Trauma Tips & Tricks: Nail Plate Combination Fixation for Distal Femur Fractures

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Background

Distal femur fractures account for less than 1% of all fractures and between 3% and 6% of all femur fractures.[1] These fractures follow a bimodal distribution between high-energy mechanisms such as motor vehicle accidents in the younger population and low-energy mechanisms such as fall from standing in the elderly and osteoporotic populations. Their incidence is increasing with the rising geriatric population and periprosthetic knee arthroplasty fractures.[2]

Distal femur fractures are significant injuries that can be technically challenging to operatively treat. The main goals of management of distal femoral fractures are 1) anatomic reduction of the articular surface, 2) restoration of length, alignment, and rotation 3) stable fixation construct to allow early knee range of motion, and 4) preservation of the soft tissue attachments to bone fragments to reduce the risk of nonunion.[3]

Nonsurgical management is reserved for non-ambulatory patients with medical comorbidities that place them at unacceptably high risk of surgical/anesthesia complications. Nonsurgical management involves protected weight or non-weight bearing in a hinged knee brace. Complications of nonsurgical management, including decreased mobility, decubitus ulcers, and thromboembolic disease, generally outweigh the risks of surgical intervention in most patients.[4]

Surgical fixation has consistently demonstrated superior outcomes as compared with nonsurgical treatment.[4] Potential methods of fixation include external fixation, plates (fixed angle blade, locking), retrograde intramedullary nail (IMN), and distal femoral replacement. Of those options, plates and intramedullary nail are most commonly used. Biomechanical studies demonstrate locking plates are more stable than IMN to loading forces in osteoporotic bone, however they have a greater incidence of sudden periprosthetic fracture.[5,6] The increased stability is thought to be due to increased distal fixation with the locking plates compared to IMNs. Nonunion rates are similar for locking plates and IMNs.[7] The use of either a locking plate or IMN alone usually warrants a protected weight-bearing status.

The nail plate combination (NPC) technique offers more stable fixation while allowing for immediate weight bearing and early mobilization, which is of particular importance in the treatment of geriatric fractures. The rationale in combining plate and IMN fixation is the stress forces are more evenly distributed between the bone and the implants.[8] Biomechanical studies have shown NPC is more resistant to failure in axial and torsional load tests, and load to failure tests compared with both locking plate and IMN alone. [9] However, in a study comparing dual plating and NPC, dual plating provided stiffer fixation to axial and torsional loading. The study hypothesized the difference was due to an inability to use all distal interlocking bolt positions within the nail or all distal screw positions within the plate in the NPC construct. [10] While dual plating provides stiffer fixation, there is a soft tissue cost of an additional surgical incision and potential effect on fracture healing that must be taken into consideration.

Below, we highlight the NPC technique using an example case of Patient X.

Perioperative Assessment

Perioperative assessment should include history-taking (baseline function, prior injuries, prior surgeries, congenital deformity to the limb) and physical exam (compartments, vascular assessment with distal pulses and ankle-brachial indices given potential popliteal artery injury). Obtain orthogonal radiographs of the femur, knee, and hip. Evaluate for an ipsilateral femoral neck fracture, particularly with high-energy mechanisms.[11] As intra-articular extension can be difficult to visualize on radiographs alone, CT imaging is usually indicated. Attention should be paid for possible Hoffa fragment (intra-articular fracture in the coronal plane of the condyle).[12]

Initial stabilization can be achieved with a knee immobilizer to ensure support proximal and distal to the fracture site without creating fulcrums for further deformity. Alternatively, a long leg splint may be applied. Distal femoral traction is not advised, even with evidence of no intraarticular extension, given the distal nature of the fracture and deformity. Proximal tibial traction may be considered unless ipsilateral ligamental knee injury is suspected. External fixation may be used as a temporizing measure for length unstable fractures with overlying soft tissue concerns and/or vascular injuries.

Example Case

Patient X, 73-year-old female with history of dementia, prior strokes with residual right sided weakness, end-stage renal disease on hemodialysis, and diastolic congestive heart failure who presented with right knee pain after an unwitnessed fall from standing position. She was a home ambulator with a walker at baseline and used a wheelchair outside of the home. Physical exam demonstrated a closed injury with a shortened and internally rotated well-profused right lower extremity. X-rays revealed a right-sided comminuted extra-articular distal third femur fracture with valgus and apex posterior deformities (Figure 1). No intra-articular extension was evident on CT imaging. She was stabilized with a knee immobilizer.

She was a good candidate for surgical intervention given her baseline ambulatory status and the morbidity of non-operative management with her multiple medical co-morbidities. NPC offered stable fixation technique for her comminution and poor distal bone quality and early mobilization with immediate weight bearing for her age and co-morbidities.

Surgical Technique

The patient was placed supine on a radiolucent table with fluoroscopic imaging on the contralateral side of the table. A small bump was placed under the ipsilateral buttock to ensure the patella was facing upwards. Next, a radiolucent triangle was placed under the injured distal thigh to bring the knee into approximately 30 degrees of flexion. Radiographs were obtained of the contralateral, uninjured, knee and femur to act as a reference for alignment and rotation.

The right femur was first approached by performing closed reduction using skeletal traction, which corrected the length and valgus deformity (Figure 2A). The radiolucent triangle aided in reducing the apex posterior deformity (Figure 2B). Having restored length, alignment and rotation, attention was turned to making a transtendinous infrapatellar incision. Sharp dissection was taken down. Patella tendon was identified and incised in line with the incision. Starting point was achieved and confirmed fluoroscopically. The guidewire was then taken into distal femur in the appropriate trajectory. The distal femur was opened with reamer and the ball-tip guidewire was then taken into the distal femur across the fracture into the proximal femur. Reaming then began sequentially up to a size 11.5 reamer. The length was measured to be just around the 360 mm. The decision was made to place a 10x360 mm nail. The nail was assembled on the back table on the jig. That trajectory through the jig was checked. The nail was then introduced over the ball-tip guidewire into the distal femur across the fracture and into the proximal femur. Appropriate depth was confirmed fluoroscopically (Figures 2C and 2D). Three distal interlocking screws were placed through the jig (Figure 2E). Two proximal interlocking screws were placed using the perfect circle technique (Figure 2F). The most distal interlocking screw was then removed in order to link the plate to the nail. Fluoroscopic evaluation revealed good length and rotation of the femur with appropriately placed hardware. Due to the poor bone quality, the decision was made to supplement with a laterally based plate.

Plate length was estimated by overlaying it on the skin under fluoroscopic imaging and determining the length

Figure 1. Patient X's injury radiographs demonstrating a right-sided comminuted extra-articular distal third femur fracture. **(A)** AP radiograph demonstrating valgus deformity. **(B)** Lateral radiograph demonstrating shortening and apex posterior deformity.

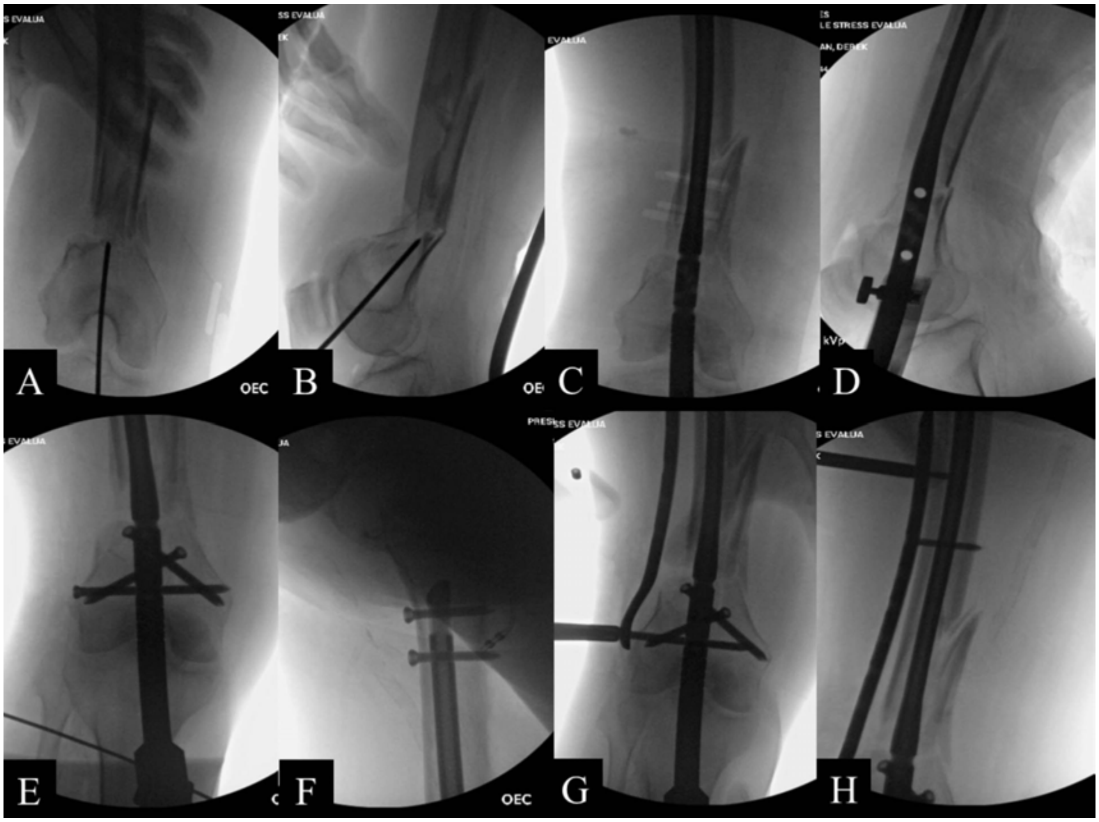

Figure 2. Patient X's intra-operative fluoroscopy. **(A)** AP distal femur demonstrating correction of the length and valgus deformity with skeletal traction. **(B)** Lateral distal femur demonstrating use of the radiolucent triangle to help correct the apex posterior deformity. **(C)** AP distal femur demonstrating final position of the retrograde IMN. **(D)** Lateral distal femur demonstrating correction of the apex posterior deformity after IMN placement. **(E)** AP distal femur demonstrating three distal interlocking screws placed through the jig. **(F)** AP proximal femur demonstrating two distal interlocking screws placed using perfect circle technique. **(G)** AP distal femur demonstrating replacement of the most distal interlocking screw through the plate to link the plate and IMN. **(H)** AP proximal femur demonstrating placement of distal screws through the plate around the IMN.

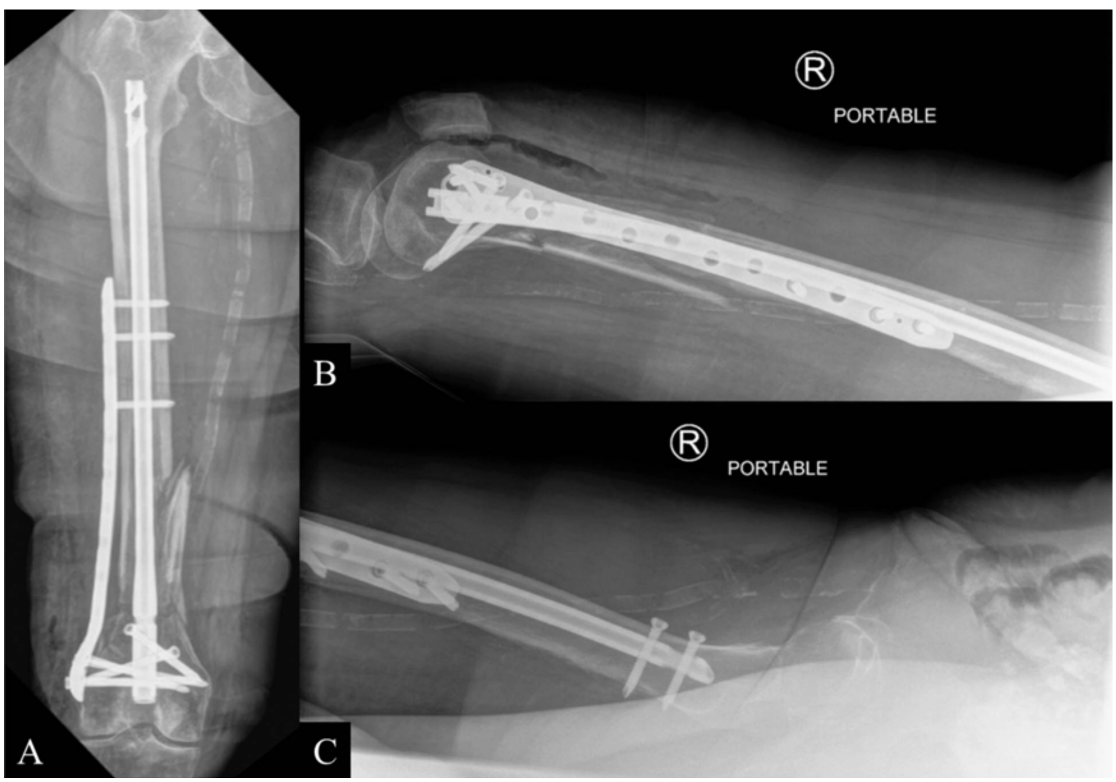

Figure 3. Patient X's final radiographs demonstrating NPC with Zimmer retrograde femoral nail and Zimmer NCB distal femur plate. **(A)** AP of the whole femur. **(B)** Lateral of the distal femur. **(C)** Lateral of the proximal femur.

necessary to achieve three screws proximally.A Zimmer distal femur NCB plate was selected. Next, a separate mid-lateral subvastus incision was made over the distal femur starting from Gerdy's tubercle. Sharp dissection was taken down. The iliotibial band was identified and incised in line with the incision. The femur was identified and the vastus lateralis was lifted off the intermuscular septum exposing the lateral aspect of the femur. This "proximal window" allows for direct visualization and mid-axial placement of the plate, which was slid under the vastus lateralis, from the distal incision. The plate was balanced with K-wired in place. The plate was then secured with nonlocking screw distally through the plate and the nail using the jig for the nail to link the constructs and a nonlocking screw proximally around the nail to compress the plate to bone (Figures 2G and 2H). The plate was further secured with hybrid fixation with locking screws distally and non-locking screws proximally around the nail. Final fluoroscopic evaluation revealed good length, alignment and rotation of the femur with appropriate placed hardware (Figure 3).

Post-operative Care

Initiation of early physical therapy post-operatively is essential to prevent stiffness and loss of function. Traditionally with either nail or plate fixation, partial or non-weight bearing precautions are maintained for 6–12 weeks after surgery or until evidence of radiographic fracture healing. NPC allows for immediate weight bearing as tolerated. In the case of Patient X, she was made weight bearing as tolerated with a walker post-operative day one. She progressed well with physical therapy and was recommended for inpatient rehabilitation to improve functional mobility and maximize independence.

Conclusion

In summary, NPC offers a reliable technique for early mobilization after distal femur fractures. While plating and nailing alone usually require protected weight bearing, using NPC allows for immediate weight bearing. This can help improve outcomes and maintain baseline function, particularly in the growing geriatric population.

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