Section: Orthopaedics

Case Series

EARLY FUNCTIONAL OUTCOME AND COMPLICATION OF FEMORAL NECK SYSTEM IN TREATING FRACTURE NECK OF FEMUR IN YOUNG ADULTS

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ABSTRACT

Background: Femoral neck fractures in young adults are associated with high functional demands and a significant risk of complications such as nonunion and avascular necrosis. The Femoral Neck System (FNS) has been introduced to provide angular stability with rotational control. However, prospective data evaluating its early outcomes in young adults remain limited. This study aimed to assess early functional outcomes and complications following FNS fixation in intracapsular femoral neck fractures in young adults.

Materials and Methods: A prospective descriptive case series was conducted at a tertiary care center between July 2023 and July 2025. Twenty consecutive patients aged 18–50 years with intracapsular femoral neck fractures treated using the FNS were included Patients were followed for at least six months. Fractures were classified using Garden, Pauwels, and AO/OTA systems. The primary outcome was the Harris Hip Score (HHS) at six months. Secondary outcomes included radiological union, time to union, and early complications.

Results: The mean age was 34.6 ± 8.2 years, with 65% male patients. Displaced fractures (Garden III–IV) accounted for 70% of cases. Radiological union was achieved in 90% of patients at a mean of 11.2 ± 2.1 weeks. The mean HHS at six months was 86.2 ± 7.5, with 85% of patients demonstrating good to excellent outcomes. Complications occurred in 15% of cases, including one implant failure, one superficial infection, and one case of early radiographic changes suggestive of avascular necrosis. No deep infections or established nonunion requiring revision were observed.

Conclusion: Fixation of intracapsular femoral neck fractures in young adults using the Femoral Neck System demonstrated satisfactory early functional outcomes with a high rate of radiological union and a low incidence of early complications. Longer follow-up studies with larger cohorts are required to assess long-term outcomes and femoral head viability.

Keywords: Femoral neck fracture, Femoral Neck System, Young adults, Internal fixation, Harris Hip Score, Intracapsular fracture, Radiological union, Avascular necrosis.

INTRODUCTION

Femoral neck fractures in young adults present a challenging clinical problem that differs substantially from similar injuries in the elderly. While hip fractures in older patients are most often the result of low-energy falls related to osteoporosis, fractures in younger individuals typically occur following high-energy trauma such as road traffic accidents or falls from height.[1] Although less common in this age group, these injuries are particularly concerning because they affect individuals with high functional demands and long-life expectancy.

The primary goal of treatment in young adults is preservation of the native femoral head. Arthroplasty is generally avoided whenever possible due to concerns regarding implant longevity and the likelihood of future revision surgery in active

patients.[2] Consequently, internal fixation remains the preferred treatment strategy. However, outcomes following fixation are not without complications. Nonunion and avascular necrosis (AVN) of the femoral head remain significant concerns, especially in displaced fractures where the vascular supply may already be compromised at the time of injury.[3] These complications can result in long-term disability and the eventual need for secondary procedures.

Multiple cancellous screws and sliding hip screw constructs have traditionally been used for fixation of femoral neck fractures.[4] While these techniques are familiar and widely practiced, they are associated with certain biomechanical limitations. Rotational instability, varus collapse, and fixation failure are more frequently observed in vertically oriented or unstable fracture patterns. These limitations have prompted the development of alternative implants designed to provide improved mechanical stability while maintaining controlled fracture impaction.

The Femoral Neck System (FNS) is a relatively recent implant designed to combine angular stability with rotational control in a minimally invasive construct.[5] Biomechanical evaluations have suggested that the FNS may provide superior resistance to shear and rotational forces compared with conventional screw constructs, particularly in unstable fracture configurations.[6] Early clinical studies have reported encouraging outcomes; however, prospective data focusing specifically on young adult populations remain limited.

Given the high functional expectations and complication risks in this age group, it is important to evaluate the early clinical performance of newer fixation systems. The purpose of the present study was to assess early functional outcomes and complication rates following fixation of intracapsular femoral neck fractures using the Femoral Neck System in young adults.

MATERIALS AND METHODS

Study Design and Reporting Standard: This prospective descriptive case series was conducted at a tertiary care orthopedic center after obtaining approval from the Institutional Ethics Committee. The study was designed and reported in accordance with established guidelines for surgical case series to ensure methodological transparency and completeness.[7] Patient recruitment was carried out between July 2023 and July 2025, and all participants were followed for a minimum duration of six months. The final follow-up for the last enrolled patient was completed in December 2025.

Patient Selection and Fracture Classification: All consecutive patients presenting with intracapsular femoral neck fractures during the study period were evaluated for eligibility. Patients aged 18 to 50 years who underwent fixation using the Femoral Neck System (FNS) were included. Written informed consent was obtained prior to enrolment.

Fractures were classified preoperatively using the Garden classification system to determine displacement status.[8] The vertical orientation and biomechanical characteristics of the fracture were further assessed using the Pauwels classification.[9] These classification systems were selected because of their widespread use in clinical practice and their relevance in predicting stability and complication risk.

Patients with pathological fractures, extracapsular fractures, previous ipsilateral hip surgery, or inadequate follow-up were excluded.

Surgical Technique and Fracture Assessment: All surgeries were performed under spinal or general anaesthesia with the patient positioned on a fracture table. Closed reduction under fluoroscopic guidance was attempted in all cases. When satisfactory alignment could not be achieved, open reduction was performed at the discretion of the operating surgeon. Fractures were additionally categorized according to the AO/OTA classification system to ensure standardized documentation and comparability with existing literature (10). The Femoral Neck System was implanted according to the manufacturer's recommended surgical technique. Intraoperative fluoroscopy was used to confirm appropriate guidewire placement, implant positioning, and restoration of alignment.

Postoperative Protocol and Follow-Up: Patients were initially mobilized with non–weight-bearing ambulation using appropriate assistive devices. Gradual progression to partial weight bearing was permitted based on clinical assessment, radiological signs of healing, and recovery of the affected limb. Full weight bearing was allowed only after evidence of satisfactory bony consolidation on follow-up radiographs.

Outcome Measures: The primary outcome measure was functional recovery assessed using the Harris Hip Score (HHS) at six months following surgery.[11] The HHS was chosen due to its established reliability and widespread application in hip outcome evaluation.

Secondary outcome measures included radiological union, time to union, and early complications. Radiological union was defined as the presence of bridging trabeculae across the fracture site on orthogonal radiographs without pain on weight bearing. Nonunion was defined as the absence of progressive healing associated with persistent symptoms. Implant failure was defined as loss of reduction, varus collapse, hardware migration, or the need for revision surgery. Clinical and radiographic features suggestive of avascular necrosis were documented during follow-up.

Statistical Analysis: Continuous variables were reported as mean and standard deviation, whilst categorical variables were provided as frequencies and percentages. Given the observational design and limited sample size, no comparative statistical testing was undertaken.

RESULTS

Patient Demographics: A total of 20 patients satisfied the inclusion criteria and completed a minimum follow-up of six months. The mean age of the cohort was 34.6 ± 8.2 years (range, 19–49 years). Thirteen patients (65%) were male and seven (35%) were female. The right hip was involved in 11 cases (55%), while 9 patients (45%) sustained left-sided fractures.

The most common mechanism of injury was road traffic accident, accounting for 14 cases (70%). Falls from height were responsible for 4 cases (20%), and ground-level falls accounted for 2 cases (10%).

Baseline characteristics are summarized in [Table 1].

Table 1: Baseline Characteristics of the Study Population (n = 20)

Variable	Value
Mean age (years)	34.6 ± 8.2
Male	13 (65%)
Female	7 (35%)
Right side	11 (55%)
Left side	9 (45%)
Road traffic accident	14 (70%)
Fall from height	4 (20%)
Ground-level fall	2 (10%)

Fracture Characteristics and Surgical Details

Preoperative radiographs demonstrated that 6 fractures (30%) were nondisplaced (Garden I–II), while 14 fractures (70%) were displaced (Garden III–IV). A representative preoperative radiograph of a displaced intracapsular femoral neck fracture is shown in [Figure 1].

Based on Pauwels classification, 12 fractures (60%) were categorized as type III, reflecting a more vertical fracture orientation. According to AO/OTA classification, the majority were classified as 31B3 fractures.

Closed reduction under fluoroscopic guidance was achieved in 15 patients (75%). Five patients (25%) required open reduction to obtain satisfactory alignment.

The mean time from injury to surgery was 18.4 ± 6.7 hours.

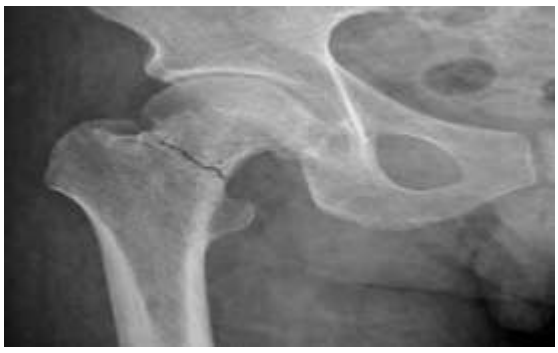

Figure 1: Preoperative radiograph

Postoperative Radiological Assessment

Immediate postoperative radiographs demonstrated satisfactory fracture reduction and appropriate positioning of the Femoral Neck System in all cases. A representative immediate postoperative image is shown in [Figure 2].

Radiological union was observed in 18 patients (90%) by the six-month follow-up. The mean time to union was 11.2 ± 2.1 weeks. Two patients demonstrated delayed radiographic healing but did not require revision surgery during the study period.

At six months, follow-up radiographs confirmed maintained alignment and progressive trabecular bridging in the majority of patients. An example of fracture union at six months is illustrated in [Figure 3].

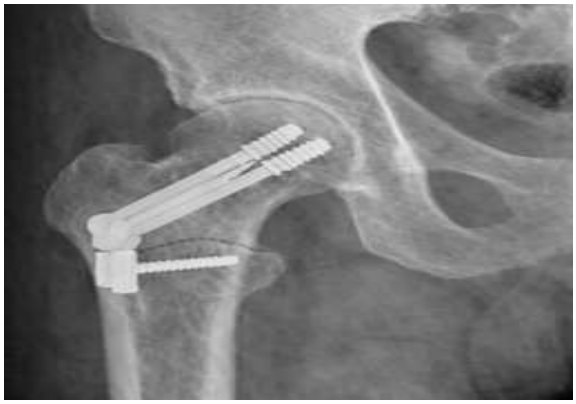

Figure 2: Immediate postoperative radiograph

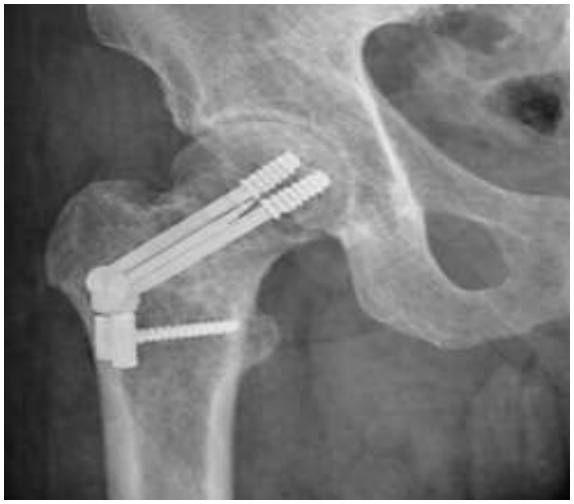

Figure 3: Six-month follow-up radiograph

Functional Outcomes: At six months postoperatively, the mean Harris Hip Score (HHS) was 86.2 ± 7.5. Based on standard grading criteria, 8 patients (40%) achieved excellent results, 9 patients

(45%) achieved good results, 2 patients (10%) had fair outcomes, and 1 patient (5%) had a poor outcome.

Most patients were able to ambulate independently without assistive devices by the final follow-up.

Functional outcomes are summarized in [Table 2].

Table 2: Functional Outcomes at 6 Months

Outcome	Value
Mean HHS	86.2 ± 7.5
Excellent (≥90)	8 (40%)
Good (80–89)	9 (45%)
Fair (70–79)	2 (10%)
Poor (<70)	1 (5%)

Complications: Complications occurred in three patients (15%). One patient developed implant failure characterized by varus collapse and required revision fixation. One patient developed a superficial surgical site infection, which resolved with oral antibiotics. One patient demonstrated early radiographic features suggestive of avascular necrosis at the six-month evaluation, though symptoms were minimal at that time.

No cases of deep infection, established nonunion requiring surgical intervention, or mortality were observed.

Complications are detailed in [Table 3].

Table 3: Complications

Complication	Number (%)
Implant failure	1 (5%)
Superficial infection	1 (5%)
Early AVN changes	1 (5%)
Deep infection	0
Nonunion requiring revision	0
Mortality	0
Total complication rate	3 (15%)

DISCUSSION

The present prospective case series evaluated early functional outcomes and complication patterns following fixation of intracapsular femoral neck fractures in young adults using the Femoral Neck System (FNS). At a minimum follow-up of six months, the majority of patients demonstrated satisfactory functional recovery, high rates of radiological union, and a relatively low complication rate. These findings suggest that the FNS provides stable fixation with encouraging short-term clinical performance in this high-demand population.

Management of femoral neck fractures in young adults continues to be challenging because of the need to preserve the femoral head while minimizing the risk of nonunion and avascular necrosis. Previous studies have reported variable outcomes following fixation with multiple cancellous screws and sliding hip screw constructs, particularly in displaced and vertically oriented fractures.[12] Mechanical instability and varus collapse remain recognized contributors to fixation failure. In this context, implants designed to improve angular stability and rotational control may offer potential advantages.

Biomechanical investigations have suggested that the FNS provides improved resistance to shear and rotational forces compared with conventional screw constructs, especially in Pauwels type III fractures.[13] The design of the FNS allows controlled impaction while maintaining angular stability, which may reduce the likelihood of secondary displacement. In our series, maintenance of alignment was observed in the majority of patients at six months, and only one case required revision due to mechanical failure.

Clinical outcome studies evaluating the FNS in adult populations have reported promising early results, with union rates comparable to or exceeding those seen with traditional fixation methods.[14] The union rate observed in the present study is consistent with these findings. Although direct comparison cannot be made due to the absence of a control group, the early radiographic healing and functional improvement noted in our cohort align with emerging literature supporting the use of fixed-angle devices in unstable fracture configurations.

Avascular necrosis remains a major concern following femoral neck fractures in young individuals. Reported rates vary widely in the literature, often influenced by fracture displacement and timing of surgery.[15] In the present study, only one patient demonstrated early radiographic changes suggestive of avascular necrosis at six months; however, definitive assessment of femoral head viability requires longer follow-up. The relatively short duration of follow-up in this series limits the ability to draw conclusions regarding late complications such as AVN or femoral head collapse.

Functional recovery, as assessed using the Harris Hip Score, was favorable in the majority of patients. Restoration of alignment and stable fixation likely contributed to early mobilization and progressive weight bearing. Previous studies have emphasized the importance of achieving anatomical reduction as a key determinant of successful outcomes in young adults.[16] In our cohort, acceptable reduction was

obtained in all cases, which may have positively influenced early functional results.

This study has several limitations. First, the sample size was limited to 20 patients, which restricts the generalizability of the findings. Second, the follow-up duration was limited to six months, precluding evaluation of long-term complications such as avascular necrosis or implant-related late failures. Third, the absence of a comparison group prevents direct assessment of superiority over other fixation methods. Despite these limitations, the prospective design and standardized evaluation of outcomes provide useful early data regarding the performance of the FNS in young adults.

CONCLUSION

In this prospective case series, fixation of intracapsular femoral neck fractures in young adults using the Femoral Neck System demonstrated encouraging early functional outcomes and a high rate of radiological union at six months. The majority of patients achieved good to excellent functional recovery with maintenance of fracture alignment and a low incidence of early complications. These findings suggest that the FNS provides stable fixation and may be a reliable option in managing femoral neck fractures in this active patient population.

However, the short duration of follow-up limits assessment of late complications such as avascular necrosis and long-term implant performance. Larger studies with extended follow-up and comparative designs are necessary to further clarify the role of the FNS in the treatment algorithm for femoral neck fractures in young adults.

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