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# Special topic: Ipsilateral femoral neck and shaft fractures – Does evidence give us the answer?

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ABSTRACT

Ipsilateral fractures of the femoral neck and shaft are rare, high-energy injuries that typically occur in young polytrauma patients. The associated fracture of the neck is often vertical in nature and is more frequently non-displaced than in isolated femoral neck fractures. Historically the diagnosis of an associated femoral neck fracture was delayed or missed in approximately one third of cases. Studies have shown that detection can be significantly improved with the implementation of a protocolized approach to hip imaging in all patients with femoral shaft fractures.

Prompt recognition of an associated femoral neck fracture allows for timely stabilization and may decrease the risks of non-union and avascular necrosis. In contrast, failure to recognize a non-displaced or minimally displaced associated neck fracture prior to fixation of the shaft can lead to displacement, a decrease in neck fixation options, a technically challenging secondary procedure and increased risk of long-term sequelae.

A vast array of treatment strategies have been described for this combined injury. Published options range from spica casting to open reduction and internal fixation of both fractures and include almost all conceivable combinations in between. While timely surgical stabilization is now universally recommended for both shaft and neck, no consensus exists as to the most appropriate method of fixation for either fracture. Most authors recommend prompt, but not emergent, surgery with priority given to anatomic reduction and stabilization of the neck fracture by either closed or open methods. Fixation of the shaft fracture follows as patient condition allows.

The rare nature of this injury makes it very challenging to study and most published series' are retrospective with very small sample sizes. In short, no scientificallycompelling study is available to definitively support any one implant choice or method of stabilzation over another for the treatment of associated fractures of the femoral neck and shaft.



## Introduction

Associated fractures of the ipsilateral femoral neck are rare, occurring with only 1–9% of femoral shaft fractures [1–11], but these are much more challenging to manage than either injury in isolation and require a modified treatment approach. These injuries often result from a high energy mechanism such as a motor vehicle crash or fall from height [1,2,4,5,8,10–16] and most commonly occur in young patients, mean age 34 years [2]. It has been postulated that they occur as the result of a longitudinal compression force on a flexed and abducted hip due to the frequency with which the injury is seen in vehicle crash front seat drivers and passengers [17,18]. Compared to isolated femoral shaft injuries, those fractures with an associated femoral neck injury are more likely to be highly comminuted (Winquist III or IV) [4,5,7], indicating a higher energy mechanism. Conversely, an associated femoral neck fracture is more likely than an isolated neck fracture to be non-displaced at presentation (25–60%) [5,7,11]. One possible explanation for this is that at the time of injury, the femoral shaft absorbs the majority of the force imparted to the femur resulting in a high degree of shaft comminution but decreasing the amount of force ultimately transferred to the femoral neck [10,19,20]. Both isolated and associated femoral neck fractures in young adults have a propensity for occurring in an intracapsular location [7,12] and an inherently unstable vertical orientation (Pauwels III) [5,7,12,21].

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## Diagnosis

Historically the diagnosis of an associated femoral neck fracture was delayed or missed in approximately 20–50% of cases [1,2,4,6,7,13,22]. This may have been due in part to the high proportion of non-displaced neck fractures as well as the distracting presence of the associated femoral shaft fracture. Patients who sustain combined femoral neck–shaft injuries also tend to have high ISS and multiple other distracting injuries [1,2,4,5,8,10,12–16] in addition to the femoral shaft which may divert focus from the femoral neck.

The historic high rate of missed femoral neck injuries and the seriousness of subsequent complications have led multiple authors to recommend dedicated imaging of the neck with radiographs or computed tomography (CT) [6,9,23,24]. O'Toole et al. have shown that CT and plain radiographs have similarly low sensitivity (56–64%) in the detection of occult associated femoral neck fractures [24] and have advocated combined use of several different imaging modalities including live intraoperative fluoroscopic exam [24]. Tornetta et al. reported that detection of associated femoral neck fracture can be significantly improved (93.7% vs. 43%) with the implementation of a protocolized approach to hip imaging in patients with femoral shaft fractures [9]. Such protocols are now common-place in trauma centres and typically involve orthogonal plain radiographs of the ipsilateral hip and small-cut (2–3 mm) CT scan through the femoral neck prior to surgical intervention for treatment of the shaft fracture. Fluoroscopic examination or plain radiographs of the hip after shaft stabilization and prior to leaving the operating room is also recommended to assess for occult or iatrogenic neck fracture [24,25]. These methods are not 100% accurate however and associated femoral neck fractures can still go unrecognized, especially in a comatose or non-ambulatory patient who does not complain of hip pain.

Prompt recognition allows for timely stabilization and may decrease the risk of non-union and avascular necrosis. In contrast, failure to recognize an associated neck fracture prior to fixation of the shaft can lead to fracture displacement at the time of surgery, limited neck fixation options and an unplanned return to the operating room for a technically challenging secondary procedure [7,22]. In cases with significant delay in diagnosis, nonunion, malunion and avascular necrosis can occur requiring extensive reconstructive procedures or arthroplasty (see Fig. 4).

## Treatment

A vast array of treatment strategies have been described for this combined injury [1,2,4,5,7,8,10–16,26]. Poor results have been reported with non-operative treatment of either the femoral neck or shaft fracture and this approach is generally avoided except in extenuating circumstances [7,22,26]. While timely surgical stabilization is now recommended for both injuries, no consensus exists as to the most appropriate method of fixation for either fracture. There is also no scientifically definitive study demonstrating which injury should be stabilized first or whether an optimal time window exists for surgery. The rare nature of this injury makes it very challenging to study and most available evidence is level III or IV [27]. While multiple small underpowered retrospective series exist, little prospective or randomized data is available to guide treatment.

Different authors have recommended ideal surgical fixation fall within 8 h [7], 12 h [4], 24 h [5], 72 h [13] and 1 week [22]. Supporting data is scant however. Most authors recommend prompt, but not emergent, surgery with priority given to anatomic reduction and stabilization of the neck fracture by either closed or open methods [7,9,11,14,19,21,26]. Others advocate for fixation of the femoral shaft first to allow better control of the leg during the more technically challenging femoral neck reduction [17,28–30]. In each case the patient's condition, associated injuries and resuscitation status all need to be taken into consideration when determining when best to operate.

Published treatments range from spica casting to open reduction and internal fixation of both fractures and include almost all conceivable combinations in between. Successful fixation strategies using a single implant have been described [5,10,14,15,31,32], but the majority of authors advocate for a combination of implants [3,4,7,13,14,16,21,22,26,33–35]. Heterogeneity between study methods, injury characteristics and follow up make it difficult to glean meaningful information from pooling data. A meta-analysis of 722 reported cases from 65 published studies demonstrated no clear superior implant choice [2].

Some studies have described successful use of femoral shaft plating in ipsilateral neck–shaft injuries [3,4,7,14,36] while others have reported high complication rates [20,33]. Most recent series advocate shaft fixation using an intramedullary nail [3,4,7,13,14,21,22,33–35], likely due to superior outcomes when this method is used for isolated femoral shaft fractures. As in isolated femoral shaft fractures, reamed nailing is preferred as unreamed nails may increase shaft nonunion rate [16] or cause displacement of the associated neck fracture even when the neck is stabilized first. The successful use of piriformis, trochanteric and retrograde entry nails has been described [1,2,5,7,12,14,21,22,31,32,34–37]. Some authors prefer not to use a piriformis entry nail due to the proximity of the starting point to the femoral neck fracture [7,34,38]. While this makes anatomic sense, multiple studies using piriformis entry nails describe no apparent ill effect [4,5,14,21,31,37].

Standard antegrade femoral nails and those with cephalomedullary or reconstruction screws have been used successfully in combination with cannulated screws across the neck [4,14,21,31,37], whereas other studies have shown suboptimal stabilization of the neck with the technique, especially when the shaft is fixed first [28]. Retrograde nailing allows enough space proximally to utilize a sliding hip screw, sliding helical blade or cannulated screws for fixation of the neck fracture (see Figs. 1 and 2). When using a fixed angle sliding screw or helical blade the side plate screws can be directed around the tip of the retrograde nail, or through the lateral to medial interlocking screw holes in the nail (see Fig. 1). Recent evidence suggests fixed-angle sliding hip screw devices may provide an advantage over cannulated screws for treatment of Pauwels III isolated vertical femoral neck fractures [39], but no specific studies have addressed this comparison in ipsilateral femoral neck fractures. No superior method for stabilization of an associated femoral neck fracture has been demonstrated in the literature.

The use of a cephalomedullary or reconstruction nail alone for fixation of both fractures has also been described and offers the benefit of fewer incisions and lower implant cost [5,10,14–16,31,32] (see Fig. 3). However, this technique can be extremely technically challenging, especially when the femoral neck injury is displaced [15,31]. In addition, several authors have proposed that this method may be associated with an increased risk of nonunion or malunion of the neck [14,16] and is best reserved for cases where the neck fracture is non-displaced and extracapsular.

## Authors' preferred treatment method

Our preferred treatment algorithm for this challenging combination of injuries places highest priority on a prompt anatomic open reduction and stabilization of the femoral neck fracture. For displaced, intra-capsular neck fractures either a sliding hip screw or crossing cannulated screws is our preferred implant choice. When a sliding hip screw is used it is often supplemented with one or more derotational screws (see Fig. 1).