Ipsilateral Femoral Neck and Shaft Fractures: Current Diagnostic and Treatment Strategies

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Abstract: Associated ipsilateral femoral neck fractures have been reported to occur in 1% to 9% of femoral shaft fractures. The associated femoral neck fracture is often nondisplaced, and the diagnosis is delayed or missed in up to one-third of cases. It is essential to carefully evaluate the femoral neck in all patients sustaining high-energy femoral shaft fractures. Although there are a number of different implant options available for management of this challenging injury, most authors recommend that priority be given to anatomic reduction and optimal stabilization of the femoral neck fracture because nonunion, malunion, or avascular necrosis of this injury is more difficult to successfully treat. [Orthopedics. 2015; 38(4):247-251.]

Although combined ipsilateral femoral neck and shaft fractures are an uncommon injury pattern, it is critical to recognize the presence of an associated ipsilateral femoral neck fracture occurring in conjunction with the more obvious femoral shaft fracture. Associated ipsilateral femoral neck fractures have been reported to occur in 1% to 9% of femoral shaft fractures.1,2 These are challenging injuries to manage and often require modification of the routine shaft fracture treatment approach. Failure to recognize an associated ipsilateral femoral neck fracture may result in fracture displacement, delayed treatment, and a poorer outcome.3 The purpose of this article is to review current diagnostic and treatment strategies to help optimize the management of patients with such injuries.

Epidemiology and Fracture Pattern

Ipsilateral femoral neck and shaft fractures typically occur as a result of high-energy trauma in a young patient.4 The injury mechanism is commonly an axially directed force against the distal femur with the hip and knee flexed, such as a motor vehicle accident in which the knee strikes the dashboard.1,5 The femoral shaft fracture is frequently comminuted as a result of the high-energy nature of this injury. The femoral neck fracture is commonly basilar in location, vertical in orientation, and minimally displaced or nondisplaced. It has been postulated that the femoral shaft absorbs the majority of injury energy, as demonstrated by the shaft comminution, decreasing the amount of force transmitted across the femoral neck, as demonstrated by the frequent lack of femoral neck displacement. Because of the mechanism of injury, associated knee injuries are commonly seen, including patellar fractures, contusions, and lacerations. In a meta-analysis of 659 cases, knee injuries were seen in half the cases.4 Because these frequently result from high-energy injuries, associated multisystem injuries are seen in 73% to 100% of patients.1

Although the vast majority of ipsilateral femoral neck fractures are due to the injury, the initial absence of radiographic findings has led some to speculate that they may occasionally be iatrogenically induced. If an antegrade nail-
Figure 1: Poor-quality radiograph with overlying objects obscuring visualization of a nondisplaced ipsilateral femoral neck fracture.

Figure 2: Ipsilateral femoral neck and segmental shaft fracture treated with a reconstruction nail.

and other associated serious injuries that occur in multiply injured patients, which focus the direction to more critical life-saving interventions. Improved awareness of the combined injury has led to a decreased incidence of missed injury. However, they may still be missed in up to 11% of cases.¹

Tornetta et al⁷ described the use of a thin-cut computed tomography (CT) scan and dedicated anteroposterior (AP) internal rotation radiographs of the femoral neck to decrease the incidence of missed femoral neck fractures. In addition, they recommend carefully examining the intraoperative lateral hip fluoroscopic view and obtaining dedicated AP internal rotation views of the hip at follow-up. At follow-up, patients were questioned about the presence of hip pain and, if positive, were imaged with CT. In the year prior to the institution of the protocol, 7 (9%) of 82 patients with a femoral shaft fracture were found to have an associated femoral neck fracture. Four of those 7 fractures were not diagnosed during the preoperative workup or while in the operating room. Three of these fractures were displaced when they were diagnosed and required additional surgical treatment. Following the institution of the protocol, the incidence of missed femoral neck fractures dropped from 57% to 6.3%.⁷

It is important to understand that associated ipsilateral femoral neck fractures may be missed even with the use of a thin-cut CT scan, especially in a multiply injured patient who is nonambulatory or comatose. O’Toole et al⁸ reported that plain radiography and CT have a similar and significant rate of missed femoral neck fractures, with a sensitivity of only 56% to 64%. They emphasized the importance of using both intraoperative and postoperative imaging to detect nondisplaced femoral neck fractures in association with femoral shaft fractures.

Because the femoral neck is antverted, internal rotation of the hip is necessary to bring the axis of the femoral neck perpendicular to the radiographic beam. With an ipsilateral femoral shaft fracture, rotating the lower leg will not change the proximal femur orientation until fixation of the shaft component is achieved. In the preoperative setting, angulation of the radiographic beam will be required to best view the femoral neck. This can be performed at the beginning of surgery with high-quality fluoroscopy, but the authors also recommend obtaining a good-quality plain radiograph view centered at the hip with 10° to 15° of hip internal rotation following fixation of any high-energy femoral shaft fracture.

TREATMENT OPTIONS

Most surgeons agree that treatment of the femoral neck should take priority because this is critical to the patient’s long-term outcome.¹⁹ Although numerous options exist for the subsequent management of a femoral neck nonunion, the complications of osteonecrosis of the femoral head and nonunion of the femoral neck are more difficult to manage. Controversy exists about whether this combined injury pattern is best treated with a single implant or with separate implants. Low-level evidence from case series suggests that separate femoral neck and shaft implants may result in fewer reoperations.¹⁰

Treatment options for ipsilateral femoral neck and shaft fractures include:

- Reconstruction nail (Figure 2)
- Antegrade nail and separate screws adjacent to the nail (Figure 3)
- Femoral neck screws and retrograde femoral nail (Figure 4)
- Sliding hip screw with or without additional derotation screw and retrograde femoral nail
- Femoral neck screws and plate fixation of the shaft (Figure 5)
- Sliding hip screw with or without additional derotation screw and plate fixation of the shaft

**Cephalomedullary Reconstruction Nail**

Jain et al reported 21 cases treated with a reconstruction nail and 2 cases treated with a standard antegrade nail and additional lag screws. In this series, they had 1 femoral neck nonunion, 1 case of avascular necrosis, and 1 femoral neck fracture that united in varus. In addition, they reported 4 femoral shaft nonunions and 6 femoral shaft delayed unions.

Watson and Moed cautioned against the use of a cephalomedullary reconstruction nail for fixation of femoral neck and shaft fractures. In their report of complications following treatment of ipsilateral femoral neck and shaft fractures, they had 8 femoral neck nonunions, and 6 (75%) of these occurred in patients treated with a reconstruction nail. They explained that the implant was designed to provide adjunctive fixation into the head and neck to decrease the moment arm when stabilizing proximal femoral shaft fractures, not for the fixation of ipsilateral femoral neck fractures. The screws inserted through the nail into the femoral head and neck were not designed to function as compression lag screws, and they have poor sliding characteristics due to the short working length of the screw within the nail. Because of the limited sliding capacity, loading may result in impaction of the femoral head cancellous bone and potentially screw cut-out. Alternatively, if the femoral head and neck are securely anchored in strong cancellous bone, resorption of bone at the fracture site effectively leads to a progressively increased distance between the fracture edges. Equally problematic is the inability to place screws optimally in the femoral head and neck because the position of the screws is fixed by the location of the proximal nail holes.

Bedi et al examined the accuracy of reduction in 37 patients with ipsilateral femoral neck and shaft fractures. Nine patients were treated with a single cephalomedullary nail, and...
28 patients were treated with separate implants. A significantly higher malreduction rate of one of the fractures was seen in patients treated with a single cephalomedullary device (3 of 9 cases had a malreduction) compared with patients treated with 2 implants (no malreductions in 28 cases) (P=.001).

**Antegrade Nail and Separate Screws Adjacent to the Nail**

The best indication for the use of screws adjacent to an antegrade nail is a femoral neck fracture that is discovered intraoperatively after the insertion of an antegrade intramedullary nail. In this situation, if the femoral neck fracture is nondisplaced, the authors recommend placement of lag screws adjacent (anterior and/or posterior) to the nail. Removal of the nail could cause displacement of the fracture. Depending on the size of the proximal femur and the diameter of the femoral nail, it can be difficult to place the lag screws, and the ideal configuration used in the absence of a femoral nail is not possible. The screws must be inserted either anterior or posterior to the nail and may have to partially cut out of the femoral neck before reentering the femoral head. At least 1 manufacturer produces a “miss-a-nail” jig, which aids placement of screws either anterior or posterior to the nail.

Wiss et al\(^13\) reported that antegrade nailing combined with lag screw fixation of the neck did not produce uniformly favorable results, which they attributed to the higher rates of varus nonunion of the neck fracture.

**Femoral Neck Screws and Retrograde Femoral Nail**

The authors recommend reduction and fixation of the femoral neck fracture prior to insertion of a retrograde femoral nail. Insertion of a retrograde nail prior to stabilization of the femoral neck could result in displacement of the femoral neck fracture. For nondisplaced femoral neck fractures, the use of a Schanz pin inserted into the femur proximal to the shaft fracture will allow positioning the proximal femur in an orientation that allows adequate fluoroscopic visualization for placement of 3 cannulated lag screws. For displaced femoral neck fractures, they recommend an open reduction approach to obtain anatomic reduction prior to stabilization of the femoral shaft. The use of a bone hook (placed at the base of the femoral neck), ball spike pusher (placed on the lateral wall of the greater trochanter), and Schanz pins (placed in the femoral head) can help restore Shenton’s line and obtain an adequate reduction. A good cortical read is often difficult to obtain in comminuted fractures, and the rotational component of the fracture can be challenging to correct. To limit the impaction force during insertion of a retrograde intramedullary nail, Boulton and Pollak\(^14\) recommended overreaming the intramedullary canal by 2.0 to 2.5 mm.

Oh et al\(^15\) reported a series of 17 ipsilateral femoral neck and shaft fractures in which they placed the retrograde nail first, then fixed the femoral neck fracture. Five patients developed a shaft nonunion, and 1 patient developed avascular necrosis of the femoral head. This case was a severely displaced Garden IV femoral neck fracture.

**Femoral Neck Screws and Plate Fixation of the Shaft**

Plate fixation of the femoral shaft can be performed before or after stabilization of the femoral neck because it is less likely to result in femoral neck displacement than is retrograde nailing. The disadvantages of plate fixation include the increased surgical dissection required and the weaker mechanical properties. However, because one may wish to maintain weight-bearing restrictions due to the femoral neck fracture, the mechanical issue may not be as critical. Plate fixation may be ideally suited for an open fracture in which wide exposure is required for fracture debridement, or for a patient with an intra-articular distal femur fracture in whom a retrograde nail would be contraindicated.

Hung et al\(^16\) reported 5 shaft nonunions in a series of 47 patients in which the shaft was treated with plate fixation and the proximal fracture was treated either with lag screws or a sliding hip screw.

**Assessment of Rotation and Knee Examination**

Because femoral shaft fractures are frequently comminuted and increased focus is placed on the femoral neck, the risk of rotational malalignment is high. Not only is a gross clinical comparison to the unaffected extremity essential prior to leaving the operating room, but a thorough, methodological intraoperative estimation of rotation will prevent an unplanned return to the operating room. The authors recommend using the lesser trochanter as a good marker of rotation once the hip fracture component has been fixed.\(^17\) Before proceeding to the final distal locking of the nail, one should compare the rotational profile of the 2 hips and align the rotational profile of the distal femur as a guide. A knee examination should also be performed after fracture fixation to examine for associated ligamentous injuries.

**Complications**

The rate of avascular necrosis of the femoral head in ipsilateral femoral neck and shaft fractures is lower than that seen with isolated femoral neck fractures. In ipsilateral femoral neck and shaft fractures, the reported incidence in various series has ranged from 1.2% to 5%, with the highest rate reported in patients treated with reconstruction nailing.\(^10\) Nonunion of both the femoral neck and femoral shaft can occur. Alho\(^4\) reported a higher rate of femoral shaft nonunion in a series of 659 cases, with only a 1% femoral neck nonunion rate.\(^4\) Femoral neck nonunions are more commonly seen with reconstruction nailing and are frequently treated by a valgus intertrochanteric osteotomy. Ostrum et al\(^18\) reported a femoral neck
nonunion rate of only 2% in a series of 95 patients treated with femoral neck screw fixation and retrograde reamed intramedullary nailing. Both were comminuted fractures treated with cannulated screw fixation. In comparison, the femoral shaft nonunion rate in this series was 9%.18

Varus malunion of the femoral neck can also occur as a technical complication when the fracture is not adequately reduced prior to fixation. Ostrum et al18 reported 5 proximal malunions in a series of 95 patients treated with femoral neck screw fixation (cannulated screws or sliding hip screw) and retrograde reamed intramedullary nailing.

CONCLUSION

Although combined ipsilateral femoral neck and shaft fractures are uncommon, it is essential to carefully evaluate the femoral neck in all patients sustaining high-energy femoral shaft fractures. Early recognition of an associated ipsilateral femoral neck fracture may permit improved outcomes, avoiding intraoperative or postoperative discovery. A number of different implant options are available for management of this challenging injury. Most authors recommend that priority be given to anatomic reduction and optimal stabilization of the femoral neck fracture because nonunion, malunion, or avascular necrosis of this injury is more difficult to successfully treat.

REFERENCES


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