

Management of Femoral Shaft Fractures

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Abstract

Introduction: Associated ipsilateral fractures of the femoral neck are estimated to happen in about one to nine percent of cases of femoral shaft fractures. The presence of an associated fracture of the femoral neck is usually non-displaced, and making the diagnosis is often delayed or even missed in a large proportion of cases that can reach thirty five percent of all femoral shaft fracture cases.

Aim of Work: In this review, we will discuss the management of femoral shaft fracture.

Methodology: We did a systematic search for the management of femoral shaft fracture. using PubMed search engine and Google Scholar search engine. All relevant studies were retrieved and discussed. We only included full articles.

Conclusions: Although combined ipsilateral femoral neck and shaft fractures are generally uncommon, it is crucial to carefully assess the femoral neck in all patients sustaining high-energy femoral shaft fractures. Early detection of an associated ipsilateral femoral neck fracture might allow for better outcomes, avoiding intraoperative or postoperative discovery. A number of different implant options are generally available for treatment of this challenging injury. Most authors advise that priority be given to structural reduction and optimal stabilization of the femoral neck fracture because non-union, malunion, or avascular necrosis of this injury is more challenging to successfully treat.

Keywords: Femoral Shaft Fracture; Neck Fracture; Management; Orthopedic Surgery

Introduction

Associated ipsilateral fractures of the femoral neck are estimated to happen in about one to nine percent of cases of femoral shaft fractures. The presence of an associated fracture of the femoral neck is usually non-displaced, and making the diagnosis is often delayed or even missed in a large proportion of cases that can reach thirty five percent of all femoral shaft fracture cases. Therefore, it is considered

to be extremely crucial to very carefully assess the status femoral neck in all patients who present to the hospital after getting high-energy fractures of femoral shaft. Despite that there are several different options for implant available for the treatment of this difficult injury, most researchers advised that priority must be given to structural reduction and ideal stabilization of the fracture of the femoral neck as the later development of non-union, malunion, or avascular necrosis complicating this injury is considered to be more challenging to manage successfully.

In this review, we will discuss the most recent evidence regarding the management of femoral shaft fracture.

Methodology

We did a systematic search for the management of femoral shaft fracture. using PubMed search engine (<http://www.ncbi.nlm.nih.gov/>) and Google Scholar search engine (<https://scholar.google.com>). All relevant studies were retrieved and discussed. We only included full articles.

The terms used in the search were: Femoral shaft fracture, neck fracture, management, orthopedic surgery.

Despite that combined ipsilateral femoral neck fractures and femoral shaft fractures are generally considered to be relatively not common injury patterns, it is essential to detect the presence of an associated ipsilateral fracture of the femoral neck happening in association with the more clear fracture of the femoral shaft. Related ipsilateral fractures of the femoral neck have been found to happen in up to nine percent of cases that have femoral shaft fractures [1].

These cases of femoral shaft fractures that is associated with ipsilateral femoral neck fractures are generally very difficult to provide management and usually need to modify the routine approach of the management of femoral shaft fractures. Not being able to detect the presence of an associated ipsilateral fracture of the femoral neck might lead to the displacement of the fracture, delayed management, and significantly worse prognosis [2].

Epidemiology and fracture pattern

Associated Ipsilateral fractures of the femoral neck and femoral shaft fractures classically happen following exposure to a high-energy trauma in a relatively young patient [2]. The mechanism of the injury is usually the development of an axially directed force towards the distal femur with the status of the knee and hip being in the flexed position. Examples to this include motor vehicle accidents where the knee hits the dashboard [3].

Fractures of the femoral shaft are usually of the comminuted type and result because of the nature of the injury which is a high-energy injury. The fractures of femoral neck are frequently located in the basilar area, oriented vertically, and show minimal displacement or even no displacement in some cases. It has been hypothesized that the femoral shaft absorbs most of the energy that results from the injury, as shown by the comminution of the shaft, reducing the amount of energy that is transmitted through the femoral neck, as shown by the usual absence of displacement of the femoral neck. As a result of the injury's mechanism, the development of associated knee damage is frequently encountered. This includes fractures of the patella, contusions, and sometimes, lacerations. In a meta-analysis that included more than six hundred patients, the presence of knee injuries was observed in about fifty percent of patients [4]. As the frequency result following high-energy injuries, associated multi-systems damage is observed in up to seventy-three percent and sometime in one hundred percent of patients [3].

Despite that most patients who have ipsilateral fractures of the femoral neck develop these fractures as a result of the injury itself, the initial absence of findings on radiology in some cases has led some to hypothesize that they might sometimes be induced iatrogenically. For example, if an antegrade nailing starting site is placed far anteriorly than it's supposed to, a stress riser could develop, causing an iatrogenic basicervical femoral neck fracture [2].

A frequently missed injury

previously, more than thirty-five percent patients who have ipsilateral fractures of the femoral neck have been primarily not diagnosed, and later detected in a later manner during or following management of the already detected fracture of the femoral shaft. There are several possible reasons that the fracture of the femoral neck is not primarily discovered. Several fractures are non-displaced and hard to be visualized. Multiple technical factors make it harder to achieve accurate diagnosis. These include radiographs that usually have a poor-quality, the usual presence of overlying objects including traction splints that can obscure the proper visualization of the femoral neck, and the absence of proper dedicated hip views. Other possible factors that make diagnosis harder include the presence of other injuries that distract clinicians and other linked severe injuries that happen in patients who have been exposed to multiple injuries, that emphasize on the direction to a more critical life-saving management. Better education and awareness towards the combined injury have resulted in a significantly reduced incidence rates of missed injuries. However, they might still be missed in more than ten percent of patients [3].

In their published study Tornetta, *et al.* [5] described the usage of a computed tomography (CT) scan that is thin-cut along with a dedicated anteroposterior internal rotation radiographs of the femoral neck to reduce the incidence of missed fractures of the femoral neck. additionally, they advise examining the intraoperative lateral hip fluoroscopic view carefully that is followed by getting dedicated anteroposterior internal rotation views of hip during follow-ups. During follow-up, patients with the fractures were asked about the presence or absence of hip pain and, if pain is present, patients were imaged with thin-cut computed tomography. In the year before the institution of this protocol, seven (nine percent) of eighty-two patients who had a fracture of the femoral shaft were demonstrated to have another associated fracture of the femoral neck. A total of 4 of those seven fractures were not detected at the pre-operative examinations or within the operating room. A total of 3 of these fractures were later displaced at the time of their diagnosis and needed additional surgical management. On the other hand, after the institution of this protocol, the incidence rates of missed fractures of the femoral neck significantly decreased from fifty-seven percent to about six percent [5].

It is essential to understand that linked ipsilateral fractures of the femoral neck might be missed even following the use of a thin-cut computed tomography radiology, specifically in patients who have multiple injuries and who are non-ambulatory or in a coma. In fact, O'Toole, *et al.* [6] concluded in their study that the use of either plain radiography or thin-cut computed tomography can have a significant and similar rate of missing fractures of the femoral neck, with a sensitivity that is as low as fifty-six percent (or even sixty-four percent in some cases). They focused, thus, on the importance of using both intra-operative imaging and post-operative imaging to discover the presence of non-displaced fractures of the femoral neck in association with fractures of the femoral shaft in some patients.

As femoral neck is considered anteverted, internal rotation of the hip is considered to be essential to be able to bring the axis of the femoral neck perpendicular to the radiographic beam. In cases of an ipsilateral fracture of the femoral shaft, however, lower leg rotation will not alter the orientation of the proximal femur until achieving complete fixation of the shaft component. In the pre-operative setting, it is also required to achieve angulation of the radiographic beam to be able to best visualize the femoral neck. This could be done early at the surgery using high-quality fluoroscopy, but clinicians also advise getting a good-quality plain radiograph view that is centered at the hip with ten-to-fifteen degree of hip internal rotation following the fixation of any high-energy fracture of the femoral shaft.

Treatment options

Most orthopedics agree that management of the femoral neck must be the priority as this is significantly correlated with better long-term prognosis [3]. Despite that multiple possibilities are present for the later treatment of the non-union of the femoral neck, the adverse events of developing osteonecrosis of the femoral head and/or non-union of the femoral neck are considered to be challenging to manage. Many debates are still present as to whether this associated injury pattern is ideally managed using a single implant or using separate implants. Low-level evidence from a previously published case series recommended that the use of separate femoral neck and shaft implants might result in less reoperations [7].

Management options for cases with ipsilateral femoral neck and shaft fractures include:

- The application of a reconstruction nail
- The application of an antegrade nail with separate screws that are adjacent to the nail itself.
- The use of femoral neck screws with a retrograde femoral nail
- The application of a sliding hip screw with the presence or absence of another derotation screw and a retrograde femoral nail.
- The application of femoral neck screws with plate fixation of the shaft
- The use of sliding hip screw with the presence or absence of another derotation screw and with plate fixation of the shaft itself.

Cephalo-medullary reconstruction nail

Jain., *et al.* [8] reported twenty-one patients who were treated using a reconstruction nail and other two patients who were treated using a standard antegrade nail and with the use of additional lag screws. In this case series, they had one case of femoral neck non-union, one case of complicated avascular necrosis, and one fracture of the femoral neck that united in varus. Additionally, they reported four femoral shaft non-union cases and six femoral shaft delayed union cases.

On the other hand, Watson and Moed [1] recommended against the usage of a cephalon-medullary reconstruction nail to achieve fixation of femoral neck and shaft fractures. In fact, in their report of adverse events that follow the management of ipsilateral fractures of the femoral neck with associated shaft fractures, they had eight cases of femoral neck non-union, and six (seventy-five percent) of these happened in patients who were treated using a reconstruction nail. They hypothesized that initially this implant was designed to give adjunctive fixation into the head and neck to reduce the moment arm when stabilizing proximal femoral shaft fractures, not to achieve fixation of ipsilateral fractures of the femoral neck. The screws that are inserted through the nail into the femoral head and the femoral neck were not actually designed to achieve compression of the lag screws, and they in fact, have bad sliding characteristics because of their short working length of the screw within the nail itself. As a result of the limited capacity of sliding, loading might lead to the impaction of the femoral head cancellous bone and potentially screw cutout. Another option is that if the femoral head and the femoral neck are safely anchored in strong cancellous bone, the resorption of bone at the site of the fracture will effectively lead to a progressively elevation of the distance between the edges of the fracture. Equally concerning is the failure to place screws ideally in the femoral head and the femoral neck as a result of the position of the screws is fixed by the location of the proximal nail holes.

In their study, Bedi., *et al.* [9] evaluated the accuracy of achieving reduction in a total of thirty-seven patients who had associated ipsilateral femoral neck and femoral shaft fractures. A total of 9 patients were managed using a single cephalon-medullary nail, and twenty-eight patients were managed using separate implants. A significantly increased mal-reduction rate of one of the fractures was observed in patients who were treated using a single cephalon-medullary device (three out of nine cases showed a mal-reduction) when compared to other patients who were treated with two implants (no mal-reductions in twenty-eight cases, and a P value of .001).

Antegrade nail and separate screws adjacent to the nail

The ideal indication for using screws adjacent to an antegrade nail is a fracture of the femoral neck which is detected intra-operatively following the insertion of an antegrade intra-medullary nail. In this case, if the fracture of the femoral neck is non-displaced, the authors advise the placement of lag screws adjacent (anterior and/or posterior) to the nail. The removal of the nail can lead to the displacement of the fracture. According to the size of the proximal femur and the diameter of the femoral nail, it could be challenging to put the lag screws, and the best configuration that is used in the absence of a femoral nail is impossible. The screws should be put either posterior or anterior to the nail and might show to partially cut out of the femoral neck before re-entering the femoral head. At least one manufacturer makes a "miss-a-nail" jig, that helps the placement of screws either posterior or anterior to the nail.

Femoral neck screws and retrograde femoral nail

Authors have advised achieving fixation and reduction of the femoral neck fracture before the insertion of a retrograde femoral nail. The insertion of a retrograde nail before stabilization of the femoral neck might lead to the displacement of the femoral neck fracture. For cases of non-displaced fractures of the femoral neck, the use of a Schanz pin that is inserted into the femur in a site that is proximal to the shaft fracture could make it possible to position the proximal femur within an orientation that make it possible to adequately fluoroscopically visualize for placement of three cannulated lag screws.

For cases with displaced fractures of the femoral neck, researchers advise the use of an open reduction approach to achieve structural reduction before the stabilization of the femoral shaft itself. The use of a bone hook (that will be placed at the base of the femoral neck), ball spike pusher (that should be placed on the lateral wall of the greater trochanter), and Schanz pins (that are usually placed in the femoral head) could aid in the restoration of Shenton's line and achieve sufficient reduction. A good cortical read is usually challenging to get in cases of comminuted fractures, and the rotational component of the fracture could be difficult to repair. To decrease the impaction force during the insertion of a retrograde intramedullary nail, Boulton and Pollak [10] advised over-reaming the intramedullary canal by two to two and a half millimeters.

On the other hand, Oh, et al. [11] reported a case series that consisted of seventeen cases of ipsilateral femoral neck and shaft fractures where they placed the retrograde nail first, then fixed the fracture of femoral neck. A total of 5 patients developed a non-union of the shaft, and only one patient got complicated avascular necrosis of the femoral head. This case was in fact a severely displaced Garden IV femoral neck fracture.

Femoral neck screws and plate fixation of the shaft

Achieving plate fixation of the femoral shaft could be done either before or after achieving stabilization of the femoral neck as it is less likely to cause femoral neck displacement when compared to retrograde nailing. The disadvantages of using plate fixation include the elevated surgical dissection that is needed and the weaker mechanical properties. On the other hand, as one might want to keep a weight-bearing restrictions because of the femoral neck fracture, the mechanical concern might not be as important. Plate fixation might be perfectly suited for cases of open fractures where wide exposure is needed for fracture debridement, or for a cases that has an intra-articular distal femur fracture in which a retrograde nail is contraindicated.

In fact, Hung, et al. [12] reported the development of five shaft non-unions in a series that consisted of forty-seven patients whose shaft was already treated using plate fixation techniques and the proximal fracture was treated either with lag screws or a sliding hip screw.

Assessment of rotation and knee examination

As fractures of the femoral shaft are usually comminuted and higher focus is put on the femoral neck, the risk of developing rotational malalignment is considered to be relatively high. Not only is a gross clinical comparison to the unaffected extremity essential before leaving the operating room, but a detailed, methodological intra-operative approximation of the rotation will avoid the occurrence of an unplanned return to the operating room. Researchers usually recommend the use of the lesser trochanter as a good indicator of rotation once the hip fracture component has been fixed [13]. Before getting into the final distal locking of the nail, one must compare the rotational profile of the two hips and align the rotational profile of the distal femur as a guide. A knee examination must also be done following the fixation of the fracture to examine for associated injuries of the ligaments.

Complications

Rates of developing avascular necrosis of the femoral head in cases of ipsilateral femoral neck and shaft fractures is generally less than rates that are observed with isolated femoral neck fractures. In cases with ipsilateral femoral neck and shaft fractures, the reported incidence rate in various series has ranged from one percent to reach five percent, with the highest incidence rate being reported in patients who were treated using reconstruction nailing [8].

Non-union of both the femoral neck and femoral shaft can happen. In fact, Alho [4] reported a significantly higher rate of developing femoral shaft non-union in a series of more than six hundred patients, with only a one percent rate of developing femoral neck non-union [4]. Femoral neck non-unions are more frequently observed in cases of reconstruction nailing and are commonly managed using a valgus intertrochanteric osteotomy. Ostrum, *et al.* [14] reported a femoral neck non-union rate that was as low as two percent in a series of ninety-five patients who were treated using femoral neck screw fixation and retrograde reamed intramedullary nailing. Both were comminuted fractures managed using cannulated screw fixation. In comparison, the femoral shaft non-union rate in this series was nine percent [14].

Conclusions

Although combined ipsilateral femoral neck and shaft fractures are generally uncommon, it is crucial to carefully assess the femoral neck in all patients sustaining high-energy femoral shaft fractures. Early detection of an associated ipsilateral femoral neck fracture might allow for better outcomes, avoiding intraoperative or postoperative discovery. A number of different implant options are generally available for treatment of this challenging injury. Most authors advise that priority be given to structural reduction and optimal stabilization of the femoral neck fracture because non-union, malunion, or avascular necrosis of this injury is more challenging to successfully treat.

Bibliography

1. Watson JT and Moed BR. "Ipsilateral femoral neck and shaft fractures: complications and their treatment". *Clinical Orthopaedics and Related Research* 399 (2002): 78-86.
2. McDonald LS, *et al.* "A cascade of preventable complications following a missed femoral neck fracture after antegrade femoral nailing". *Patient Safety in Surgery* 7 (2013): 16.
3. Peljovich AE and Patterson BM. "Ipsilateral femoral neck and shaft fractures". *Journal of the American Academy of Orthopaedic Surgeons* 6.2 (1998): 106-113.
4. Alho A. "Concurrent ipsilateral fractures of the hip and femoral shaft: a meta-analysis of 659 cases". *Acta Orthopaedica Scandinavica* 67.1 (1996): 19-28.
5. Tornetta P III, *et al.* "Diagnosis of femoral neck fractures in patients with a femoral shaft fracture. Improvement with a standard protocol". *Journal of Bone and Joint Surgery-American Volume* 89.1 (2007): 39-43.
6. O'Toole RV, *et al.* "Diagnosis of femoral neck fracture associated with femoral shaft fracture: blinded comparison of computed tomography and plain radiography". *Journal of Orthopaedic Trauma* 27.6 (2013): 325-330.
7. Bhandari M. "Ipsilateral femoral neck and shaft fractures". *Journal of Orthopaedic Trauma* 17.2 (2003): 138-140.
8. Jain P, *et al.* "Cephalomedullary interlocked nail for ipsilateral hip and femoral shaft fractures". *Injury* 35.10 (2004): 1031-1038.
9. Bedi A, *et al.* "Accuracy of reduction of ipsilateral femoral neck and shaft fractures: an analysis of various internal fixation strategies". *Journal of Orthopaedic Trauma* 23.4 (2009): 249-253.
10. Boulton CL and Pollak AN. "Ipsilateral femoral neck and shaft fractures: does evidence give us the answer?" *Injury* 46.3 (2015): 478-483.
11. Oh CW, *et al.* "Retrograde nailing with subsequent screw fixation for ipsilateral femoral shaft and neck fractures". *Archives of Orthopaedic and Trauma Surgery* 126.7 (2006): 448-453.

12. Hung SH, *et al.* "Surgical treatment for ipsilateral fractures of the hip and femoral shaft". *Injury* 35.2 (2004): 165-169.
13. Krettek C., *et al.* "Intraoperative control of axes, rotation and length in femoral and tibial fractures". *Injury* 29.3 (1998): C29-C39.
14. Ostrum RF, *et al.* "Ipsilateral proximal femur and shaft fractures treated with hip screws and a reamed retrograde intramedullary nail". *Clinical Orthopaedics and Related Research* 472.9 (2014): 2751-2758.

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