CASE REPORT

Repair of a Highly Displaced Comminuted Femoral Neck Fracture in a Young Patient

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Treatment of femoral neck fractures often come with complications. This case demonstrates the successful repair of a 21-year-old male with a highly displaced, comminuted femoral neck fracture sustained in a motor vehicle collision. Utilizing the Femoral Neck System (FNS), the fracture healed and the patient was able to return to a productive, active life.

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

1. INTRODUCTION

Femoral neck fractures in younger patients are difficult to treat due to their high rates of complications which are devastating to the patient. Often its younger patients who sustain high energy fractures of the femoral neck and thus have high Pauwel angle fractures with significant shear forces resulting in a challenging healing environment and the potential for varus instability. Furthermore, these fractures are often comminuted and displaced complicating matters with a disrupted blood supply to the femoral head leading to avascular necrosis. Arthroplasty at a young age places a significant burden on the patient over their lifetime therefore preserving their native bone is critical.
For these high Pauwel angle fractures, the traditional implant is a sliding hip screw due to its angular stability. However, these solutions do not go without their own challenges, with overall reoperation rates reported at 22%.[1] The treatment of femoral neck fractures in younger patients is a complex procedure for orthopaedic surgeons given the significant risk of complications.

The Femoral Neck System (FNS) is a dedicated solution for femoral neck fractures, providing both angular and rotational stability in a single implant.[2,3] Launching in 2018, clinical results are just becoming available – the purpose of this case report is to discuss a patient who received the FNS implant and assess their six-month follow-up x-rays and discuss their one-year follow-up.

2. CASE REPORT

2.1 Pre-operative

A 21-year-old restrained male driver was involved in a head-on motor vehicle crash sustaining facial, thoracic spine, distal humerus, olecranon, radius, open femoral shaft, tibial plateau, fifth metacarpal, and a highly displaced right femoral neck fracture (Garden IV, Pauwels III, AO 31B2.2) (Figure 1).

Radiographically, the femoral neck fracture was multi-fragmented with a vertical shear pattern. A large fragment from the inferior femoral neck, which is essential for transmitting load from the femoral head to the femoral shaft, was completely displaced and sitting in the soft tissues superior to the femoral neck.

The patient was young and active therefore the decision was to repair the femoral neck. Given the complex fracture pattern and level of displacement, an anatomic reduction was expected to be difficult to achieve, and maintaining it during implant insertion was going to be challenging.

Although emergent surgery within 6 to 8 hours was once considered to be the standard of care for femoral neck fractures, most surgeons recommend that these fractures be reduced and stabilized within 24 hours.[4,5,6] However, due to other life-threatening injuries this patient was not cleared for surgery until two days after the crash and there was concern that having to wait this extended period of time would increase the risk of avascular necrosis and non-union.

2.2 Intra-operative

The open femoral shaft fracture was treated first. The patient was positioned supine on a radiolucent flat top table for a retrograde nailing of his left femur. At this time, the decision was made to also treat his right femoral neck fracture. For this fracture, a common setup is to use a fracture table however to avoid moving the patient and changing tables both fractures were treated on the radiolucent flat top table.

The patient's leg was hung off the end of the table to provide traction. A Hueter Approach (modified Smith-Peterson Approach) was used to provide direct anterior exposure to the femoral neck to attempt an open reduction.

The patient had a sizable bone fragment from the inferior femoral neck that was essential to reduce so that the load placed on the implant would be shared with the fragments of the femur during healing, otherwise the implant may fail. Weber Clamps and 4mm Schanz Pins, acting as "joy sticks", were used as reduction aids and while irregularities of the inferior calcar complicated a pure anatomic reduction, the use of an open approach provided the opportunity to reduce the fracture as close to anatomic as possible (Figure 2).

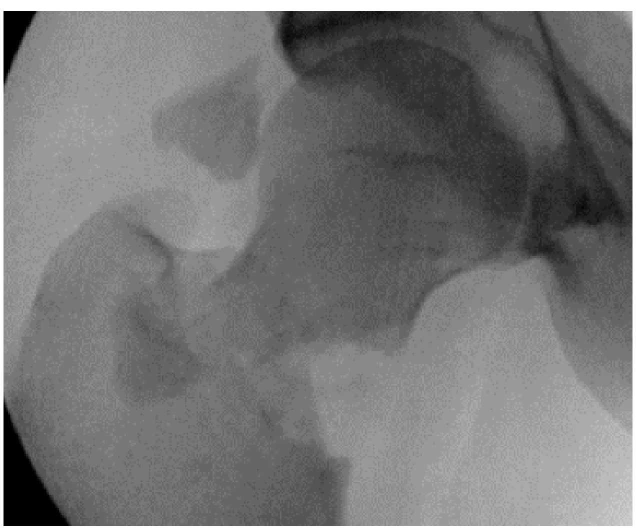

Figure 1: Initial pre-operative radiograph of right femoral neck

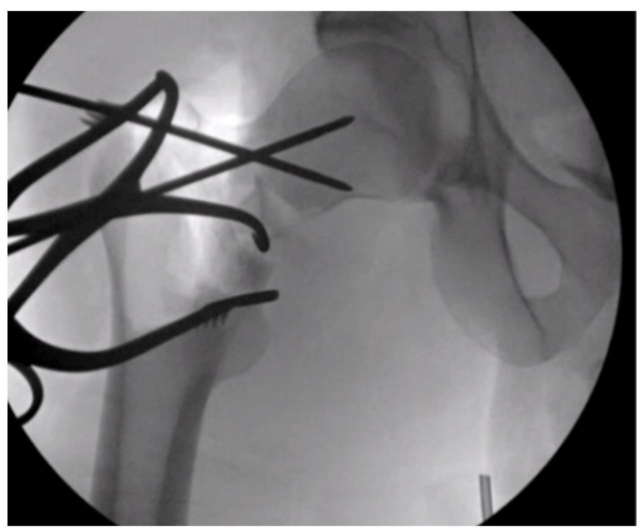

Figure 2: Intra-operative radiograph of right femoral neck following reduction

Given the vertical nature of the fracture, a device with strong angular stability was required to allow the patient to mobilize. A sliding hip screw with de-rotation screw is currently the generally accepted treatment, however given the innovation with FNS it was considered ideal for this case, providing angular and rotational stability in one implant. In addition, insertion of the FNS implant does not require the "screwing in" of the bolt, which reduces the risk of mal-reduction that often occurs with insertion of a sliding hip screw device.

A lateral incision of approximately 5 to 10 centimeters was made over the lateral aspect of the femur just distal to the vastus ridge (Figure 3).

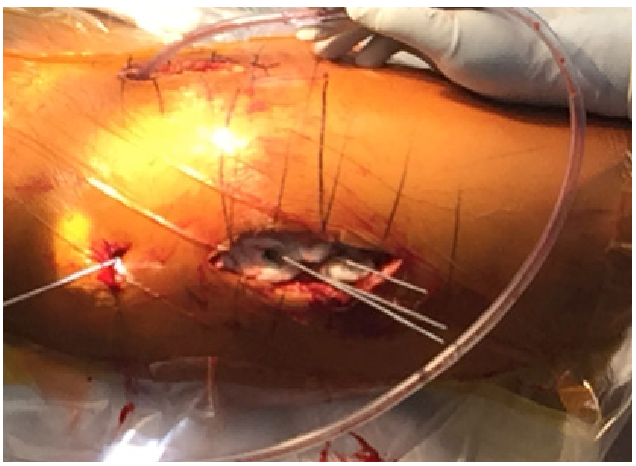

Figure 3: Intra-operative planned incision

After inserting a single guide wire into the femoral head, a measurement was taken, and the implant size was determined. As the bolt is smooth, reduction was able to be maintained without mal-rotating the femoral head during insertion (Figure 4).

Figure 4: Intra-operative radiograph of guide wire placement in the femoral head and back-table image of smooth bolt

Note: This radiograph is taken from another case and used for illustrative purposes.

The antirotation screw is inserted through the bolt to create one fixed assembly. Once the antirotation screw is inserted, the plate position is set. The position of the plate was checked using the image intensifier to ensure center placement in relation to the shaft of the femur prior to drilling and inserting the antirotation screw. All components of the FNS implant were inserted with a few instruments through a targeting jig (Figure 5).

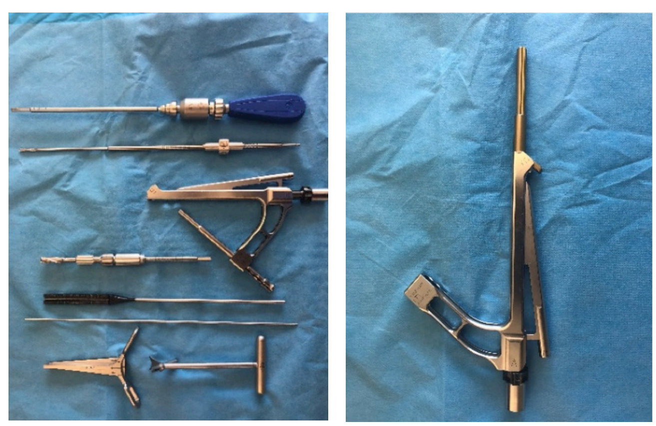

Figure 5: Intra-operative insertion of antirotation screw, back table instruments, and assembled bolt on targeting jig

Considering the vertical nature of the fracture as well as the inferior comminution, a two-hole plate was selected for this patient (Figure 6). The patient was released and allowed to weight-bear-as-tolerated (WBAT). With so many injuries, allowing the patient to WBAT was necessary for him to be able to mobilize and rehabilitate.

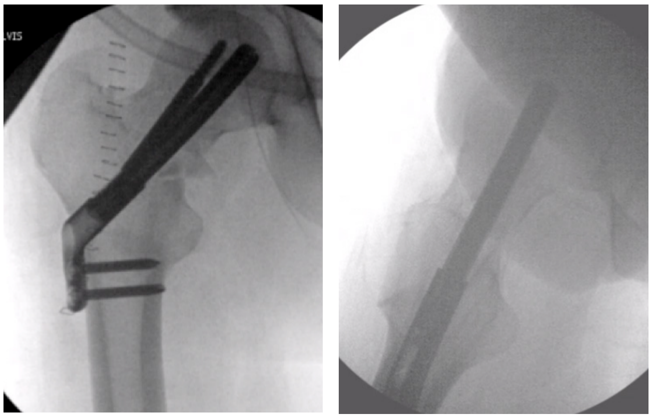

Figure 6: Intra-operative radiographs following implant insertion

2.3 Post-operative

While the patient was lost to immediate follow-up, he returned six months and one year later for evaluation. His femoral neck fracture had healed, the FNS implant was intact, and the patient was ambulating pain free without a limp (Figure 7). The patient went on to heal all his injuries without additional operations and could once again ride his bicycle, jog, and work as an autobody mechanic.

The only unknown at this time was whether the femoral head would develop osteonecrosis, which may take up to two years to become evident.[4] This is true for all femoral neck fractures however early results for this patient are promising.

Figure 7: Radiographs from six month follow-up of patient

3. DISCUSSION

The most critical element of treating femoral neck fractures is reduction. Closed reduction should be attempted to minimize disruption of soft tissues however open reduction should be used when necessary to achieve adequate reduction as was the case with this patient. Even with open approaches, high energy femoral neck fractures can still be difficult to achieve anatomic reduction, and surgeons may need to use various combinations of wires, Schanz Pins, clamps, and even small plates to obtain and maintain reduction.

Prior to the availability of FNS, the two main choices of implants for femoral neck fractures were three cannulated screws or a sliding hip screw with a de-rotation screw. Cannulated screws are considered for low Pauwels Angle, transcervical, or sub-capital fractures whereas a sliding hip screw is preferred for basicervical and high Pauwels Angle fractures due to the angular stability of the barrel and side plate.

Independent cannulated screws are worse at resisting shear forces compared to sliding hip screws, which makes them inadequate for vertical fracture patterns.[2] Cannulated screws often inhibit fracture collapse, which is necessary for femoral neck healing, and when they do collapse often result in lateral protrusion and thigh discomfort or pain.

A significant problem with sliding hip screws is the high torque requirement to insert the central lag screw in dense, young bone. The high torque may lead to mal-reduction (mal-rotation) of the femoral neck during implant insertion which frequently displaces a good reduction even when pins or independent screws are used to prevent displacement. This, in addition to their size and additional parallel de-rotation screw, often makes these difficult to implant.

For this patient, a sliding hip screw with a de-rotation screw would have traditionally been used. However, based on the above-mentioned disadvantages, FNS was chosen to treat this patient. The FNS provided sufficient angular and rotational stability to allow the femoral neck fracture to heal, allowing the patient to ambulate pain free without a limp at both a six-month and one-year follow-up.

The design of the bolt component allowed insertion without secondary displacement of the femoral head, sometimes seen from the torsional forces when "screwing in" a sliding hip screw device. In addition, the FNS is designed for controlled collapse of the fracture such that the bolt slides within the barrel of the plate for up to 15mm without lateral protrusion. This was especially useful as some collapse occurred in the six months following surgery, allowing the fracture to heal, but not an excessive amount such that anatomic reduction was lost, and no lateral protrusion of the implant was evident at this follow-up.

The use of the FNS two-hole side plate is controversial; while mechanical strength of the one-hole plate is sufficient for these fractures, a two-hole plate is available, which some surgeons prefer for basilar neck fractures and highly unstable fractures. The two-hole plate still offers a small footprint and can be inserted through a small incision.

SURGEON PROFILE

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† Benchtop testing may not be indicative of clinical performance.

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

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