

Prevention of Complications After Treatment of Femoral Shaft and Distal Femoral Fractures

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Abstract

The need for surgical treatment of femoral shaft and distal femoral fractures is undisputed. The treatment options are varied, and often the choice is based on the surgeon's preference rather than orthopaedic science. The decision should be determined by the predicted functional outcome rather than by the type of implant to be used. The entry point for intramedullary femoral nailing is of no consequence, if the nailing is performed correctly and the patient has a good functional outcome. The primary goal of treatment for a supracondylar femoral fracture is to restore limb alignment while preventing angular deformity. Proper technique, not the choice of a nail or plate, is key to recovery.

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Complications after treatment of femoral shaft and distal femoral fractures can be avoided. It is important to identify treatment pitfalls as well as strategies to avoid complications.

Femoral Shaft Fractures

During intramedullary nailing of the femoral shaft, several steps can lead to complications if they are in-

correctly performed. Angular malalignment can occur, especially in a proximal, distal, or comminuted midshaft fracture.¹ To ensure proper alignment in the sagittal and coronal planes, the two most important principles are to make sure the starting point for nail entry is correct and to maintain fracture reduction throughout the reaming process. Whether the nail is inserted from

the piriformis fossa, intercondylar notch, or greater trochanter, the entry site must be carefully determined. From the piriformis fossa, an overly anterior starting point results in an increase in hoop stresses in the proximal femur and the potential for bursting of the femur. If the nail entry is too lateral, a varus deformity commonly results, especially with a proximal fracture.² A retrograde nail inserted too far anterior leads to an increase in patellofemoral contact forces; starting the nail entry too far either medial or lateral in the femoral condyle leads to valgus or varus, respectively, especially in an infraisthmal fracture.³ Similarly, increased proximal stresses, difficult insertion, comminution, and varus can be produced by starting nail entry too far lateral on the greater trochanter.

The ball-tipped guide rod is flexible and has a much smaller diameter than the nail itself. The guide rod can easily cross most fracture lines. However, if the reduction is less than perfect, the flexible intramed-

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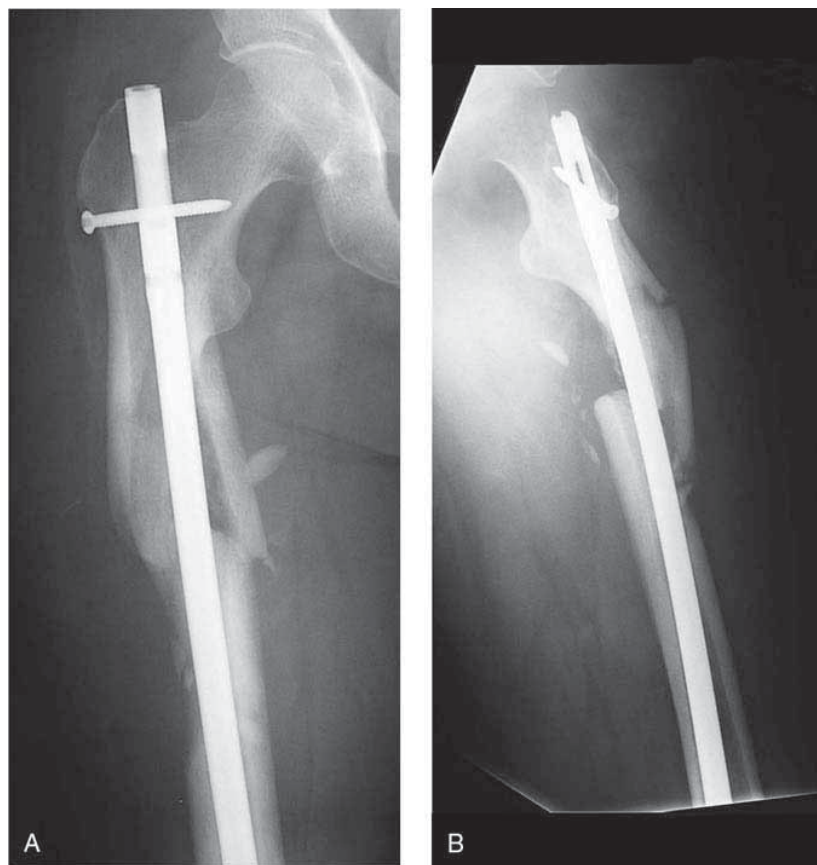


Figure 1 AP (A) and lateral (B) radiographs of a femoral fracture that was not reduced during reaming, showing the expected deformity caused by muscle pulling.

ullary reamer produces eccentric reaming, and the deformity apparent during reaming is maintained upon nail insertion (Figure 1). This common difficulty can be avoided by maintaining the fracture reduction during reaming and nail insertion. Simply choosing a centromedullary insertion site in line with the femoral shaft for piriformis or retrograde intercondylar nailing and maintaining the reduction during reaming can prevent angular deformities.

Because the supracondylar region is wide, with fractures of the distal femur comminution can lead to deformity. Correction can be achieved by placing a blocking screw to act as an artificial cortex that guides the

nail and straightens the femur. These Poller screws are placed on the concave side of the deformity before reaming and nail insertion.⁴

The surgeon must maintain femoral length, rotation, and angular alignment during final placement of the locking screw.⁵ Strategies differ according to whether the surgeon decides to perform the operation with or without a fracture table. Assessing and maintaining length can be difficult unless a fracture table is used. Using a radiopaque ruler to measure the intact contralateral femur during surgery allows accurate measurement of the unaffected limb. Then the appropriate nail length can be selected, and the frac-

tured limb length can be maintained during distal interlocking in antegrade nailing or proximal locking in retrograde nailing. During antegrade nailing, further length can be obtained through primary distal interlocking followed by blows to the insertion handle. During retrograde nailing, attaining limb length is easier; distal locking with the outrigger insertion device is followed by backslapping of the nail. This application of a distracting force will restore femoral length until the iliotibial band tightens. Rotational malalignment is more difficult to assess during surgery.⁶ One option for rotational evaluation is to ensure that the patella points directly anterior before final locking, with the pelvis flat on the table. Another option is to match the rotation seen on fluoroscopic views of the proximal and distal femoral segments. Malrotation of as much as 10° is well tolerated by patients, although external rotation is less well tolerated than internal rotation⁶ (Figure 2).

Using a canal-sized reamed implant inserted antegrade or retrograde with static locking proximally and distally has been supported as the treatment of choice in femoral shaft intramedullary nailing.⁷ A small-diameter nail does not prevent or mitigate the pulmonary issues associated with femoral nailing, and a mismatch of the nail and the canal diameter increases the likelihood of malunion or nonunion.⁸

Distal Femoral Fractures

Fractures involving the supracondylar region of the femur can be treated with an intramedullary nail or a locking plate.⁹ A retrograde nail is commonly used and can be inserted through a percutaneous incision. A centromedullary insertion site should not lead to varus or valgus

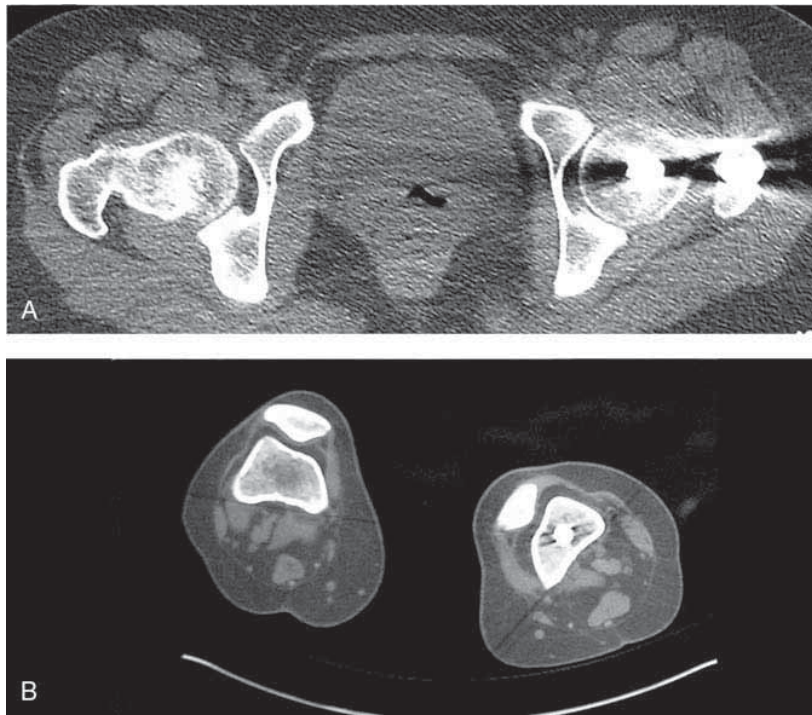


Figure 2 Proximal (A) and distal (B) CT studies showing a deformity of 26° of internal rotation in a left femur after intramedullary nailing.

malalignment. A lateral condylar starting point leads to varus and should be avoided. An intra-articular split fracture can be reduced through a suitably sized incision with the screws kept in the anterior part of the condyles to allow the nail to pass posteriorly through the intramedullary canal.

The use of locked distal femoral plating with an anatomically contoured plate has gained popularity because the plate can help in obtaining the correct coronal plane alignment. However, length and rotational malalignments continue to occur. In biologic plating, smaller incisions are used to slip the plate submuscularly up the femur from the distal lateral insertion site. Two incisions are most commonly used: a 5-cm incision when there is no intercondylar involvement and a

15-cm anterolateral incision, starting at the tibial tubercle, when the joint must be exposed for reduction and fixation. By using indirect reduction techniques, the intermuscular plane between the vastus lateralis and the rectus femoris can be developed, and the capsule can be opened with retraction for joint exposure, without disrupting the fracture hematoma or stripping the medial soft tissue. Lag screws can be placed across the condyles to fix the articular surface before plate fixation. Locking plates do not allow subsequent varus drifting of the distal femoral segment. Care must be taken when fixing the plate to the shaft because locking screws do not reduce the bone to the plate. Clamps or nonlocking cortical screws are necessary to take advantage of the plate's anatomic contours. Attention

also must be paid to the lateral fluoroscopic view to identify recurvatum of the distal femoral segment caused by the pull of the gastrocnemius muscle. Recurvatum can usually be prevented by placing a bolster behind the patient's knee to relax the gastrocnemius and push the posteriorly angulated distal femoral segment anteriorly.

The hybrid combination of locking and nonlocking screws with a locking plate has been shown to be biomechanically strong in long bone fractures.¹⁰ Unicortical locking screws perform poorly in mechanical testing and probably should not be routinely used.¹¹ In osteoporotic bone, bicortical locking screws provide a stronger construct than bicortical nonlocking screws.^{11,12} Two comparison studies of retrograde intramedullary nailing and plating for distal femoral fractures revealed no differences in knee motion, angulation, knee scores, or union rates,^{9,13} although one study found that blood loss and surgical times were greater when plating was used.¹³

Nonunion of Femoral Shaft Fractures

Hypertrophic nonunion of the femur is the most common form of delayed healing in femoral shaft fractures because of the abundant surrounding soft tissues and lack of stability. Hypertrophic nonunions most commonly have abundant nonbridging callus that is oriented perpendicular to the shaft with interposed osteoid. Most can be treated with exchange nailing by reaming the intramedullary canal up several millimeters and inserting a larger diameter, dynamically locked nail.¹⁴ This technique increases stability, and union after exchange nailing commonly occurs after several months. The nonunion does not

have to be exposed because it is usually stable in length and rotation. The locking screws are placed on the shorter side of the fracture, and the nail uses the isthmus for fixation on the longer side. The dynamic nature of the nailing and the increased stability permit early weight bearing. Cultures should be taken from the reamed material, regardless of whether the fracture was initially open, to ensure that the nonunion was not caused by infection. Good rates of union also were found after intramedullary nail removal and plating for femoral nonunion, although the lengthy surgical procedures resulted in a large blood loss.¹⁵

Atrophic nonunion is best treated with the addition of a bone graft (allograft, autograft, or a combination). The fibrous tissue at the nonunion site must be excised, the bone ends freshened, and the canal reamed or curetted to improve the blood supply. The intramedullary nail can be left in place if it is tightly fitted into the canal, and grafting alone can be performed. If instability is present or the nail is too small for the canal, statically locked exchange nailing or nail removal with plating is necessary for stability. These fractures are unstable in length, and stable static fixation must be provided. Weight bearing is delayed until some of the graft is incorporated and visible on radiographs.

Ipsilateral Femoral Neck and Shaft Fractures

The initial challenge is in making the diagnosis of an ipsilateral femoral neck and shaft fracture. Dedicated radiographs of the hip should be obtained in every patient with a femoral shaft fracture. Because most such patients have multiple injuries, a pelvic CT scan should always be

obtained; often it can help in identifying subtle fractures before surgery. The treatment plan should include the choice of table to be used for the surgery as well as the implants needed for fixation. The goal is to achieve optimal fixation of both the femoral neck and shaft fractures. A displaced femoral neck or intertrochanteric hip fracture associated with a femoral shaft fracture is best treated using a sliding hip screw. The femoral shaft can be fixed with a retrograde femoral nail after the hip fracture is stabilized. A hip screw is preferable to cannulated screws because 26% to 59% of femoral neck fractures have a vertical angle of 70° or greater,¹⁶ and these vertical fractures are subjected to great shear from joint reaction forces and possible fixation failure.¹⁷ The risk of osteonecrosis after these hip fractures is approximately 3%, even when initially missed.¹⁶

Although surgical strategies and techniques vary, it is important to internally rotate the intercalary shaft fragment when reducing a femoral neck fracture. An open reduction through an anterior capsulotomy can then be done with anterior Kirschner wires to hold the hip fracture reduction before final fixation. The fixation technique can include the use of a sliding hip screw with a long side plate, if the fracture is proximal to the isthmus. Another option is to use a cephalomedullary device to fix both the femoral neck and shaft fractures. When a single implant is used, a lateral trochanteric starting point or adduction of the limb leads to varus of the femoral neck. Many surgeons have abandoned this type of implant because of poor reduction of the proximal fracture.¹⁸ A meta-analysis found a higher revision rate in combined femoral fractures treated with a single implant than in similar fractures treated with two implants; in

addition, small-diameter retrograde nails led to a higher incidence of nonunion.¹⁹

Summary

Femoral shaft fractures are common injuries and are most often treated with intramedullary nailing. The surgeon must pay careful attention to an accurate starting point, regardless of the entry portal chosen. Further, reduction of the fracture during the reaming process and attention to length and rotation during final interlocking will lead to good clinical results. Whether an intramedullary nail or fixed angle locking plate is used to treat a distal femoral fracture, appropriate alignment must be obtained in both the sagittal and coronal planes. Blocking screws can be used with nails to prevent varus or valgus, and correction of the recurvatum of the distal femur seen with lateral fluoroscopy when using either implant will allow for proper axial alignment. Indirect reduction techniques should be used with a locking plate to prevent devascularization of the fracture site and promote early union. Nonunions of the femur should be recognized early when there is no further progression of healing, and depending on the type of nonunion should be treated with appropriate surgical intervention. Recognition of ipsilateral femoral neck and shaft fractures and treatment with adequate fixation of the femoral neck fracture and retrograde nailing have produced encouraging results in the management of this difficult associated fracture pattern.

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