

## Outcomes of High Pauwel's Angle Femoral Neck Fractures in Patients <60 Years Old Treated with the Synthes Femoral Neck System

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**Disclosures:** The authors have no disclosures for this study.

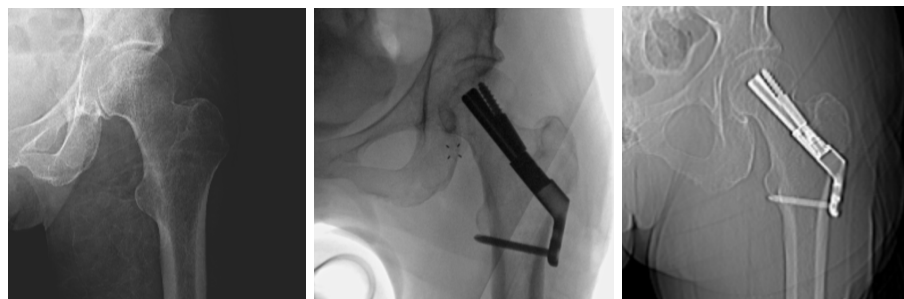
**Introduction:** The optimal treatment strategy for displaced femoral neck fractures in young patients continues to evolve, and there remains significant practice variation in terms of surgical approach, open versus closed reduction, and implants used for fixation. Despite extensive research, these high-energy injuries continue to have high complication rates related to varus fracture collapse, femoral neck shortening, implant failure or cut-out, non-union, and avascular necrosis of the femoral head. To address these complications, numerous implant designs have been utilized, including sliding hip screws, cephalomedullary nails and multiple cannulated screws. The optimal implant for a given patient and injury pattern remains unclear. The Synthes Femoral Neck System is a newly developed fixed-angle implant with a sliding central bolt and antirotation screw. The outcomes of this implant in young patients and the modes of implant failure have not yet been well described. The purpose of this study was to describe the short-term results and complications of this device in a cohort of young patients with displaced femoral neck fractures.

**Methods:** A retrospective review was conducted of all patients <60 years of age with a minimum follow-up of 3 months that underwent operative management of a displaced femoral neck fracture using the Femoral Neck System from 2018-2022. Approval was obtained from the Institutional Review Board. Patient and fracture characteristics, open versus closed reduction, use of supplemental fixation and quality of reduction (Haidukewych and Berry et al 2004) was recorded. Primary outcomes at 3 months were femoral neck shortening, varus fracture collapse (Zlowodzki and Bhandari et al 2008), implant cut-out or breakage, and reoperation at any timepoint. All images were adjusted for magnification using the 10 millimeter central bolt for reference.

**Results:** Twelve patients with an average age of 45+/- 8.8 (range 33-59) years old and follow-up time of 7.5 +/- 6 (range 3-20) months. Six patients were treated with a closed reduction, one with percutaneous fracture reduction, and five with an open reduction. Eight fractures had major comminution (fragments >1.5 cm in any dimension) (Collinge and Reddix et al. 2014), two had minor comminution, and two had no significant comminution. Comminution involved the posterior or inferior quadrant of the femoral neck in 9/10 patients with comminution. The average modified Pauwels angle was found to be 61.9° +/- 12.2° (42.5°-72.5°). The quality of reduction was excellent in seven patients and good in five patients. At 3 month follow-up, the mean femoral neck shortening was 8.2 +/- 6.0 (1.8-19.0) mm. Varus collapse of the fracture was classified as mild in 8 patients, moderate in 3 patients, and severe in 1 patient. Two patients underwent conversion to total hip arthroplasty: one due to complete cut-out of the implant from the femoral head, and one due to severe varus collapse and femoral neck shortening. Both conversion procedures were able to be performed using primary total hip arthroplasty stems. Figures 1-3 demonstrate AP hip radiographs of a study patient undergoing FNS placement for displaced femoral neck fracture with associated 12 month follow-up film.

**Discussion:** This study describes the short-term outcomes of femoral neck fractures in patients <60 years old treated with a novel implant designed to provide rotational control of the fracture and allow for controlled fracture collapse. Consistent with prior studies, displaced femoral neck fractures in this young population had high rates of major comminution and a high modified Pauwel's angle (mean 61.9°), which contributes to the biomechanically and biologically challenging environment for bony healing. In this series, 10/12 patients went on to bony union without need for reoperation at mean follow-up of 7.5 months. Femoral neck shortening remained significant despite high rates of good or excellent reduction, and the mean shortening of 8.2 mm has been previously shown to lead to worse functional outcomes. In addition to femoral neck shortening, both patients that failed and required conversion to total hip arthroplasty demonstrated progressive varus fracture collapse about the central bolt, demonstrating that this remains a common mode of failure with the Femoral Neck System. Both conversion procedures were able to be performed using primary total hip arthroplasty stems. In conclusion, the Femoral Neck System performed well in displaced femoral neck fractures with a high mean Pauwel's angle, though femoral neck shortening, varus collapse and conversion to total hip arthroplasty remain common complications of these challenging injuries.

**Significance/Clinical Relevance:** In high Pauwel's angle femoral neck fractures in patients <60 years of age treated with the Femoral Neck System, 10/12 fractures went on to bony union without any mechanical failure of the implant, though femoral neck shortening, varus collapse and cut-out of the central bolt remain a common mode of failure.



Figures 1-4. Example AP hip radiographs of a patient included in the study. Figure 1 demonstrates initial displaced femoral neck fracture radiograph. Figure 2 demonstrates intraoperative fluoroscopic radiograph of FNS placement. Figure 3 demonstrates 12 month follow-up radiograph.