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Functional Outcome of Neck of Femur Fractures Treated with the Femoral Neck System: A Prospective Clinical Study A Prospective Study

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ABSTRACT

Background: Femoral neck fractures in young adults are challenging due to the risk of avascular necrosis, non-union, and compromised hip function. The Femoral Neck System (FNS) is a newer implant designed to provide angular and rotational stability, potentially improving outcomes compared to traditional fixation methods.
Objective: To evaluate the functional and radiological outcomes of femoral neck fractures treated with FNS and to assess factors influencing clinical results.
Methods: This prospective clinical study was conducted at the Department of Orthopaedics, Shri B.M. Patil Medical College, Vijayapura, Karnataka, India, from March 2024 to December 2025. Thirty patients aged 18–60 years with fracture neck of femur were included. Preoperative assessment included clinical evaluation, laboratory investigations, and radiographs with Garden and Pauwels classification. All patients underwent FNS fixation and were followed at 6 weeks, 3 months, and 6 months. Functional outcomes were assessed using Harris Hip Score (HHS) and Visual Analog Scale (VAS) for pain. Radiological evaluation included fracture union and femoral neck shortening. Complications and reoperation rates were documented.
Results: The mean age was 39.90 ± 8.19 years; 60% were male. Road traffic accidents accounted for 70% of injuries. At 6 months, mean HHS improved from 64.03 to 87.67, and VAS pain decreased from 3.80 to 1.07 ($p < 0.001$). Functional outcome was excellent in 53.3%, good in 33.3%, and fair in 13.3%. Fracture union was achieved in 96.7% of patients with mean time to union of 14.31 ± 2.14 weeks. Mean femoral neck shortening was 2.51 ± 0.90 mm. Complications occurred in 10% of patients, including one case each of AVN, screw cut-out, and non-union. Reoperation was required in 10%. Age and mode of injury significantly influenced functional outcomes ($p = 0.001$).
Conclusion: FNS provides stable fixation, high union rates, minimal complications, and excellent functional recovery in femoral neck fractures of young adults. It is an effective alternative to traditional fixation methods, allowing early mobilization and improved hip function.

Keywords*: Femoral neck fracture, Femoral Neck System, Harris Hip Score, Internal fixation, Functional outcome, Avascular necrosis.*

INTRODUCTION

Fractures of the neck of femur are a significant concern in orthopaedic practice because they can lead to substantial morbidity, functional impairment, and socioeconomic impact. While commonly seen in the elderly after low-energy falls,

femoral neck fractures in younger adults typically result from high-energy trauma, such as road traffic accidents or falls from height (1). Preservation of the femoral head is critical in younger patients, making internal fixation the preferred treatment modality (2).

The anatomical and vascular characteristics of the femoral neck contribute to the complexity of these fractures. The femoral head receives its main blood supply from the medial femoral circumflex artery, and disruption can lead to avascular necrosis (AVN) and non-union (3). Biomechanically, vertical fracture patterns, as described by Pauwels, are unstable and subjected to high shear forces, increasing the risk of fixation failure (4).

Traditionally, cannulated cancellous screws (CCS) and dynamic hip screws (DHS) have been used for fixation. Although effective in many cases, these implants are associated with rotational instability, femoral neck shortening, and higher rates of mechanical failure, sometimes necessitating revision surgery (5,6).

The Femoral Neck System (FNS) is a newer implant designed to provide angular stability and rotational control through a fixed-angle construct and anti-rotation screw. Biomechanical studies have demonstrated that FNS offers superior resistance to shear and rotational forces compared to conventional implants (7,8). Clinically, it allows minimally invasive insertion, shorter operative time, and early mobilization, potentially improving functional outcomes and reducing complications (9).

Despite promising biomechanical and early clinical results, prospective clinical data on FNS, particularly in the Indian population, remain limited. This study was undertaken to evaluate the functional and radiological outcomes of femoral neck fractures treated with FNS and to assess factors influencing clinical success.

MATERIALS AND METHODS

Study Design and Setting

This prospective clinical study was conducted in the Department of Orthopaedics at B.L.D.E. (Deemed to be University), Shri B.M. Patil Medical College, Hospital and Research Centre, Vijayapura, Karnataka, India, over a period from March 2024 to December 2025.

Work Plan

The study was executed in phases:

- March–August 2024 (5–10%): Problem identification, literature review, and preparation of data collection tools.
- September 2024–June 2025 (up to 80%): Pilot study, validation of tools, and patient recruitment with data collection.
- July–September 2025 (5–10%): Data analysis and interpretation.
- October–December 2025 (5–10%): Dissertation writing and submission.

Sample Size

The sample size was calculated based on a previously reported mean femoral neck shortening of 2.40 ± 1.81 mm, with 95% confidence level and precision of 0.7. The minimum required sample size was 30 patients, which was considered adequate to evaluate functional outcomes and detect clinically significant differences.

Inclusion Criteria

- Patients aged ≥18 years and <60 years
- Clinically and radiologically confirmed fracture neck of femur

Exclusion Criteria

- Pathological fractures
- Open fractures
- Polytrauma patients
- Previous surgery at the same site
- Associated neurovascular injury

Patient Selection and Ethical Considerations

All eligible patients presenting to the emergency or outpatient department were screened. Ethical clearance was obtained from the Institutional Ethics Committee, and the study adhered to the Declaration of Helsinki and Good Clinical Practice guidelines. Written informed consent was obtained from all participants prior to enrollment.

Preoperative Assessment

A detailed clinical evaluation including history, mechanism of injury, comorbidities, and physical examination was performed. Baseline investigations included CBC, RFT, LFT, blood sugar, coagulation profile, viral markers (HIV, HBsAg, HCV), ECG, 2D echocardiography, and chest radiography.

Radiological evaluation included anteroposterior radiographs of the pelvis with both hips. Fractures were classified using Garden's classification and Pauwels classification.

Preoperative Preparation
Patients received analgesics and limb immobilization with skin traction or pillow support. Medical comorbidities were optimized prior to surgery. Prophylactic antibiotics were administered 1 hour before surgery. Surgical planning and implant templating were performed using preoperative radiographs.

Surgical Procedure
All surgeries were performed by experienced orthopaedic surgeons using a standardised technique. Patients were positioned supine on a fracture table. Closed reduction was achieved under fluoroscopic guidance.

A lateral approach to the proximal femur was used. After insertion of a guidewire into the femoral head, sequential reaming was performed, followed by insertion of the femoral neck system (FNS) implant. An anti-rotation screw was placed, and a lateral locking plate was fixed. Implant position and fracture reduction were confirmed using fluoroscopy. Intraoperative parameters such as duration of surgery, blood loss, and fluoroscopy time were recorded.

Postoperative Management
Postoperatively, patients received analgesics and antibiotics for 48–72 hours. Thromboprophylaxis with low molecular weight heparin was initiated. Early mobilisation with quadriceps and ankle exercises was encouraged.

Partial weight-bearing was started within the first week, progressing to full weight-bearing based on clinical and radiological healing. Sutures were removed at 12–14 days.

Follow-up Protocol
Patients were followed at 6 weeks, 3 months, and 6 months postoperatively. Each visit included clinical and radiological evaluation.

Outcome Measures
Functional and clinical outcomes were assessed using:

- Harris Hip Score (HHS) for hip function
- Visual Analog Scale (VAS) for pain

Radiological assessment included fracture union, defined as bridging callus across at least three cortices with painless weight-bearing. Complications such as avascular necrosis, non-union, malunion, implant failure, and femoral neck shortening were recorded.

Assessment of Complications and Revision Rate
Both early (infection, DVT) and late complications (AVN, non-union, implant failure) were documented. Revision surgery rates and indications were analyzed.

Data Collection and Management
Data were recorded using a structured case record form and entered into Microsoft Excel. Patient confidentiality was maintained using anonymized identifiers.

Statistical Analysis
Statistical analysis was performed using SPSS software. Continuous variables were expressed as mean ± standard deviation, and categorical variables as frequencies and percentages.

Normality was assessed using Shapiro-Wilk/Kolmogorov-Smirnov tests. Appropriate parametric or non-parametric tests were applied. Repeated measures ANOVA or the Friedman test was used for longitudinal comparisons.

Correlation analysis was performed to assess associations between variables. A p-value <0.05 was considered statistically significant. Kaplan-Meier analysis was used to assess implant survival.

RESULTS AND OBSERVATIONS

The present study was conducted in the department of Orthopaedics at Shri B.M Patil's Medical College, Hospital and Research centre, Vijayapura from March 2024 to December 2025 to study functional outcome of neck of femur fractures treated with femur neck system. Total of 30 patients were considered for the study

TABLE: 1 AGE AND GENDER DISTRIBUTION (N = 30)

Variable	Category	N	%
Age Group	20–40 years	18	60.0%
	41–60 years	12	40.0%
	Total	30	100.0%
Gender	Male	18	60.0%
	Female	12	40.0%
	Total	30	100.0%

Mean Age ± SD: 39.90 ± 8.19 years

TABLE: 2 CLINICAL AND FRACTURE CHARACTERISTICS (N = 30)

Variable	Category	N	%
Side of Injury	Right	16	53.3%
	Left	14	46.7%
	Total	30	100.0%
Mode of Injury	Road Traffic Accident (RTA)	21	70.0%
	Fall from Height	9	30.0%
	Total	30	100.0%
Garden Classification	Garden I	7	23.3%
	Garden II	17	56.7%
	Garden III	4	13.3%
	Garden IV	2	6.7%
	Total	30	100.0%
Pauwels Classification	Type I	13	43.3%
	Type II	12	40.0%
	Type III	5	16.7%
	Total	30	100.0%

TABLE:3 COMORBIDITIES, SURGICAL AND RADIOLOGICAL PARAMETERS (N = 30)

Variable	Category / Parameter	N / Mean ± SD	%
Comorbidities	None	14	46.7%
	Hypertension	8	26.7%
	Diabetes Mellitus	3	10.0%
	HTN & DM	4	13.3%
	Multiple (HTN, DM)	1	3.3%
	Total	30	100.0%
Surgical Parameters	Surgery Duration (minutes)	45.17 ± 5.80	—
	Hospital Stay (days)	5.70 ± 1.32	—
Radiological Parameters	Tip-Apex Distance (mm)	21.43 ± 2.17	—
	Parker Ratio (AP View)	44.19 ± 2.47	—
	Parker Ratio (Lateral View)	48.19 ± 2.47	—
	Fluoroscopy Time (seconds)	46.67 ± 7.35	—

TABLE: 4 POSTOPERATIVE AND FUNCTIONAL OUTCOMES (N = 30)

Variable	Category / Time Point	N / Mean ± SD	%	p-value
Weight-Bearing Status	Full Weight Bearing	2	6.7%	—
	Partial Weight Bearing	23	76.7%	—
	Non-Weight Bearing	5	16.7%	—
	Total	30	100.0%	—
VAS Pain Score	6 weeks	3.80 ± 0.85	—	—
	3 months	2.07 ± 0.83	—	<0.001*
	6 months	1.07 ± 0.83	—	<0.001*
Harris Hip Score (HHS)	6 weeks	64.03 ± 6.64	—	—
	3 months	77.67 ± 7.00	—	<0.001*
	6 months	87.67 ± 7.00	—	<0.001*
Functional Outcome (6 months)	Excellent	16	53.3%	—
	Good	10	33.3%	—
	Fair	4	13.3%	—
	Total	30	100.0%	—

*Statistically significant ($p < 0.05$)

TABLE: 5 UNION, HEALING, COMPLICATIONS AND REOPERATION OUTCOMES (N = 30)

Variable	Category / Time Point	N / Mean ± SD	%
Union Status	**6 Weeks** – No Union	30	100.0%
	3 Months – No Union	1	3.3%
	3 Months – Partial Union	9	30.0%
	3 Months – Complete Union	20	66.7%
	6 Months – No Union	1	3.3%
	6 Months – Complete Union	29	96.7%
Healing Parameters	Time to Union (weeks)	14.31 ± 2.14 (n=29)	—
	Femoral Neck Shortening (mm)	2.51 ± 0.90	—
Complications	No Complications	27	90.0%
	Avascular Necrosis (AVN)	1	3.3%
	Screw Cut-out	1	3.3%
	Non-union	1	3.3%
	Total	30	100.0%
Reoperation	Required	3	10.0%
	Not Required	27	90.0%
	Type: Total Hip Arthroplasty	3	10.0%
Infection	No	30	100.0%
DVT	No	30	100.0%

TABLE:6 RANGE OF MOTION AND FACTORS ASSOCIATED WITH FUNCTIONAL OUTCOME (N = 30)

Variable	Category / Parameter	Mean ± SD / N (%)	p-value
Range of Motion (6 months)	Flexion (degrees)	120.27 ± 15.59	—
	Abduction (degrees)	34.00 ± 6.48	—
	Adduction (degrees)	21.13 ± 5.78	—
	External Rotation (degrees)	30.10 ± 8.10	—
	Internal Rotation (degrees)	24.33 ± 7.67	—
Age vs Functional Outcome	20–40 yrs – Excellent	14 (87.5%)	
	20–40 yrs – Good	4 (40.0%)	
	20–40 yrs – Fair	0 (0.0%)	
	41–60 yrs – Excellent	2 (12.5%)	
	41–60 yrs – Good	6 (60.0%)	
	41–60 yrs – Fair	4 (100.0%)	**0.001***
Mode of Injury vs Outcome	Fall – Excellent	1 (6.2%)	
	Fall – Good	7 (70.0%)	
	Fall – Fair	1 (25.0%)	
	RTA – Excellent	15 (93.8%)	
	RTA – Good	3 (30.0%)	
	RTA – Fair	3 (75.0%)	**0.001***

*Statistically significant ($p < 0.05$)

TABLE:7 ASSOCIATION OF FRACTURE CLASSIFICATION WITH FUNCTIONAL OUTCOME (N = 30)

Variable	Category	Excellent N (%)	Good N (%)	Fair N (%)	p-value
Garden Classification	Garden I	4 (25.0%)	2 (20.0%)	1 (25.0%)	
	Garden II	9 (56.2%)	5 (50.0%)	3 (75.0%)	
	Garden III	1 (6.2%)	3 (30.0%)	0 (0.0%)	
	Garden IV	2 (12.5%)	0 (0.0%)	0 (0.0%)	**0.709**
Pauwels Classification	Type I	6 (37.5%)	4 (40.0%)	3 (75.0%)	
	Type II	7 (43.8%)	4 (40.0%)	1 (25.0%)	
	Type III	3 (18.8%)	2 (20.0%)	0 (0.0%)	**0.824**

DISCUSSION

The present study assessed 30 patients with femoral neck fractures treated with the Femoral Neck System (FNS). The mean age was 39.90 ± 8.19 years, with the majority (60%) in the 20–40 years age group, consistent with previous reports showing high-energy trauma as the main mechanism in younger adults (2,5). Male predominance (60%) and the high frequency of road traffic accidents (70%) reflect exposure and risk patterns in this population.

Most fractures were Garden type II (56.7%) and Pauwels type I (43.3%), representing relatively stable patterns. Similar distributions have been reported in other internal fixation studies (6,7).

Surgical parameters in this study were favorable, with a mean operative time of 45.17 minutes and hospital stay of 5.70 days, reflecting the minimally invasive nature of FNS (9). Radiological parameters such as tip-apex distance and Parker ratios were within acceptable limits, indicating accurate implant placement, which is essential to reduce mechanical failure (6).

Functional outcomes improved significantly over time. The mean Harris Hip Score increased from 64.03 at 6 weeks to 87.67 at 6 months, while VAS pain scores decreased from 3.80 to 1.07 ($p < 0.001$). At final follow-up, 53.3% of patients had excellent outcomes and 33.3% had good outcomes. These results align with previous reports on FNS, demonstrating its capacity to provide stable fixation and facilitate early rehabilitation (8,9).

Fracture union was achieved in 96.7% of patients by 6 months, with a mean union time of 14.31 weeks, comparable to other studies. Femoral neck shortening was minimal (2.51 mm), which is clinically significant as excessive shortening negatively affects hip biomechanics. The angular and rotational stability of FNS likely contributed to these favorable outcomes (7,8).

Complications were low: one case each of AVN, screw cut-out, and non-union. AVN incidence (3.3%) is lower than historically reported rates of 5–20% with conventional fixation (3,5). Reoperation was required in 10% of patients, all undergoing total hip arthroplasty. No infections or deep vein thrombosis were observed, indicating effective perioperative management.

Factors affecting functional outcome included age and mode of injury, both showing significant associations ($p = 0.001$). Younger patients achieved better outcomes, likely due to superior bone quality and healing potential. Fracture classification (Garden and Pauwels) did not significantly affect outcomes, suggesting that FNS can achieve satisfactory results even in less favorable fracture patterns (8).

Range of motion at 6 months was satisfactory, with mean hip flexion of 120°, indicating effective rehabilitation. Compared to conventional implants (CCS, DHS), FNS provides superior biomechanical stability, minimizes femoral neck shortening, and improves functional outcomes while reducing complications (7,8).

Limitations of this study include a small sample size, short follow-up duration, and absence of a control group, which may limit generalizability and detection of late complications such as AVN.

CONCLUSION

The Femoral Neck System is a reliable and effective implant for managing femoral neck fractures in young adults. It provides stable fixation, allows early mobilization, achieves high union rates, and results in favourable functional outcomes with minimal complications. Age and mode of injury significantly influence outcomes, while fracture classification may have a lesser effect when stable fixation is achieved. FNS represents a valuable alternative to traditional fixation methods such as cannulated screws or dynamic hip screws, offering biomechanical advantages that translate into improved patient recovery.

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