

Original Research Article

Outcome of femoral neck system for the management of femoral neck fractures

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ABSTRACT

Background: Femoral neck fractures present significant challenges in orthopedic practice, necessitating effective surgical interventions for optimal recovery. This study aims to evaluate the outcomes of femoral neck fracture fixation using the femoral neck system (FNS).

Methods: This quasi-experimental study at National Institute of Traumatology and Orthopedic Rehabilitation (NITOR), Dhaka, Bangladesh, from March 2022 to September 2024 included 45 patients with femoral neck fractures. Patients aged 18-65 years with fractures within 14 days were treated using the FNS after preoperative assessment and prophylactic antibiotics. Postop care involved exercises, progressive weight-bearing, radiographic follow-up, and Harris hip score (HHS) evaluation. Data were analyzed using SPSS 26; ethical approval and informed consent were obtained.

Results: In 45 patients undergoing femoral neck fixation with FNS, mean age was 41.8±9.3 years, with 78% males. Road traffic accidents caused 60% of fractures; 53% involved the right femur. Surgery occurred at 4.6±1.8 days post-injury, with a mean hospital stay of 9.6±1.8 days. At final follow-up, 62% reported slight pain, 80% had no limping, and 13% experienced complications. Radiological union was achieved in 96% at 13.3±1.6 weeks. Mean HHS was 86.1±8.8, with 85% showing excellent or good functional outcomes.

Conclusions: FNS fixation of femoral neck fractures is a safe and effective approach, yielding high rates of healing, functional recovery, and minimal complications.

Keywords: Femoral neck, Fracture fixation, Femoral neck system

INTRODUCTION

Femoral neck fractures (FNFs) are a prevalent injury in orthopedics, often accompanied by numerous complications, poor prognosis, and a significant economic impact. They predominantly affect older adults, typically resulting from low-energy trauma, while being rare in younger individuals where they primarily arise from high-

velocity trauma.^{1,2} FNFs represent the most frequently occurring type of clinical fracture, constituting approximately 3.6% of all systemic fractures and 57% of hip fractures.³

Demographic trends indicate an increasing elderly population, correlating with a rise in fragility fractures among geriatric patients. Hip fractures in this population are associated with chronic comorbidities, elevated

perioperative risk, and a reported 6-11% mortality rate within the first 30 days following trauma.⁴ These challenges underscore the difficulty in determining the optimal treatment strategy for FNFs, particularly in older adults.

Current internal fixation techniques include hollow compression screws, dynamic hip screws, compression plates, and novel compression locking nail plate systems. However, complications such as loosening of fixation devices, nail backouts, and inadequate anti-rotation stability remain issues, prompting ongoing debate over the most effective internal fixation method.⁵ Cannulated screws (CS) are widely used due to minimal soft tissue damage, low blood loss, and reliable fixation. Nonetheless, they demonstrate poor stability in unstable fractures, with postoperative complication rates estimated at approximately 46.7%.⁶ Traditional fixation with three 7.5-mm cannulated screws compresses fracture ends to achieve anatomical reduction and union but may fail in partially unstable FNFs, particularly under vertical shear forces or increased fracture angles, increasing the risk of fixation failure.⁷

An ideal implant should provide adequate stability while minimizing femoral neck shortening and preventing femoral head tilting or rotation. The recently developed FNS, introduced in 2018, offers dynamic fixation, angular stability, anti-rotation, and minimally invasive surgery. Its design includes a plate with locking nails and a 10 mm bolt with an anti-rotation screw that allows relative movement between fracture ends.² Biomechanical studies demonstrate that FNS resists varus deformation, dorsal tilting of the femoral head, and rotational displacement, providing superior stability compared to traditional CS in unstable FNFs.⁸ Multiple clinical studies and meta-analyses report FNS complication rates between 9.2% and 13.3%.⁹

The primary goal of this study is to evaluate the effectiveness of FNS in managing femoral neck fractures, with particular focus on fracture healing, functional outcomes, and complication rates. Additionally, short-term comparisons of FNS with other fixation methods, including MCS and DHS, are considered in younger patient populations.¹⁰

Objectives

Objectives were to evaluate the outcomes associated with the fixation of femoral neck fractures using the FNS.

METHODS

This quasi-experimental study was conducted at the NITOR, Dhaka, Bangladesh, from March 2022 to September 2024. A total of 45 patients with femoral neck fractures were included, selected using purposive sampling based on specific inclusion and exclusion

criteria, to evaluate outcomes of fracture fixation using the FNS.

Inclusion criteria

Patients aged 18-65 years with fracture of the femoral neck and fracture occurring within 14 days of injury were included in the study.

Exclusion criteria

Fracture of the femoral neck associated with hip dislocation, pathological fractures, unstable medical conditions significantly increasing morbidity or mortality and associated pelvic or acetabular fractures were excluded from the study.

Independent variables included age, gender, cause of fracture, affected side, fracture type, and time from injury to operation, while dependent variables were radiological union, functional status (HHS), and postoperative complications. Preoperative assessment involved detailed history-taking, clinical examination, initial resuscitation according to ATLS guidelines, and standard anterior-posterior and lateral hip X-rays. Surface traction was applied for immobilization, and routine investigations were conducted for anesthesia clearance. Written informed consent was obtained from all patients.

All patients received a prophylactic dose of Cefuroxime one hour before surgery. Fracture fixation was performed using the FNS. Postoperatively, patients were monitored in the recovery room and initiated on isometric quadriceps exercises 24 hours after surgery as tolerated. Discharge typically occurred on the 3rd or 4th postoperative day with instructions for continued exercises, active hip, knee, and ankle movements, non-weight-bearing ambulation with crutches, and scheduled follow-up visits at 2, 6, 12 weeks, and 6 months. Radiographs at each visit assessed fracture alignment, length, rotation, and union, while weight-bearing was gradually progressed from non-weight-bearing to partial and then full based on radiological evaluation. Functional outcomes were assessed using the HHS.

Data were collected using a pretested structured questionnaire documenting history, examination, investigations, intraoperative and postoperative findings, complications, and follow-up outcomes. Statistical analysis was performed using SPSS version 26, with categorical variables expressed as frequencies and percentages, continuous variables as mean±SD and range, Student's t-test for continuous variables, and Chi-square test for qualitative variables; p values <0.05 were considered statistically significant. Ethical approval was obtained from the institutional review board of NITOR, and written informed consent was obtained from all participants, with confidentiality and voluntary participation maintained throughout the study.

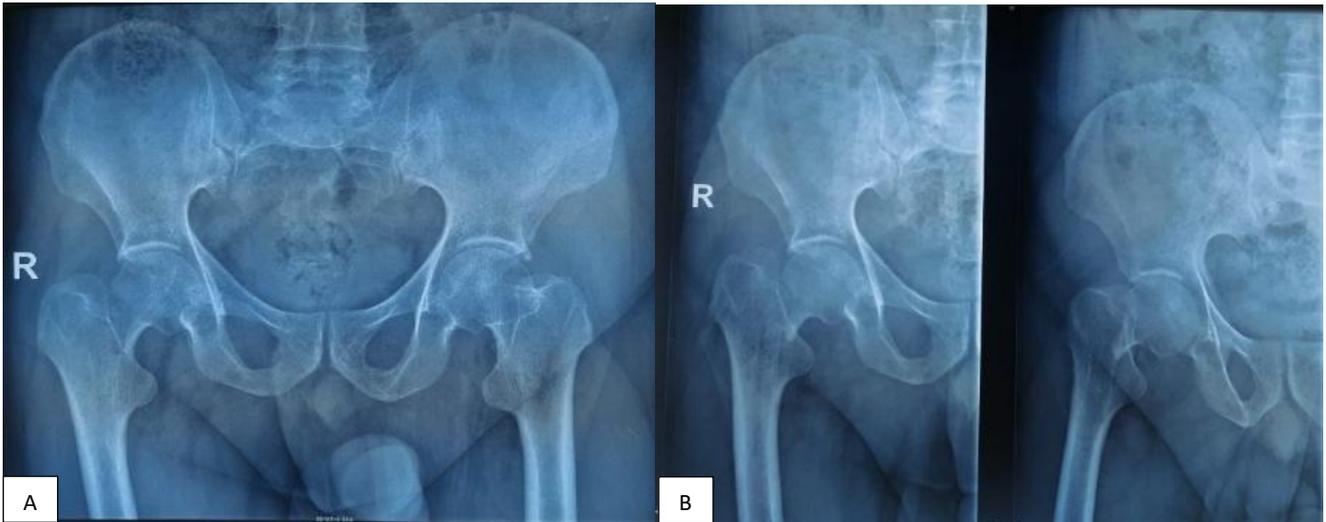


Figure 1 (A and B): Preoperative radiographs of displaced femoral neck fracture prior to FNS fixation.



Figure 2 (A and B): Immediate postoperative radiographs demonstrating stabilization with FNS implant.



Figure 3 (A and B): A-Follow-up radiographs at 12 weeks. B-Follow-up radiographs at 6th month.

RESULTS

Table 1 shows the baseline characteristics of the study participants. The majority of patients belonged to the 28-38 years age group (n=19, 42.0%), followed by those aged 39-49 years and 50-60 years (n=13, 28.9% each), while no patients were observed in the 18-27 years or 61-65 years age groups. The mean age was 41.76±9.29 years, ranging from 28-60 years. Male patients predominated, accounting for 35 cases (77.8%), whereas 10 patients (22.2%) were female, resulting in male to female ratio of 3.5:1. Regarding occupational status, most participants service holders (44.4%), followed by businessmen (22.2%), housewives (22.2%), farmers (8.9%), and one film director (2.2%). Road traffic accidents were the most common mechanism of injury (60.0%), while 40.0% of fractures resulted from falls from height. The right femur was involved in 53.3% of cases, whereas 46.7% involved left femur.

Table 2 shows distribution of study participants according to the time interval between injury and operation and the duration of hospital stay. The mean time interval between injury and surgery was 4.6±1.84 days, ranging from 1 to 9 days, with the majority of patients (n=27, 60.0%) operated on within 4-6 days, followed by 13 patients (28.9%) within 1-3 days and 5 patients (11.1%) between 7-9 days. Regarding the duration of hospital stay, the mean stay was 9.6±1.84 days, ranging from 6 to 14 days. Most patients (n=27, 60.0%) remained hospitalized for 9-11 days, followed by 13 patients (28.9%) who stayed for 6-8 days, while 5 patients (11.1%) had a hospital stay of the 12-14 days.

Table 3 shows the distribution of the study participants according to postoperative pain and limping at final

follow-up. Most patients, 28 (62.0%), reported slight pain, while 16 patients (36.0%) had no pain, and only 1 patient (2.0%) experienced mild pain. No patients reported moderate or severe pain. Regarding postoperative limping, the majority of patients, 36 (80.0%), had no limping, 3 patients (7.0%) had slight limping, and six patients (13.0%) had moderate limping. No patients had severe limping.

Table 4 shows the distribution of the study participants according to postoperative complications and their specific patterns. The majority of patients, 39 (86.7%), had no complications, while 6 patients (13.3%) experienced complications. Among the complications, superficial surgical site infection (SSI) was the most common, occurring in 3 patients (6.7%), followed by avascular necrosis (AVN) in 2 patients (4.4%) and broken guidewire in 1 patient (2.2%).

Table 5 shows the distribution of the study participants according to radiological union and time to union of femoral neck fractures. The majority of patients, 43 (95.6%), achieved radiological union, while 2 patients (4.4%) did not unite. Regarding the time to union, most patients, 22 (48.9%), achieved union by 12 weeks, followed by 13 patients (28.9%) at 14 weeks and 8 patients (17.8%) at 16 weeks. The mean time to union was 13.34±1.56 weeks.

Table 6 shows the distribution of the study participants according to HHS at final follow-up. Most patients, 20 (44.4%), had scores in the 80-89 range, followed by 18 patients (40.0%) with scores >90, indicating good to excellent hip function. 5 patients (11.1%) scored 70-79, and only 2 patients (4.4%) had scores <70. The mean HHS was 86.09±8.79.

Table 1: Baseline characteristics of the study participants, (n=45).

Variables	N	Percentage (%)
Age group (in years)	18-27	0
	28-38	19
	39-49	13
	50-60	13
	61-65	0
	Mean±SD	41.76±9.29
Sex	Male	35
	Female	10
Occupational status	Service holder	20
	Businessman	10
	Housewife	10
	Farmer	4
	Film director	1
Mechanism of injury	Road traffic accident	27
	Fall from height	18
Side of fracture	Right femur	24
	Left femur	21

Table 2: Distribution of the study participants by time to surgery and hospital stay, (n=45).

Variables	N	Percentage (%)
Time interval between injury to operation (days)	01-03	28.9
	04-06	60
	07-09	11.1
	Mean±SD	4.6±1.84
	Range	1-9
Duration of hospital stay (days)	06-08	28.9
	09-11	60
	12-14	11.1
	Mean±SD	9.6±1.84
	Range	6-14

Table 3: Postoperative pain and limping status at final follow-up, (n=45).

Variables	N	Percentage (%)
Postoperative pain	No pain	36.0
	Slight	62.0
	Mild	2.0
	Moderate	0.0
	Severe	0.0
Postoperative limping	None	80.0
	Slight	7.0
	Moderate	13.0
	Severe	0.0

Table 4: Distribution of the study participants by complications, (n=45).

Variables	N	Percentage (%)
Overall complications	Complication	13.3
	No complication	86.7
Pattern of complications	Superficial surgical site infection	6.7
	AVN	4.4
	Broken guidewire	2.2

Table 5: Distribution of the study participants by radiological union of FNS, (n=45).

Variables	N	Percentage (%)
Radiological union	Not united	4.4
	United	95.6
Time to union (weeks)	12	48.9
	14	28.9
	16	17.8
	Mean±SD	13.34±1.56

Table 6: Distribution of the study participants according to HHS, (n=45).

HHS	N	Percentage (%)
<70	2	4.4
70-79	5	11.1
80-89	20	44.4
>90	18	40.0
Mean±SD	86.09±8.79	

Figure 1 shows distribution of study participants according to the functional outcome following FNS fixation. Most patients, 20 (45%), had good functional outcome, followed

by 18 patients (40.0%) with an excellent outcome. Five patients (11.0%) had a fair outcome, while only 2 patients (4.0%) experienced a poor functional outcome.



Figure 4: Distribution of the study participants according to functional outcome of FNS, (n=45).

DISCUSSION

This study was conducted at NITOR from March 2022 to September 2024 to evaluate the outcomes of femoral neck fracture fixation using the FNS. A total of 45 patients were prospectively assessed for functional outcomes and quality of life following osteosynthesis, with the aim of identifying patient and operative factors influencing results.

Among the 45 patients, the largest proportion, 19 (42%), were aged 28-38 years, followed by 13 patients (28.9%) each in the 39-49 and 50-60 years age groups, while no patients were observed in the 18-27 or 61-65 years groups. The mean age was 41.76 ± 9.29 years (range 28-60), indicating a relatively young cohort. This aligns closely with Wang et al who reported a mean age of 41.83 ± 13.16 years and Kale et al with 44.12 ± 2 years, whereas Mehraj et al reported a slightly older population (mean 47.5 years).¹¹⁻¹³ In contrast, Stassen et al and Davidson et al studied significantly older populations with mean ages of 63 and 62.9 years, respectively.^{14,15} Zhang et al also presented a mean age of 57.61 ± 11.87 years, highlighting variations across different study populations.⁸

Male patients predominated in our study, with 35 (77.8%) males and 10 (22.2%) females, resulting in a male-to-female ratio of 3.5:1. Similar male predominance was observed by Mehraj et al (86.6%), Wang et al and Zhang et al (66.67%).^{8,11,13} Conversely, Stassen et al and Kale et al reported higher female representation, and Davidson et al observed a nearly equal gender distribution, indicating variability across populations.^{12,14,15}

Road traffic accidents were the most common mechanism of injury (27 patients, 60%), with falls from height accounting for 18 cases (40%). Right-sided fractures were slightly more common (24 patients, 53.3%) than left-sided (21 patients, 46.7%). These findings are consistent with

Wang et al, Tarrant et al, and Liang et al although variations in injury mechanism and side affected are noted across studies.^{11,16,17}

The mean interval from injury to surgery was 4.6 ± 1.84 days (range 1-9), with 27 patients (60%) operated on within 4-6 days. Kale et al reported surgery within 72 hours, while Liang et al and Zhang et al documented shorter intervals averaging 2.1 and 1.79 ± 0.86 days, respectively.^{8,12,17} Schuetze et al and Cinteau et al reported times in hours (13.5 ± 15.9 and 14.3 hours), indicating faster surgical intervention in those cohorts.^{4,18}

The mean hospital stay was 9.6 ± 1.84 days (range 6-14), with most patients (27, 60%) staying 9-11 days. Similar durations were reported by Mehraj et al (9.5 ± 4.2 days) and Cinteau et al (9.8 ± 3.8 days), while Wang et al observed slightly longer stays (11.09 ± 2.30 days), and Davidson et al shorter (5.7 ± 3.9 days).^{4,11,13,15}

At final follow-up, 28 patients (62%) reported slight pain, 16 (36%) no pain, and 1 (2%) mild pain, with no moderate or severe pain. Xu et al reported a mean VAS of 0.9 ± 1.1 , while Mehraj et al reported higher postoperative pain (3.24 ± 1.06).^{13,19} Fan et al observed ten patients with residual pain or dysfunction, and Yoon et al reported 9.1% of patients with persistent hip pain, highlighting variability in postoperative experiences.^{20,21}

Regarding limping, 36 patients (80%) had no limping, 3 (7%) slight, and 6 (13%) moderate, indicating generally positive gait outcomes. Yoon et al reported similar trends, with slightly higher limping incidence (13.6%).²¹

Most patients (39, 86.7%) experienced no complications, while 6 patients (13.3%) did. Superficial surgical site infection occurred in 3 patients (6.7%), AVN in 2 (4.4%), and a broken guidewire in 1 (2.2%). No nonunion cases were reported. Comparatively, Mehraj et al reported one nonunion and one femoral neck shortening, Davidson et al 8.8% complications, Schuetze et al 13.3% surgical complications, Caldaria et al documented femoral head necrosis and screw back out, and He et al 6.1% complications.^{5,13,15,18,23} Liang et al reported no AVN or nonunion, with mostly mild shortening.¹⁷ Overall, the majority of patients in our study fared well postoperatively, with a minority experiencing complications.

Radiological union was achieved in 43 patients (95.6%), with 2 patients (4.4%) not united. The majority, 22 patients (48.9%), united at 12 weeks, followed by 13 (28.9%) at 14 weeks and 8 (17.8%) at 16 weeks. The mean time to union was 13.34 ± 1.56 weeks. He et al reported 13.82 ± 1.59 weeks, Wang et al 17.09 ± 2.87 weeks, Chung et al 17.6 weeks (4.4 ± 0.9 months), and Liang et al 4.25 months, while Stoffel et al noted 68% union at 3 months, 90% at 6 months, and 98% at 12 months, demonstrating variability in union timelines.^{5,9,11,17,22}

The mean HHS was 86.09 ± 8.79 , with 20 patients (44.4%) scoring 80-89, 18 (40%) >90 , 5 (11.1%) 70-79, and 2 (4.4%) <70 , indicating good to excellent hip function. Comparable studies reported similar outcomes: Kale et al 89.6 ± 3.61 , Zhang et al 84.61 ± 3.42 , Stoffel et al 82, Caldaria et al 87.07 ± 11.77 , He et al 90.42 ± 4.82 , and Xu et al 89.2 ± 4.0 .^{5,8,9,12,19,23}

At final follow-up, 20 patients (45%) had a good functional outcome, 18 (40%) excellent, 5 (11%) fair, and 2 (4%) poor, resulting in a combined excellent and good rate of 85%. Wang et al reported 96.67% excellent/good, He et al 90.9%, and Xu et al similar trends, supporting the efficacy of FNS fixation in achieving positive functional recovery.^{5,11,19}

Limitations

The study had a few limitations: The outcome may be influenced by various types of fractures, which were not assessed in this study. The potential effects of rehabilitation were not assessed, which could impact the overall outcome. The absence of a control group hinders comparison with other treatments. A short follow-up period may miss long-term outcomes and complications.

CONCLUSION

This study demonstrates that the use of the FNS for fixation of femoral neck fractures yields favorable outcomes. The findings indicate that this surgical approach effectively promotes fracture healing and restores hip function, with a significant proportion of patients achieving excellent or good results, as measured by the HHS. Notably, the absence of poor outcomes among participants underscores the procedure's efficacy. The FNS represents a reliable and effective option for managing femoral neck fractures, offering high rates of successful recovery with minimal complications, making it a valuable choice for surgical fixation in these cases.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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