Special Situations

Polytrauma Patient

The timing of IM nailing and the safety of reaming in the multitrauma patient have been closely scrutinized in recent years.

Current damage control principles include provisional surgical stabilization methods that minimize surgical time, blood loss, and additional trauma. Most commonly, these are practiced with monolateral external fixation that, in the absence of pin-site infection, can be safely converted to IM nailing once the patient is optimally stabilized. Retrograde unreamed nailing with or without proximal locking has recently been advocated as an alternative to external fixation.

Open Fractures

Open fractures of the femur are much less common than those of the tibia. Because of the presence of a large protective soft-tissue envelope about the femur, open fractures are often associated with significant soft-tissue trauma. Small skin wounds can disguise significant deep muscle and periosteal injury.
Several studies have shown that the timing to initial débridement of open fractures does not significantly affect infection risk; rather, the severity of the open injury is the most significant factor determining the risk of deep infection. Wounds should be extended for evaluation of the deep soft tissues, and all nonviable soft tissues and bone should be débrided. Serial débridement at 24-to 48-hour intervals is typically recommended with higher-grade or highly contaminated open injuries.

Immediate IM nailing of open femoral shaft fractures is indicated in all but the most severe cases, most notably those involving grossly contaminated canals. Intravenous antibiotics should be initiated at presentation and continued until definitive wound closure. Routine wound culture is not indicated.

Fractures of the femur caused by gunshot wound are technically open fractures; however, they can usually be treated as closed injuries. The entry and exit wounds should be débrided locally at the level of skin and subcutaneous tissue. The deeper tissues do not require formal irrigation and débridement.

Fracture stabilization can thereafter follow standard treatment of closed fractures. The exceptions to this method are wounds from shotgun blasts at close range and high-velocity gunshot wounds with severe soft-tissue compromise. In these instances, treatment should be as for other high-grade open injuries.

Vascular and Neurologic Injury

Femoral shaft fractures associated with either vascular or neurologic injury are rare and are usually associated with penetrating trauma. The algorithm for management of fractures with associated vascular injury traditionally consists of bony stabilization, either definitive or provisional, followed by neurovascular repair with attention to obtaining proper length. The most expeditious stabilization method is usually external fixation, which, in the absence of infected pin sites, can be safely converted to definitive IM nailing within 2 weeks without increased risk of deep infection. Another expeditious alternative is retrograde nailing with interlocking deferred until after neurovascular repair. Deferring any skeletal stabilization until after vascular repair can reduce ischemic time as well as the need for fasciotomy. Recent clinical evidence indicates that this sequence can be applied safely without

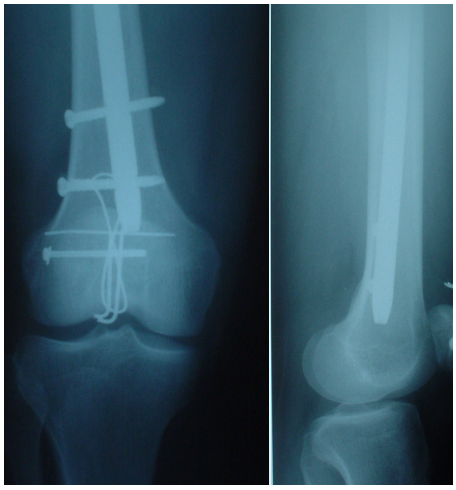
disruption of the vascular repair during definitive fracture treatment.

Obese Patients

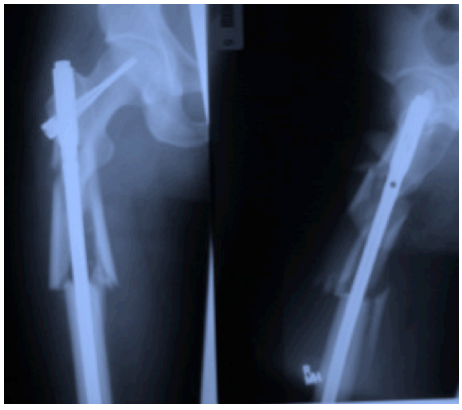
Obtaining a proper starting point for antegrade nailing in obese patients can be difficult. Retrograde nailing in this setting provides advantages of reduced radiation exposure and surgical time.

Fracture hip and Femoral Shaft Fractures

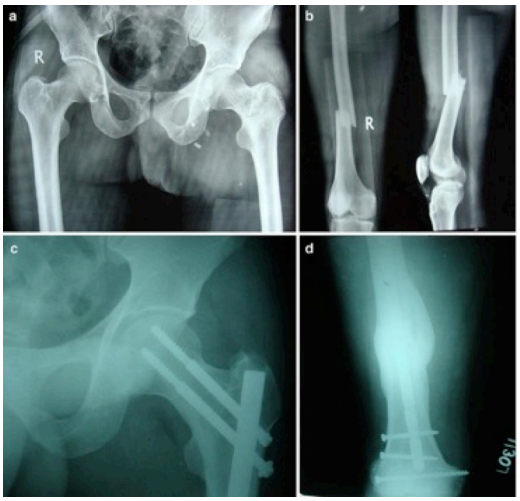
Occur in 10 of all femoral shaft fractures.
Hip fracture are often minimally displaced (25% to 60%) and are easily missed (20% to 50%).
Evaluation of the femoral neck with fine-cut computed tomography (CT) imaging is indicated.
The femoral neck component of such injuries is the highest priority for optimal, but not necessarily initial, stabilization.
A variety of fixation techniques can be used to address both femoral neck and femoral shaft fractures. These include separate implant placements, such as retrograde nailing or plating of the shaft combined with standard fixation of the proximal fracture using cannulated screws or a sliding hip screw. Alternatively, simultaneous treatment of the proximal and shaft fractures using a single IM device in a reconstruction model has been advocated.
Antegrade IM nailing can cause displacement of occult nondisplaced fractures of the femoral neck. Thus, intraoperative anteroposterior and lateral radiographs of the femoral neck should be obtained after the nailing procedure. These practices can reduce the risk of delayed diagnosis of a femoral neck fracture and potentially prevent the devastating sequelae of osteonecrosis and nonunion associated with nailing.



Comminuted fracture shaft



Simple stable fracture



Ipsilateral fracture neck and shaft

Complications of Femoral Nailing

Malunion

Angular malunion of femoral shaft fractures after IM nailing is most common in proximal (30%) and distal (10%) fractures, in which the surgeon cannot rely on the interference fit of the nail to align the fracture.

Blocking screws can be used to assist in aligning more proximal and distal fractures, but these are unnecessary in the diaphysis.

Reaming until osseous chatter is heard, then selecting a nail approximately 1 mm smaller, will provide excellent interference fit and will neatly align most diaphyseal fractures.

Rotational malunion remains a concern even with modern nailing techniques. The patient may “sag” on the fracture table, resulting in relative external rotation of the hemipelvis.

a. Alignment of the anterior superior iliac spine, the patella, and the second toe can assist the surgeon in obtaining correct rotation.

b. Additionally, fluoroscopic evaluation of cortical widths, any key fragments, or femoral anteversion can assist in obtaining proper rotation.

c. Both legs should be examined for rotational symmetry before exit from the operating suite.

Removing interlocking screws, manually correcting the rota-tion, and reinserting interlocking screws, if noted at this time, can easily treat rotational malalignment. Rotational malalignment can be evaluated by clinical examination; however, a CT scan can be more accurate.

Symptomatic rotational malunion after union is achieved requires osteotomy, either open or with an IM saw.

Nonunion

Broken rod

Uncommon these days

Infected Non-union

The rate of nonunion after nailing of femoral shaft fractures, regardless of starting point, is low, usually <10%. In the event of nonunion, deep infection should be considered and ruled out before surgical repair is undertaken. The treatment of nonunion may involve dynamization, exchange nailing, or plate fixation with bone grafting. Dynamization can be useful for distracted fractures; however, no large series have evaluated the efficacy of this strategy, and success rates vary from 54% to 92.3%.

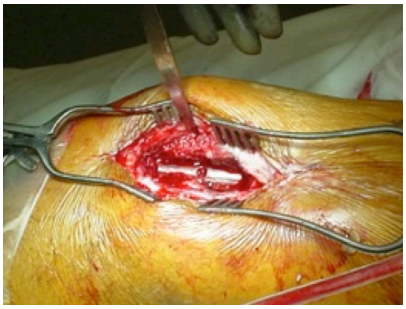
Fractures with bony defects, atrophic characteristics, or failed dynamization may benefit from reaming and exchange nailing or open grafting and repair. Results for exchange nailing of femoral shaft fractures show good but not outstanding union rates, ranging from 53% to 96%.

Recalcitrant non-unions may warrant an evaluation for underlying metabolic disturbances and can be successfully managed with bone grafting and plating.

Leg Length Discrepancy

The treatment protocol for a problematic discrepancy is to return to the operating room and re-lock the nail at the correct length.

Infection



Infection rates noted in large series of femoral shaft fractures treated with IM nails are low, ranging from 1% to 3.8%. Infections can be categorized as early (<3 months) or chronic; both are generally associated with ununited fractures. Early infections, such as those associated with open fracture wounds, can typically be treated with nail retention, serial débridement, and organism-specific intravenous antibiotics. Nail removal is indicated when the early infections cannot be controlled. External fixation or antibiotic cement nails, created over a metal wire or other substrate, can provide stability during the treatment period.

Chronic infections and infected nonunions are treated based on the principles of osteomyelitis management. Generally, the nail is removed, the canal is reamed for débridement purposes, and nonviable bone from the fracture margin is resected. Intravenous and potentially local antibiotics in the form of cement beads or a cement spacer are typically administered for at least 6 weeks. Definitive reconstruction is delayed until the infection is controlled.

Other Potential Complications

A patient may develop heterotopic bone at the site of antegrade nail insertion. Although present radiographically, heterotopic bone islands often have little functional significance. A mass that becomes large can cause pain and limit motion; thus, excision should be considered.

IM nailing can directly or indirectly result in neurovascular injury. Positioning on the fracture table with excessive traction may cause pudendal nerve compression. Fortunately, this neurapraxia often resolves without sequelae. Insertion of the proximal locking screws during retrograde nailing can cause injury to branches of the femoral nerve; locking the nail proximal to the lesser tro-chanter can minimize risk of this out-come. Overzealous drilling for interlocking screw placement can cause vascular injury and pseudoaneurysms.

Some patients may report knee pain secondary to inadequately countersunk retrograde nails. This complication warrants revision to prevent further articular damage to the patella.

Well leg compartment syndrome has been described. Prolonged pressure on the calf muscles should be avoided on the contralateral leg during the procedure.

Summary

IM nailing is an effective method for the treatment of fractures of the femoral shaft, providing generally high union rates and low complication rates. With the use of modern techniques and implants, good results can be obtained for femoral nailing with any pairing of starting point (ie, piriformis, greater trochanter, retrograde), the choice of which depends on several factors. These include fracture characteristics, associated injuries, body habitus, and surgeon familiarity with each nailing method. Other important technical decisions concern body position, use of traction, and reaming. Of paramount importance to outcome is adherence to meticulous surgical technique, with each combination of starting point and positioning method requiring specific attention to detail.

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