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Case Series

Iatrogenic distal femur fractures after long proximal femur nailing: a three-case series with prevention and management strategies

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ABSTRACT

Proximal femur nails (PFNs) are widely regarded as the gold standard for unstable intertrochanteric fractures due to their biomechanical strength and minimally invasive nature; however, complications such as iatrogenic distal femur fractures and anterior cortical perforation remain important concerns. This case series describes three such complications: a 56-year-old female who developed a postoperative distal femur fracture after long PFN fixation, managed with ORIF using a distal femur plate with distal locking screws, proximal unicortical screws, and cerclage augmentation; an 82-year-old female with a similar fracture pattern managed with distal femur plating and cerclage wire; and a 58-year-old male who sustained anterior cortical perforation of the nail and was treated conservatively with non-weight-bearing due to medical unfitness for revision surgery. These complications typically arise from femoral bow mismatch, nail design limitations, surgical technique factors, and patient-specific anatomy. Management options include distal femur plating with or without cerclage augmentation or conservative treatment in selected patients, while prevention hinges on careful preoperative planning, appropriate implant selection, and meticulous technique. Although uncommon, distal femur complications after long PFN require early identification and individualized management to prevent progression and ensure favorable outcomes.

Keywords: Long proximal femur nail, Iatrogenic distal femur fracture, Anterior femur bowing, Distal femur plating, Intramedullary nail complication

INTRODUCTION

Intertrochanteric fractures represent one of the most common fractures in the elderly population, accounting for approximately 50% of all hip fractures. The demographic shift toward an aging population has resulted in an increased incidence of these fractures, making their optimal management a critical concern for orthopedic surgeons worldwide.[1] The management of intertrochanteric femur fractures has evolved considerably over recent decades. While extramedullary devices such as the dynamic hip screw were once considered the gold standard, intramedullary fixation has become increasingly favored for its superior biomechanical stability and clinical outcomes. Proximal femur nails (PFNs), available in short and long variants, are now widely used—particularly for unstable fracture patterns—owing to their proximity to the weight-bearing axis, reduced stress concentration, and ability to permit early mobilization.[2] Long PFNs are specifically indicated in unstable fractures with subtrochanteric extension, reverse oblique patterns, compromised lateral walls, and in patients predisposed to periprosthetic fractures. Their extended length theoretically allows for better stress distribution along the femoral shaft, potentially minimizing the risk of periprosthetic fractures seen with shorter implants.

However, the use of long PFNs is not without complications. Reported issues include anterior cortical perforation, periprosthetic fractures, knee joint nail protrusion, and iatrogenic fractures during insertion. Among these, iatrogenic distal femur fractures represent a particularly challenging and uncommon complication, with reported incidences up to 0.47% in antegrade femoral nailing.[3] The etiology of these distal femur complications is multifactorial. Anatomical factors, notably the mismatch between the natural anterior bow of the femur and the straighter design of modern intramedullary nails, can lead to cortical impingement or perforation—especially in osteoporotic bone where the anterior cortex is thin. Technical factors, such as improper entry point, inadequate preoperative planning, and forceful insertion, further increase the risk.[4]

Management of iatrogenic distal femur fractures following long PFN insertion requires an individualized approach based on fracture configuration, bone quality, displacement, and patient factors. Treatment options range from conservative care with protected weight-bearing to surgical fixation using distal femoral locking plates, often with augmentation techniques like cerclage wiring.[5]

This case series describes three patients who developed iatrogenic distal femur complications after long PFN fixation for intertrochanteric fractures, emphasizing the mechanisms, presentations, and management strategies for this rare but significant complication.

CASE SERIES

We report three consecutive patients. Case 1 is a 56-year-old woman sustained a left subtrochanteric femur fracture following a fall from standing height. She underwent fixation with a long PFN using standard technique, with intraoperative fluoroscopy confirming acceptable reduction and implant alignment. The immediate postoperative period was uneventful, and routine postoperative imaging was planned as part of the early rehabilitation protocol. Post operative radiographs revealed a new distal femur fracture located just below the nail tip. The fracture was minimally displaced and was likely related to femoral bow–nail mismatch combined with stress concentration at the distal interlocking region. There was no interval trauma or precipitating event, supporting an iatrogenic mechanism.

The patient underwent open reduction and internal fixation (ORIF) with a locking distal femur plate. Distal locking bolts of the PFN were removed, and proximal fixation was achieved with unicortical screws to avoid interference with the intramedullary nail. Cerclage wiring was added for supplemental stability. She was maintained non–weight-bearing for six weeks followed by gradual progression. In one year, she achieved radiological union and good functional recovery without implant-related complications.

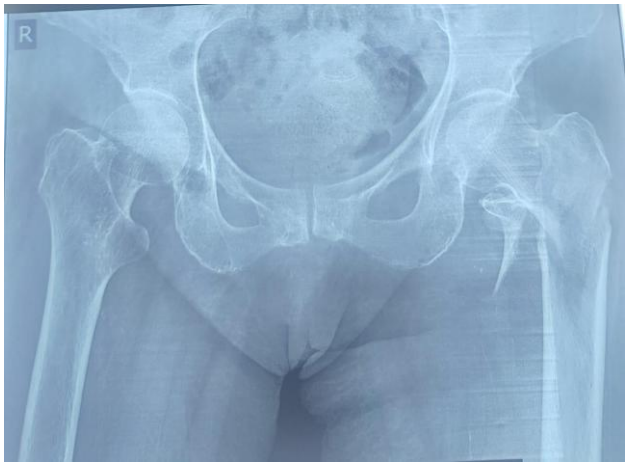

Figure 1: Radiograph showing left intertrochanteric fracture (case 1).

Figure 2: Immediate post operative Xray shows distal femur fracture at the tip of nail.

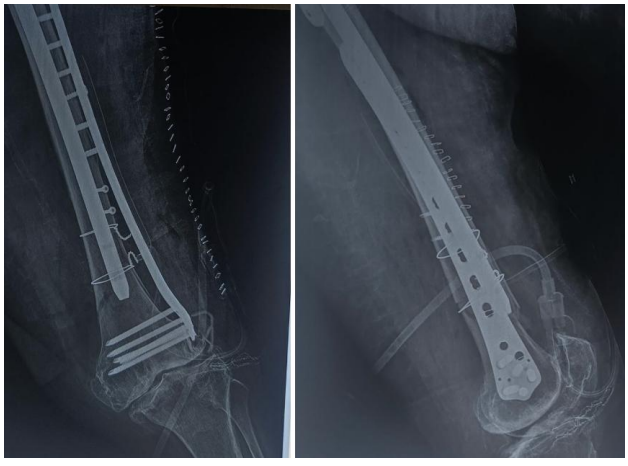

Figure 3: Distal femur plate fixed with unicortical locking screws proximally; additional cerclage wire around fracture site.

Case 2 is an 82-year-old woman presented with a left unstable intertrochanteric fracture. Given her osteoporotic bone quality and fracture complexity, she underwent long PFN fixation. Satisfactory alignment was achieved. She

was placed on a standard postoperative protocol with planned early mobilization using a walker. But early postoperative radiographs obtained during routine evaluation revealed a spiral distal femur fracture originating near the nail tip. The fracture pattern suggested excessive anterior cortical stress from the nail, likely aggravated by osteoporotic bone and mismatch between the nail's curvature and the patient's femoral anatomy. There was no history of additional trauma, indicating an iatrogenic origin.

ORIF was performed using a distal femur locking plate with supplemental cerclage wiring to control the spiral component. Distal locking bolts of the PFN were removed to reduce stress concentration and lack of bony purchase. Proximal fixation was again achieved with unicortical screws to avoid violating the intramedullary nail. Her postoperative course included strict non–weight-bearing for six weeks, with gradual progression thereafter. At one year, she regained independent ambulation with radiographic union and no evidence of plate or nail complications.

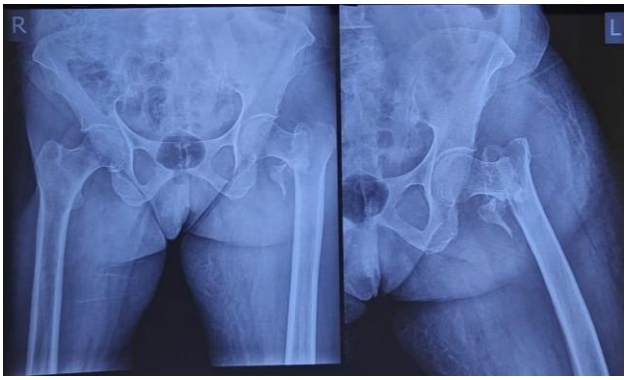

Figure 4: Radiograph showing left intertrochanteric femur fracture (case 2).

Figure 5: Immediate post operative Xray shows a displaced distal femur fracture.

Case 3 is a 58-year-old man presented with a right intertrochanteric fracture and underwent long PFN fixation. Intraoperatively, the nail advanced with noticeable resistance, suggesting a mismatch between the patient's femoral curvature and the nail geometry. He was otherwise stable postoperatively. Radiographs obtained the following morning demonstrated anterior cortical perforation of the distal femur by the nail tip. There was no displaced fracture line, but significant risk of propagation was anticipated if weight-bearing were permitted.

Figure 6: Post operative radiographs showing distal femur plate fixation augmented with cerclage wire.

Figure 7: Radiograph showing right intertrochanteric femur fracture (case 3).

Revision surgery was advised; however, the patient was medically unfit and declined further operative intervention. He was managed conservatively with strict non–weight-bearing and protected mobilization. He remained clinically stable during early follow-up but was lost to follow-up after six weeks, and longer-term outcomes could not be obtained.

Figure 8: Immediate post op Xray showing anterior cortical perforation.

DISCUSSION

Iatrogenic distal femur fractures following long PFN insertion represent a rare but significant complication with potentially serious consequences for patient outcomes. The incidence of such complications varies in the literature, with reported rates ranging from 0.47% to 1% for anterior cortical perforation and related distal femur complications. Understanding the pathophysiology, risk factors, and management strategies for these complications is crucial for optimizing patient care and minimizing adverse outcomes.[3] This geometric mismatch becomes particularly problematic in the distal femur, where the medullary canal lies more anteriorly and the anterior cortex undergoes significant thinning with age. Additionally, patient-specific factors such as severe osteoporosis, previous deformity, or anatomical variations can further predispose to complications.

These "peri-implant" fractures occur at or around the tip of the antegrade nail, often adjacent to distal interlocking screws, creating stress risers in the osteoporotic femur. Fantry et al described such distal femoral complications – including fracture through a distal screw and anterior nail perforation – and emphasized the need for postoperative distal femur imaging when long nails are used. Risk factors include a high anterior femoral bow (small radius of curvature) and a posterior entry point for the nail. Roberts et al found that a more pronounced femoral bow and short patient stature were strongly correlated with anterior nail tip impingement or perforation. In their series, nails with an anterior one-third tip position caused cortical breach in 25% of cases, particularly in patients under 160 cm height. Posterior starting points also significantly increased this risk.[6] Avoiding these fractures requires careful preoperative planning.

We recommend obtaining full-length femur radiographs (AP and lateral) or a contralateral femur radiograph preoperatively to assess individual anatomy. This can reveal excessive bowing or unusual curvature that may prevent a straight nail from seating without impingement. If a marked anterior bow is present, alternative fixation (such as a sliding hip screw) should be considered. Intraoperatively, the entry point should be precisely at the lateral apex of the greater trochanter (avoiding too posterior a start). The nail should be inserted with gentle, vertical trajectory and the canal fully reamed, especially in elderly patients, to reduce axial impaction forces. Violent hammering of the nail – particularly in an osteoporotic, bowed femur – should be avoided as it may drive the nail tip through the cortex. If difficulty is encountered, intraoperative fluoroscopy (AP and lateral of the knee region) should be used to confirm that the nail tip is central and not abutting the anterior cortex. Subtle misalignment or resistance during nail insertion often precedes fracture: in our experience and reported cases, once the nail tip impinges the cortex, further force can produce a fracture.

When an iatrogenic distal fracture is identified postoperatively, management options depend on the fracture pattern and patient status. Surgical management typically involves open reduction internal fixation using distal femur plates, which can be performed while retaining the existing PFN. The choice of plate design is important, with locking plates providing superior fixation in osteoporotic bone and allowing for multiple fixation options around the existing hardware. The surgical approach requires careful planning to avoid interference between the new plate and existing nail while ensuring adequate fixation of the distal fracture.

Cerclage wire augmentation has emerged as a valuable adjunct in the management of these complex cases.[7] The use of cerclage wires provides additional stability, particularly beneficial in osteoporotic bone, and can help maintain reduction while allowing for biological healing. The reported outcomes with cerclage augmentation show no significant increase in nonunion rates while potentially improving time to union.[5] Postoperatively, both patients were maintained protected weight-bearing until radiographic union.

In case 3, the complication was not a full-thickness fracture but an anterior cortical perforation by the nail tip. This likely occurred due to an overbowed femur and a suboptimal trajectory. He was kept non–weight bearing for an extended period with bracing. Such conservative treatment of distal femur fractures generally risks malunion or nonunion, but in low-demand high risk patients it may be the only option. We planned eventual hardware removal if union occurs or consider a sliding partial weight-bearing program if healing progresses. Ultimately, every case requires individualized decision-making based on fracture stability and patient health.

Preventive guidelines

Preoperative full-length femur or contralateral radiographs should be obtained to assess femoral bow and canal size, as marked anterior bow significantly increases the risk of complications and may warrant consideration of

alternative fixation methods such as a sliding hip screw. During surgery, using the correct entry point at or slightly lateral to the greater trochanter and avoiding a posterior start is essential. A vertical nail trajectory must be maintained, particularly in obese patients, to reduce the risk of anterior or lateral malposition.

The canal should be fully reamed, and the nail inserted smoothly under fluoroscopic guidance, with the surgeon stopping immediately if resistance is encountered. Forceful hammering should be avoided; if difficulties arise, the trajectory should be corrected or a smaller nail selected. Distal interlocking screws should be used judiciously, as they act as stress risers; in stable intertrochanteric fractures, a single distal screw may be sufficient. Repeated drilling in the distal femur should also be minimized to prevent cortical weakening. Throughout the procedure, intraoperative fluoroscopy is crucial to confirm central nail positioning and identify any early signs of cortical encroachment, allowing timely correction and preventing iatrogenic complications.

Iatrogenic distal femur fractures following long proximal femoral nailing are uncommon but require prompt recognition and tailored management. Stable fractures around a well-positioned nail can often be managed with open reduction and internal fixation using a distal femur locking plate, with unicortical proximal screws and cerclage wiring to preserve the intramedullary implant and provide additional stability.Preoperative planning, careful surgical technique, and intraoperative imaging are essential to minimize these complications, while early recognition allows timely intervention to restore alignment, maintain function, and reduce the risk of further morbidity.

CONCLUSION

Distal femur fractures or cortical perforations following long PFN are rare but serious complications, especially in elderly osteoporotic patients with pronounced femoral bowing. A high index of suspicion and careful technique are required to prevent them. When they do occur, management typically involves ORIF of the distal fracture while preserving the proximal nail, using locking plates with unicortical proximal fixation and cerclage wires for osteoporotic bone. Surgeons should plan preoperatively for anatomical variations (using full-length femur films or contralateral views), choose the correct entry point, ream fully, and avoid undue force. In emergent cases, exchanging to a longer nail or employing a nail-plate construct can salvage the situation. Our cases illustrate the need for vigilance: even routine nailing of trochanteric fractures can lead to unexpected distal femur injuries. By following these prevention strategies and management options, orthopedic surgeons can reduce the risk and mitigate the impact of iatrogenic distal femur fractures after antegrade nailing.

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