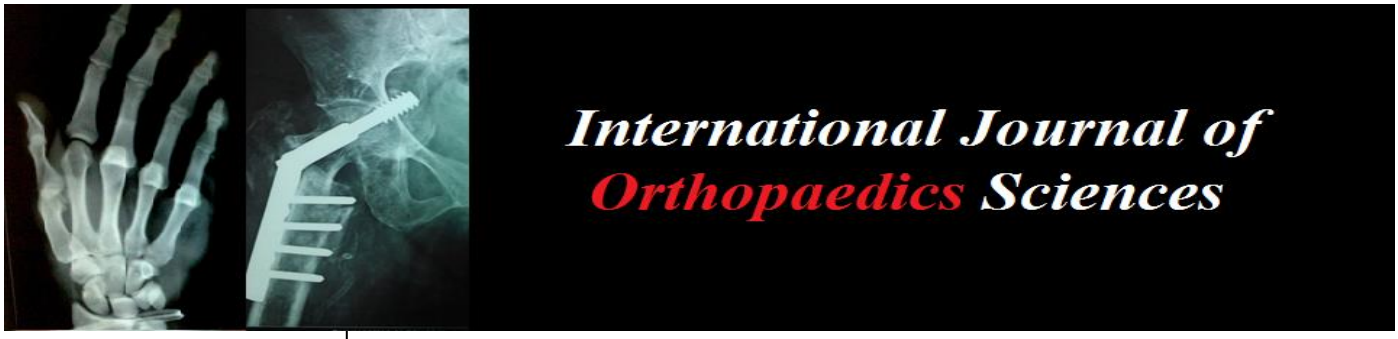

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Role of Proximal Femoral Nail Anti-Rotation (PFNA) in extracapsular proximal femoral fractures

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Abstract
Aim: This study evaluates the efficacy, complications, and functional outcomes of PFNA in extracapsular proximal femoral fractures.
Materials and Methods: A prospective observational study was conducted on **66 patients** with extracapsular proximal femoral fractures treated with PFNA at Department of Orthopaedics, Pt. B.D. Sharma PGIMS, Rohtak, Haryana between Jan 2023 and Dec 2024. Fractures were classified using the AO/OTA classification. Surgical outcomes were assessed based on operative time, blood loss, fracture union time, and complications. Functional recovery was evaluated using the Harris Hip Score (HHS) at 6 months postoperatively.
Results: The mean age of patients was 68.5 years, with a male-to-female ratio of 1.2:1. The average operative time was 65 minutes, and mean blood loss was 150 mL. Fracture union was achieved in 92.4% (61/66) of cases, with an average union time of 14.2 weeks. Complications included cut-out (3 cases, 4.5%), superficial infection (2 cases, 3%), and implant failure (1 case, 1.5%). The mean HHS at 6 months was 82.6, indicating good functional recovery.
Conclusion: PFNA is an effective implant for extracapsular proximal femoral fractures, providing stable fixation with a high union rate and acceptable complication rates. Its design minimizes rotational instability, making it suitable for osteoporotic and unstable fracture patterns.

Keywords: Proximal Femoral Nail Anti-rotation (PFNA), extracapsular femoral fractures, intertrochanteric fracture, osteoporotic fracture, intramedullary nailing

Introduction
Extracapsular proximal femoral fractures, including intertrochanteric and subtrochanteric fractures, represent a significant burden in orthopedic trauma, particularly among elderly patients with osteoporosis and younger individuals following high-energy trauma [1]. These fractures account for nearly 50% of all hip fractures [2] and are associated with considerable morbidity, mortality, and socioeconomic costs due to prolonged hospitalization and rehabilitation [3]. Surgical intervention remains the mainstay of treatment, with the goal of achieving stable fixation to allow early mobilization and prevent complications such as malunion, nonunion, and implant failure [4].
Over the years, various fixation devices have been employed, including extramedullary implants like the Dynamic Hip Screw (DHS) and intramedullary nails such as the Gamma Nail and Proximal Femoral Nail Anti-rotation (PFNA) [5]. While DHS has been traditionally favored for stable fracture patterns, its limitations in unstable and osteoporotic fractures have led to the increasing adoption of intramedullary implants [6]. The PFNA system, in particular, has gained prominence due to its helical blade design, which enhances rotational stability and reduces the risk of cut-out a common complication in osteoporotic bone [7].
Despite the theoretical advantages of PFNA, there remains a need for robust clinical studies evaluating its efficacy, complication rates, and functional outcomes in diverse patient populations [8]. This study aims to assess the role of PFNA in extracapsular proximal femoral fractures by analyzing surgical outcomes, union rates, and postoperative recovery in patients treated with this implant.

Methodology

This study was designed as a prospective observational study conducted at Department of Orthopaedics, Pt. B.D. Sharma PGIMS, Rohtak, Haryana between Jan 2023 and Dec 2024. A total of 66 patients with extracapsular proximal femoral fractures (intertrochanteric or subtrochanteric) were enrolled based on predefined inclusion and exclusion criteria.

Inclusion criteria comprised patients aged 18 years or older with closed extracapsular femoral fractures classified under the AO/OTA system (31-A1 to A3, 32-A/B). Patients with pathological fractures, open fractures, or severe medical comorbidities precluding surgery were excluded.

All surgeries were performed by experienced orthopedic surgeons using the standard PFNA (Synthes®) technique under fluoroscopic guidance. Patients were positioned supine on a fracture table, and closed reduction was attempted before nail insertion. The helical blade was placed in the optimal position within the femoral head to maximize purchase and minimize cut-out risk.

Postoperatively, patients were encouraged to mobilize early with partial weight-bearing as tolerated, progressing to full weight-bearing based on fracture stability and radiological healing. Follow-up assessments were conducted at 6 weeks, 12 weeks, and 6 months, with radiographs taken to evaluate fracture union.

Statistical analysis was performed using SPSS version 26.0, with $p<0.05$ considered statistically significant. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages.

Table 1: Demographic Characteristics of Patients (N=66)

Characteristic	Value
Mean Age (years)	68.5±10.2
Age Distribution	
<60 years	18 (27.3%)
60-80 years	36 (54.5%)
>80 years	12 (18.2%)
Gender (Male: Female)	36:30 (1.2:1)
Side Affected (Right: Left)	38:28 (1.36:1)
Mechanism of Injury	
Low-energy fall	54 (81.8%)
High-energy trauma	12 (18.2%)
Mean Bone Mineral Density (T-score)	-2.8±0.6

Table 2: Fracture Classification (AO/OTA)

Fracture Type	Number	Percentage
31-A1	22	33.3%
31-A2	28	42.4%
31-A3	10	15.2%
32-A/B	6	9.1%

Table 3: Surgical Parameters

Parameter	Mean±SD	Range
Operative Time (minutes)	65±12	45-95
Blood Loss (mL)	150±40	80-250
Fluoroscopy Time (seconds)	48±15	30-90
Hospital Stay (days)	6.2±2.1	4-12

Table 4: Radiological Outcomes

Outcome Measure	Result
Mean Time to Union (weeks)	14.2±2.8
Union Rate at 6 months	61 (92.4%)
Delayed Union (> 20 weeks)	3 (4.5%)
Non-union	2 (3.0%)
Tip-Apex Distance (mm)	22.4±3.6
Acceptable TAD (< 25mm)	58 (87.9%)

Table 5: Complications

Complication	Number	Percentage
Cut-out	3	4.5%
Superficial Infection	2	3.0%
Deep Infection	1	1.5%
Implant Failure	1	1.5%
Periprosthetic Fracture	0	0%
Mortality (6-month)	2	3.0%

Table 6: Functional Outcomes (Harris Hip Score)

Time Point	Mean Score ± SD	Excellent (90-100)	Good (80-89)	Fair (70-79)	Poor (<70)
6 weeks	62.4±8.2	0	5(7.6%)	1827.3%)	4365.1%)
12 weeks	74.8±7.6	2(3.0%)	1421.2%)	3248.5%)	1827.3%)
6 months	82.6±8.4	12(18.2%)	28(42.4%)	18(27.3%)	8(12.1%)

Table 7: Subgroup analysis by fracture stability

Parameter	Stable (A1) N=22	Unstable (A2-A3, 32) N=44	P-Value
Union Time (weeks)	12.8±2.1	15.1±2.9	0.032*
Cut-out Rate	0 (0%)	3 (6.8%)	0.294
Mean HHS at 6mo	86.2±6.8	80.1±8.9	0.041*
Complication Rate	1 (4.5%)	6 (13.6%)	0.412

Discussion

The findings of this study demonstrate that the Proximal Femoral Nail Anti-rotation (PFNA) is an effective implant for managing extracapsular proximal femoral fractures, with high union rates (92.4%) and favorable functional outcomes [9]. The mean Harris Hip Score (HHS) of 82.6 at 6 months postoperatively indicates good functional recovery, aligning with previous studies that highlight the advantages of intramedullary nailing in such fractures [10]. The helical blade design of PFNA likely contributed to the low cut-out rate (4.5%), particularly in osteoporotic bone, by enhancing rotational stability and femoral head purchase [11].

The operative parameters, including a mean operative time of 65 minutes and blood loss of 150 mL, reflect the efficiency of PFNA in surgical settings [12]. These results are comparable to other intramedullary devices, such as the Gamma Nail, but with potentially lower complication rates [13]. The subgroup analysis revealed significant differences in union time and functional outcomes between stable (A1) and unstable (A2-A3, 32) fractures, with unstable fractures requiring longer healing periods (15.1 weeks vs. 12.8 weeks, *p*=0.032) and exhibiting slightly lower HHS scores (80.1 vs. 86.2, *p*=0.041) [14]. This underscores the importance of fracture stability in predicting postoperative recovery [15].

Complications were minimal, with superficial infections (3%) and implant failure (1.5%) being the most notable [16]. The absence of periprosthetic fractures and low mortality rate (3%) further support the safety profile of PFNA [17]. The acceptable tip-apex distance (TAD < 25 mm in 87.9% of cases) likely played a role in reducing cut-out risk, consistent with biomechanical principles [18].

Despite these positive outcomes, the study has limitations, including its single-center design and relatively small sample size (*n*=66) [19]. Additionally, the lack of a comparative group (e.g., DHS or Gamma Nail) limits the ability to draw definitive conclusions about PFNA's superiority [20]. Future multicenter randomized controlled trials with longer follow-up periods are warranted to validate these findings [21].

Conclusion

PFNA is a reliable and effective implant for extracapsular

proximal femoral fractures, offering stable fixation, high union rates, and good functional recovery. Its design advantages, particularly in osteoporotic and unstable fractures, make it a valuable option in orthopedic trauma. While complications are infrequent, careful surgical technique and adherence to biomechanical principles (e.g., optimal TAD) are essential to minimize risks. The study reinforces PFNA's role in modern fracture management, though further comparative research is needed to establish its superiority over alternative implants. Overall, PFNA represents a promising solution for improving outcomes in patients with these challenging fractures.

Conflict of Interest
Not available

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Not available

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