

Fixation of Femoral Neck Fractures Using the Femoral Neck System, A Tertiary Care Based Study.

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Original Article

Abstract**Background**

Femoral neck fractures remain a significant cause of morbidity in adults, and achieving stable fixation with early mobilization continues to be a clinical challenge. The Femoral Neck System (FNS) is a novel fixation device designed to provide angular stability and controlled dynamic compression, potentially improving outcomes compared to conventional methods.

Aim

To evaluate the clinical and radiological outcomes of femoral neck fractures managed with the Femoral Neck System (FNS).

Methods

In this prospective study, 25 patients with closed femoral neck fractures amenable to closed reduction were included. All patients underwent internal fixation using the FNS. Clinical and radiological assessments were performed at regular follow-ups, and outcomes were evaluated using the Harris Hip Score (HHS) and Radiographic Union Score for Hip (RUSH) at 6 months.

Results:

The mean age of patients was 51.52 years, with a male-to-female ratio of 1.7. The mean operative time was 40.44 minutes and average fracture healing time 12.92 weeks. The mean HHS was 92.64 ± 5.51 , with 84% of patients achieving good to excellent results. Radiologically, union was achieved in 96% of cases, delayed union in 4%, and non-union in 4%. Complications included one case each of non-union and 2 cases of avascular necrosis.

Conclusion

The Femoral Neck System provides stable fixation, high union rates, and excellent functional outcomes with minimal complications. It represents a reliable and biomechanically superior alternative for managing femoral neck fractures in adults.

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Introduction

Fractures of the femoral neck constitute one of the most common and challenging injuries in orthopaedic practice, particularly among the elderly population with osteoporotic bone and in younger adults following high-energy trauma [1,2]. These fractures account for nearly 48-54% of all hip fractures and are associated with considerable morbidity, mortality, and socioeconomic burden due to prolonged hospitalization, loss of mobility, and functional dependence [3,4]. The goals of treatment include achieving stable fixation, maintaining anatomical reduction, promoting early mobilization, and preventing complications such as avascular necrosis and non-union [5].

Despite advances in surgical techniques and implant design, the optimal fixation method for femoral neck fractures remains a topic of ongoing debate. Conventional fixation methods such as multiple cancellous screws and dynamic hip screw (DHS) have been widely used, but they are often associated with biomechanical limitations including inadequate rotational stability, risk of fixation failure, and collapse at the fracture site, especially in vertically oriented (Pauwels type III) and displaced fractures [6,7]. These challenges have driven the development of new fixation systems aimed at improving biomechanical stability and reducing postoperative complications.

The Femoral Neck System (FNS), introduced by the AO Foundation, represents a novel, minimally invasive implant designed to combine the angular stability of a fixed-angle construct with controlled dynamic compression at the fracture site. The system consists of a locking plate, a bolt, and an antirotation screw that together provide enhanced resistance to shear and torsional forces while allowing limited axial sliding for fracture impaction and healing [8]. Biomechanical studies have demonstrated that FNS offers compared to traditional screw, fixation,

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Keywords

Femoral neck fracture, Femoral Neck System, internal fixation, Harris Hip Score, fracture union.

particularly in unstable fracture configurations [9]. femoral neck fractures; extracapsular fractures; However, clinical data on its real-world effectiveness, pathological fractures; and refractures.

union rates, and functional recovery remain limited, particularly from developing countries and varied patient populations. While the femoral neck system (FNS) has mechanical superiority over the traditional implants in cadaveric experiments, it is crucial to evaluate the safety and report outcomes of this new implant. The aim of this study was to investigate the outcome of patients with femoral neck fractures managed with FNS and we wish to validate the safety of this implant.

Given these considerations, evaluating the clinical and radiological outcomes of femoral neck fracture fixation using the Femoral Neck System is essential to determine its efficacy, safety, and potential advantages over conventional techniques. The present study aims to assess union rates, time to union, functional outcomes, and postoperative complications in patients with femoral neck fractures managed with the Femoral Neck System at our tertiary care center.

Materials and Methods

This prospective observational study was conducted in tertiary care hospital in kashmir. A total of 25 patients with femoral neck fractures fulfilling the inclusion criteria were enrolled after obtaining informed consent. Inclusion criteria consisted of patients aged 18–70 years with femoral neck fractures, of both genders, with closed injuries amenable to closed reduction. Both displaced and undisplaced intracapsular femoral neck fractures were included. Exclusion criteria included associated Hip Score (HHS) for functional evaluation and the femoral, acetabular, or segmental injuries; expected Radiographic Union Score for Hip (RUSH) for radiological assessment; patient non-compliance; severe systemic disorders with immunodeficiency or poor overall prognosis; bilateral

Surgical technique

The procedure was performed under general or spinal anesthesia with the patient in the supine position on a traction table. After achieving satisfactory closed reduction under fluoroscopic guidance, a longitudinal incision of approximately 3.5–4 cm was made distal to the greater trochanter to expose the lateral femoral cortex. An anti-rotation Kirschner wire was first placed near the superior aspect of the femoral neck to maintain reduction. A central guide wire was then inserted at an angle of 130° under fluoroscopic control using the FNS guide system. The position and depth of the guide wire were confirmed on anteroposterior and lateral views. The channel was reamed along the central guide wire, and the Femoral Neck System (FNS) implant was inserted over the guide wire into the pre-reamed hole. The lateral plate was secured to the femur with one or two locking screws. Through the guide sleeve, an anti-rotation screw of appropriate length was inserted, and interfragmentary compression was applied by turning the insertion screw counterclockwise when required. The final implant position was verified using C-arm fluoroscopy in both planes.

Postoperatively the patients were mobilized on first post-op day and partial weight-bearing was allowed. Patients were followed up at regular intervals upto 6 months postoperatively. Functional and radiological outcomes were assessed at 6 months using the Harris Hip Score (HHS) for functional evaluation and the Radiographic Union Score for Hip (RUSH) for radiological assessment.

Statistical Analysis

All collected data were entered into Microsoft Excel and analyzed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Quantitative variables were expressed as mean $\pm$ standard deviation (SD), and categorical variables as frequencies and percentages. Comparisons between continuous variables were performed using the Student's t-test or Mann–Whitney U test as appropriate, while categorical variables were compared using the Chi-square test or Fisher's exact test. A p-value of less than 0.05 was considered statistically significant.

Results

The mean age of the patients was 51.20 years (range 29–70 years). The majority of patients (42.9%) were above 50 years of age. There were 16 males (64%) and 9 females (36%). The right side

Table 1: Demographic characters of the enrolled population (N=25)

Parameters	Variables	No. of patients	Percentage
Age (Years)	<30	1	4%
	30-40	3	12%
	41-50	9	36%
	>50	12	48%
Gender	Male	16	64%
	Female	9	36%
Laterality	Right	14	56%
	Left	11	44%
Mechanism of injury	Simple fall	14	56%
	Fall from height	7	28%
	Road traffic accidents	4	16%
Garden classification	I	1	4%
	II	9	36%
	III	4	12%
	IV	11	44%

was involved in 14 patients (56%), while the left side was involved in 11 patients (44%). The most common mechanism of injury was a simple fall 14(56%), followed by fall from height 7(28%) and road traffic accidents 4(16%). According to Garden's classification, 4% of patients were type I, 36% type II, 16% type III, and 44% type IV fractures (Table 1).

The mean operative time was 40.44

Table 4: Functional and Radiological Outcome

Scales	Grade	No. of Patients	Percentage
Harris hip score (HSS)	Excellent (90-100)	17	68%
	Good (80-89)	4	16%
	Fair (70-89)	1	4%
	Poor (<70)	3	12%
Radiological outcome	Union	24	96%
	Delayed Union	2	8%
	Non-union	1	4%

Table 2: Surgical and functional outcomes of the study population

Parameters	Mean $\pm$ SD	Range
Operative time (Minutes)	40.44 $\pm$ 10.89	30-75
Fracture healing time (weeks)	12.92 $\pm$ 3.17	10-20
Harris hip score	92.64 $\pm$ 5.51	68-100
RUSH Score	25.30 $\pm$ 4.76	10-30
Femoral neck shortening (mm)	2.8 $\pm$ 2.1	0-9

$\pm$ 10.89 minutes (range 30–75 minutes). The average fracture healing time was 12.92 $\pm$ 3.17 weeks (range 10–20 weeks). The mean Harris Hip Score (HHS) at the final follow-up was 92.64 $\pm$ 5.51 (range 68–100), indicating a predominantly good to excellent functional outcome. The mean Radiographic Union Score for Hip (RUSH) was 25.30 $\pm$ 4.76 (range 10–30), and the mean femoral neck shortening was 2.8 $\pm$ 2.1 mm (range 0–9 mm) (Table 2).

Postoperative complications were observed in a small proportion of patients. Non-union was noted in 1 patient (4%), and avascular necrosis in 2 patients (8%). Delayed union occurred in 1 patient (4%). There were no cases of hardware removal, implant cut-out, or re-operation (Table 3).

Table 3: Post-operative Complication

Complications	No. of patients	Percentage
Non-union	1	4%
Femoral necrosis	2	8%
Delayed union	1	4%

Functional and radiological outcomes were evaluated at the final follow-up. Based on the Harris Hip Score, 68% of patients had excellent results, 16% had good results, and three patients (12%) had a poor outcome. Radiologically, union was achieved in 96% of cases, delayed union in 8%, and non-union in 4% of patients (Table 4).

Discussion

The increase in high-energy trauma, such as traffic injuries and high falls, has significantly increased the incidence rate of femoral neck fractures in young and middle-aged adults. However, the majority of hip fracture patients are still the elderly, many of whom

already have other major complications. The outcomes of femoral neck fractures mainly depend on the physical status and age of the patient, type of fracture, quality of reduction, and stable internal fixation [10]. It is generally acknowledged that anatomical reduction, stable and strong fracture fixation early after injury are

important factors ensuring good treatment effects [11]. This prospective study evaluating the clinical and radiological outcomes of femoral neck fractures managed with the Femoral Neck System (FNS) demonstrated excellent functional recovery and high union rates in the majority of patients. The mean age of the study population was 51.52 years, reflecting a mixed cohort of middle-aged and older adults—an age group where femoral neck fractures are increasingly encountered due to both high-energy trauma in younger individuals and low-energy falls in those with osteopenic bone. The mean Harris Hip Score (HHS) achieved at final follow-up was 92.64 $\pm$ 5.51, with 84% of patients attaining good to excellent outcomes.

Radiologically, union was achieved in 96% of patients, while delayed union and nonunion occurred in 4% each. The mean femoral neck shortening was 2.98 mm, indicating satisfactory maintenance of limb length and biomechanics. Overall, complications such as avascular

necrosis and nonunion were infrequent, suggesting that FNS provides a stable construct conducive to early union and functional recovery.

The results of this study are comparable with findings from existing literature. Previous studies by He C et al (2021) [12], and Hernández-Naranjo J M et al (2024)[13], have reported mean Harris Hip Scores 90.42 and 90.9 respectively, following fixation with FNS, while in our study the score was slightly higher, possibly due to the inclusion of younger patients and early mobilization protocols. Similarly, the union rate of 96% in the present series aligns with studies such as that of Hu H et al (2021)[14], who reported union rates around

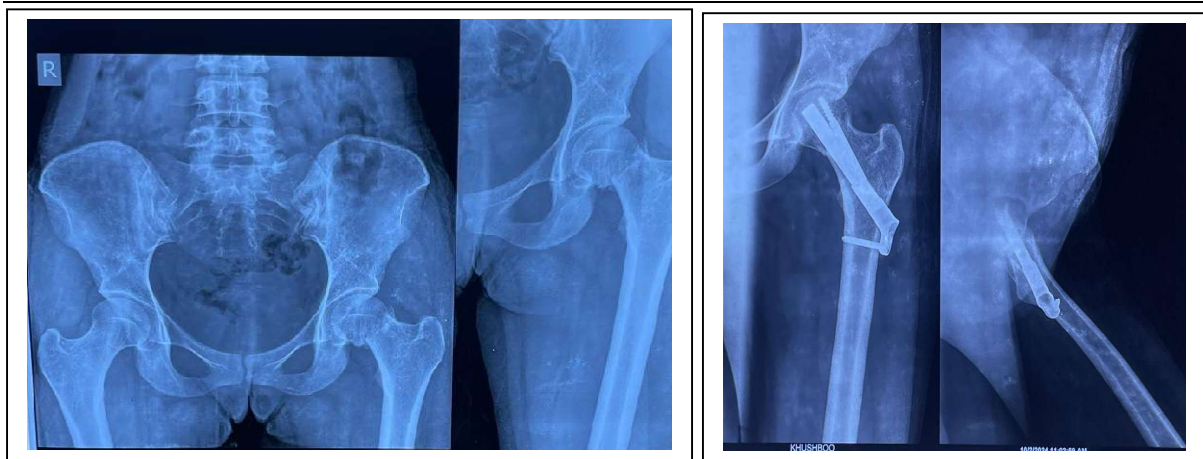


Figure 1: Pre-operative (left) and immediate post-operative (right) radiographs of one of the cases.

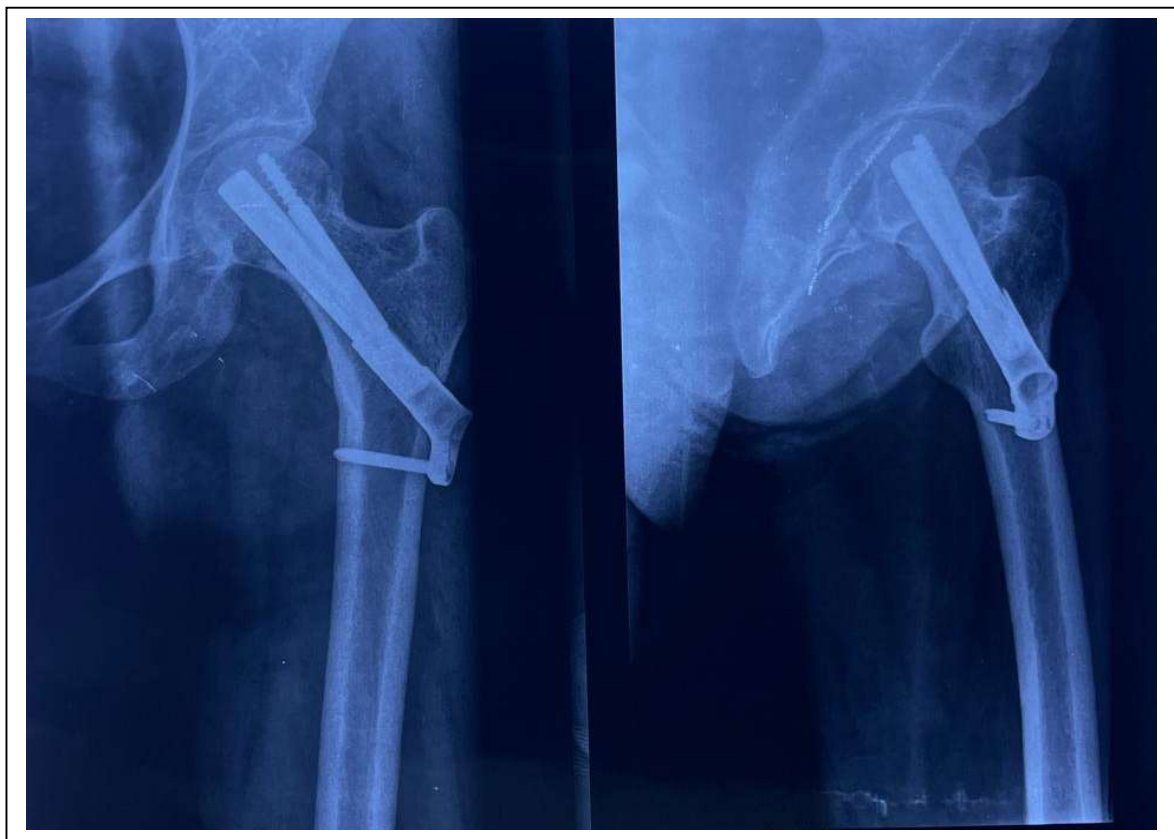


Fig 2: Radiograph of same patient at 6-month follow-up showing united fracture.

90% with minimal complications. The low rates of Pauwels type III fractures, thereby reducing the nonunion and avascular necrosis in our study are also likelihood of fixation failure and varus collapse [9]. consistent with those of Xu Z et al. (2024)[15]and Hu H In comparison with conventional fixation methods, the et al (2021)[14],who observed that FNS provides FNS offers distinct biomechanical advantages. The improved rotational and angular stability, leading to design incorporates a central bolt for load-bearing, an fewer fixation failures compared to multiple cancellous antirotation screw for torsional stability, and a lateral screws (CCS) or dynamic hip screws (DHS). locking plate that provides angular stability while Furthermore, biomechanical studies have demonstrated allowing controlled compression at the fracture site. that the FNS construct exhibits higher stiffness and This hybrid mechanism ensures both rigidity and limited superior resistance to shear forces, particularly in dynamic sliding, optimizing conditions for fracture

healing. Studies by Stoffel et al. (2017)⁹ and Yang Y et al. (2021)[16], have shown that FNS fixation results in less femoral neck shortening and higher axial stability than multiple screw constructs. The mean shortening of 2.8 mm in our series is within acceptable limits and lower than that observed with traditional screw fixation, where shortening of 5–10 mm is commonly reported [17,18]. Reduced shortening contributes to better abductor mechanics, improved gait, and higher functional scores.

The low incidence of avascular necrosis (8%) observed in this study is noteworthy. Avascular necrosis remains one of the most feared complications following femoral neck fractures, with rates ranging from 10–30% in displaced fractures [19]. The lower incidence in our study may be attributed to careful reduction techniques, minimal soft tissue dissection, and prompt fixation, factors known to preserve the femoral head's vascularity. The mean operative time of 40 minutes indicating that the procedure is not technically demanding and can be performed efficiently with minimal surgical trauma. These features enhance the feasibility of the Femoral Neck System (FNS) even in resource-limited settings where advanced arthroplasty options may not be readily available. Comparable findings have been reported by other authors. He et al. (2021) [12], documented a mean operative duration of 49.94 minutes consistent with the present study's observations.

Despite these encouraging outcomes, certain limitations of the study should be acknowledged. The relatively small sample size limits the generalizability of the results and the ability to detect less frequent complications. Additionally, the follow-up period of up to 6 months, though sufficient to assess union and early functional outcomes, may not be long enough to evaluate late complications such as avascular necrosis or post-traumatic arthritis. The absence of a control group treated with conventional implants such as DHS or CCS precludes direct comparative analysis of relative efficacy. Furthermore, detailed assessment of reduction quality and fracture orientation (e.g., Pauwels angle) was not incorporated, though these parameters are known to influence the mechanical environment and healing potential.

Nevertheless, the findings from this study provide meaningful clinical insights. The FNS appears to combine the strengths of dynamic compression and fixed-angle stability, achieving predictable union and excellent function with minimal morbidity. These outcomes underscore its potential as a preferred implant for femoral neck fractures, particularly in young and middle-aged adults where preservation of the native hip joint is paramount. Early rehabilitation and weight-bearing, made possible by stable fixation, contribute to faster functional recovery and reduced postoperative complications.

Conclusion

Fixation of femoral neck fractures with the Femoral Neck System in our series yielded high rates of union,

excellent functional results, minimal complications, and negligible femoral neck shortening. These findings corroborate the growing evidence that FNS is a reliable and biomechanically superior alternative to traditional fixation methods for intracapsular fractures of the femoral neck. However, larger multicentric randomized trials with longer follow-up are warranted to confirm these results and further define the indications, cost-effectiveness, and long-term durability of this novel implant.

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