Repair of a Displaced Intracapsular Femoral Neck Fracture

Eben Carroll, MD
Department of Orthopaedic Surgery, Wake Forest Health Sciences, Winston-Salem, NC

Treatment of femoral neck fractures presents a challenge to clinicians. Fractures which are displaced, intracapsular, and have vertical fracture lines (high shear) are particularly problematic. This case presents a 35-year-old male with a displaced, intracapsular femoral neck fracture with associated comminution. This fracture was successfully managed with the Femoral Neck System (FNS) which allowed the patient to return to his previous activity level.

Fracture Classification:
AO 31B2.2
Garden IV / Pauwels III

1. INTRODUCTION

The management of femoral neck fractures in young and young elderly patients presents challenges to the treating surgeon. For displaced femoral neck fractures in younger populations, complication rates in the literature approach 64% if you combine rates of reoperation, malunion, nonunion, avascular necrosis, infection, and hardware failure. Even non-displaced femoral neck fractures in the young elderly have a 9% reoperation rate. In many cases, these complications necessitate revision, osteotomy, or replacement for the patient to regain function. The demanding biomechanical environment of the proximal femur, a tenuous vascular supply, and a lack of periosteal fracture response all contribute in making femoral neck fractures challenging to manage clinically.

Most of these injuries require operative management to minimize complications. Historically, mechanical stabilization of these fractures has been accomplished using multiple cannulated screws or compression hip screws, which act to reduce the fracture and allow compression across the fracture site to allow healing. It is widely accepted that for displaced femoral neck fractures, the quality of reduction seems to drive outcome more than any other surgeon controlled variable. The literature, however, is not clear as to which method of fixation (fixed angle devices or non-fixed angle devices) are superior.

The Femoral Neck System (FNS) represents the next generation of implants designed to improve outcomes in the treatment of femoral neck fractures. These implants offer a fixed angle construct and all of its mechanical advantages with regards to neutralizing shear and providing stability and are designed to avoid rotational malreduction forces on the fracture. The FNS system has been shown to compare favorably to traditional fixed angle constructs in a cadaveric model. As will be demonstrated in this paper, clinical experience has shown FNS to be friendly to a provisional reduction.
2. CASE REPORT

2.1 Pre-operative

A 35-year-old male wrecked while riding his all-terrain vehicle (ATV). He presented with an isolated left transcervical, displaced, femoral neck fracture with associated comminution (Figure 1 and Figure 2). He was deemed stable for operative intervention by the acute care surgery service and was taken to the operating room the following morning for management of his femoral neck fracture.

A long discussion was had with the patient and family regarding options for management. The patient was young and active. However, there were questions about his ability to be compliant with weight bearing restrictions and the patient was a smoker. Options outlined included open reduction and internal fixation or arthroplasty. The family and patient elected to proceed with open reduction and internal fixation.

Figure 1: Initial pre-operative radiographs of left femoral neck

Figure 2: Initial pre-operative 3D reconstructions of left femoral neck
2.2 Intra-operative

Attempts at closed reduction were predictably unsuccessful in this patient. Given the well-established fact that reduction is the single most important surgeon-related modifiable variable, the surgical team elected to proceed with an open reduction.

The patient was placed supine on a radiolucent table with a bump placed under the operative hip in attempts to facilitate intraoperative lateral imaging. A modified Smith Peterson approach was made to the left hip (Figure 3) as it allows for a direct “birds eye view” of the fracture. It does, however, require a separate lateral incision for placement of the implant. Another advantage of the FNS implant is that this lateral incision can be quite small compared to the incision required for a sliding hip screw device.

Figure 3: Intra-operative images show patient positioning and superficial and deep dissection.
After anatomic reduction was confirmed under direct visualization, a provisional reduction was maintained with K-wires (Figure 4). Given the complexity of the fracture and the vertical fracture line, a decision was made to utilize a fixed angle implant. Traditionally this would be a sliding hip screw device, potentially including a de-rotation screw (Figure 5). These constructs, however, can exert a strong malreduction force on a provisional reduction. For the sliding hip screw device with a lag screw head element, the fracture tends to experience a rotational malreduction force; for the sliding hip screw device with a helical blade head element, the fracture tends to gap. One of the biggest advantages to the FNS implant is that it was designed such that it does not exert a malreduction force (either rotational or axial) on a well reduced provisional fixation. As a result of this fact, only limited provisional fixation points to maintain reduction during FNS insertion may be needed.

In the current case after provisional fixation, the FNS implant was placed without disrupting the anatomic reduction of the fracture (Figure 6).

2.3 Post-operative

The patient was allowed to weight bear as tolerated after surgery. His post-operative course was uncomplicated. He was seen at 2-week, 6-week, and 3-month intervals and was noted to be pain-free and doing well. At 8 months he had returned to work (Figure 7).
Femoral neck fractures remain an extremely challenging fracture to treat. The ideal manner of mechanically stabilizing these fractures has yet to be elucidated.\(^3\) Implants widely available today include fully and partially threaded cannulated screws and fixed angle sliding hip screw devices. Screws are non-fixed angle constructs. Partially threaded screws allow for compression across the fracture, while fully threaded screws do not. A sliding hip screw device is a fixed angle device that allows for compression.

Sliding hip screw devices have been shown to have a lower short-term failure rate than cannulated screws.\(^5\) However, there is not enough evidence to recommend an optimal method of internal fixation regarding long-term outcome.\(^3\)

Screws are advantageous in terms of reduction. At worst, screws do not disrupt a good provisional reduction, and at best they fine tune or improve a provisional reduction. However, screws lack in maintaining the neck-shaft angle and preventing varus collapse and retroversion. They are not as effective in combating shear forces as compared to sliding hip screw devices.\(^4\)

Fixed angle sliding hip screw devices resist shear and varus collapse, however they have a propensity to disrupt a provisional reduction. This is especially true in the rotational plane as the sliding screw is advanced in transcervical or subcapital fracture patterns. Sliding hip screw devices exert a strong rotational force on the head segment which may cause inadvertent rotational malreduction, despite abundant provisional fixation. Even in cases where this malreduction is realized and corrected, irreversible damage to the femoral head blood supply may occur. Though the fixed angle sliding hip screw device has been shown to be biomechanically superior to cannulated screws, this advantage is not realized in clinical studies.\(^3,6\) This may be due to disruption of a provisional anatomic reduction, which mitigates the biomechanical advantage. This rotational disruption of reduction may also lead to increased rates of avascular necrosis.\(^7\)

A new generation of implants are emerging which may leverage the mechanical strengths of fixed angle devices and reductive advantages of cannulated screws. The FNS has an articulated bolt and screw construct which exerts no rotational moment on the head segment and is protective of an anatomic provisional reduction. It may optimize the mechanical advantage of a sliding hip screw device by mitigating the negative effects of rotational displacement. It also allows for dynamic compression of the fracture with weight bearing.

---

**SURGEON PROFILE**

Eben Carroll, MD  
Orthopaedic Trauma Surgeon  
Director of Orthopaedic Trauma  
Director of Orthopaedic Trauma Fellowship  
Wake Forest Health Sciences  
Winston Salem, North Carolina
REFERENCES


Results from case studies are not predictive of results in other cases. Results in other cases may vary.