ institution between September 2012 and November 2013. Within this series, 3 patients sustained 2 diaphyseal femur fractures and 1 diaphyseal tibia fracture that had an incarcerated cortical fragment detected intraoperatively. At the authors’ institution, the prevalence of an incarcerated fragment is 2 of 80 (2.5%) for femur fractures and 1 of 70 (1.4%) for tibia fractures. In accordance with the AO/OTA classification system, there were one 32-C3, one 32-B3, and one 42-B2 fractures. These were 3 male patients with an average age of 30 years (range, 24-38 years). The mechanisms of injury included 1 high-velocity gunshot wound, 1 motor vehicle collision, and 1 auto vs pedestrian accident.

All patients underwent operative fixation of their fracture with standard percutaneous intramedullary nailing techniques. When the incarcerated fragment was encountered, initial attempts were made to dislodge the fragment with
could not be removed through the proximal segment and was instead replaced extramedullary immediately adjacent to the fracture site (Figures 5-7). There were no perioperative complications related to their orthopedic injuries for all patients. Average follow-up was 12.3 months (range, 12-13 months). All fractures showed complete radiographic union at an average of 5.3 months (range, 4.5-6 months). There was no secondary intervention in any patient.

**Discussion**

Comminuted fractures of the long bones can successfully be managed surgically with an intramedullary device.\(^1\)\(^2\) In any fracture pattern, especially comminuted fractures, it is possible for a cortical fragment to become entrapped within the intramedullary canal of the proximal or distal segment. The entrapment can occur during the injury or during initial guidewire and reamer insertion. Johnson and Wiss\(^17\) described 2 cases of propagation of an intramedullary cortical fragment into and through the intercondylar notch of the femur by the intramedullary nail. Nag et al\(^22\) reported on a tibia fracture treated with closed intramedullary nailing that was complicated by an intramedullary bone fragment in the distal segment. An attempt at forceful reaming and insertion of the nail led to a break in the cortex of the distal fragment as well as bending of the guidewire. Ultimately, an open approach was used to remove the fragment and complete the procedure.\(^22\) Rajappa and Kumar\(^18\) reported on an incarcerated fragment that became inadvertently trapped between the nail and the guidewire, causing binding of the guidewire. With complete passage of the intramedullary nail, the guidewire was driven distally, penetrating the tibiotalar and subtalar joints. Rodger and Atkins\(^20\) described a case in which an incarcerated cortical fragment was driven through the plafond and postoperative radiographs showed an intra-articular osseous fragment in the ankle joint. Salamon and Finkemeier\(^21\) reported a case where a 2×1-cm fragment of bone was wedged into the intramedullary canal. An open approach was used to remove the fragment and complete the operation.

The above cases suggest that if the guidewire, reamer, or nail cannot be passed easily across a reduced fracture during the operation, the surgeon should suspect an incarcerated fragment. Through the current authors’ series, the presence of an incarcerated fragment is not common, with an occurrence of only 2.5% of femur fractures and 1.7% of tibia fractures. Although rare, these fragments can cause a significant problem intraoperatively. They can impede fracture reduction and prevent passage of the guidewire, intramedullary reamer, or nail, as well as be forced further distally into the canal with potential sequelae. When a fragment obstructs the medullary canal, the surgeon needs to consider retrieval of the fragment because forcing
the wire distally may wedge an incarcerated fragment more securely into the canal. Proceeding without removal of the incarcerated fragment can also potentially jam a reamer or cause intra-articular penetration of the fragment or guidewire.

**Conclusion**

To the authors’ knowledge, there has been no previously described technique to assist in dealing with incarcerated fragments using percutaneous techniques and avoiding an open approach. In the current case example, a standard pituitary rongeur was simply not long enough to reach down the entire length of the femoral canal. The endoscopic grasper was used through the standard skin incision for the piriformis start site. The endoscopic graspers are available in many different lengths as well as with varying sizes of the grasper portion. If the fragments are of an appropriate size, they can be completely removed from the canal. In some cases, the fragments can be large or irregularly shaped and it is not possible to bring them completely out of the proximal segment. As shown in the current case, such fragments can be removed back to the level of the fracture site and placed into the soft tissues adjacent to the fracture as long as the soft tissues are amenable. Once there, the fragments are completely out of the way of the guidewire, reamers, and intramedullary nail. By working through the percutaneous incisions, a formal open approach is avoided. This technique is safe, uses preexisting incisions, and allows for extraction or relocation of the incarcerated fragment without further surgical trauma to the limb.

**References**


