Proximal Femoral Nail vs. Dynamic Condylar Screw in Unstable Intertrochanteric Fractures: A Randomized Comparative Study

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Abstract: ***Background**: Unstable intertrochanteric femoral fractures are common in the elderly and associated with significant morbidity. This study compares the clinical, radiological, and functional outcomes of Proximal Femoral Nail (PFN) and Dynamic Condylar Screw (DCS) fixation in managing these fractures. **Methods**: A prospective, randomized, controlled study was conducted in the Department of Orthopaedics, S.M.S. Medical College, Jaipur, from January to December 2024. Sixty adult patients (>18 years) with unstable intertrochanteric fractures were equally divided into two groups: Group A (DCS, n=30) and Group B (PFN, n=30). Both groups underwent standardized surgical and rehabilitation protocols. Functional outcomes were assessed using the Harris Hip Score (HHS) and radiological union by the Radiographic Union Score for Hip (RUSH) at 2 weeks, 6 weeks, 3 months, and 6 months. Operative parameters, complications, and union rates were statistically analyzed. **Results**: The mean age was 72.3 years, with comparable demographics between groups. PFN demonstrated significantly shorter operative time (64.8 ± 7.9 vs. 112.7 ± 11.1 min; p<0.001) and lower intraoperative blood loss (116.3 ± 36.1 vs. 281.6 ± 84.1 mL; p<0.001). Radiological and functional outcomes improved steadily in both groups, with PFN showing slightly higher mean RUSH (28.9 ± 2.05 vs. 27.5 ± 3.83) and HHS (83.7 ± 8.0 vs. 82.6 ± 9.8) at six months, though not statistically significant. Union rates were 90% for PFN and 80% for DCS (p=0.278). Complications, including implant failure and infection, were comparable. **Conclusion**: Both PFN and DCS provide satisfactory results; however, PFN offers notable intraoperative advantages with less blood loss, shorter surgery time, and a trend toward faster union, making it the preferred option for unstable intertrochanteric fractures in elderly patients.***

Keywords: Proximal femoral nail, Dynamic condylar screw, Intertrochanteric fracture, Harris Hip Score, RUSH score.

1. Introduction

Intertrochanteric fractures, a major subtype of proximal femoral fractures, occur in the region extending from the extracapsular portion of the femoral neck down to the area just inferior to the lesser trochanter.[1] These fractures are particularly prevalent among the geriatric population and are predominantly caused by low-energy trauma, most commonly falls from standing height in osteoporotic individuals. In younger patients, such fractures may result from high-energy trauma such as road traffic accidents or falls from height.[2] The incidence of intertrochanteric fractures is increasing at an alarming rate, especially in developing countries like India, where the elderly population is expanding rapidly.[3] According to recent global epidemiological projections, the total number of hip fractures- including intertrochanteric types- is expected to rise to 6.3 million cases annually by the year 2050.[4] This escalating trend reflects the cumulative impact of aging demographics, urbanization, increased life expectancy, and lifestyle changes, all of which collectively contribute to increased fall risk and bone fragility in older adults.[5]

Among all hip fractures, intertrochanteric fractures constitute nearly 50% and pose significant management challenges, especially when classified as unstable.[6] These unstable fractures, defined by various radiological and intraoperative criteria, typically exhibit posteromedial comminution, fracture line reversal (reverse obliquity), subtrochanteric extension, lateral wall disruption, or involvement of the lesser or greater trochanters.[7] The presence of these features compromises the structural integrity of the proximal femur and increases the risk of implant failure, non-union, and varus collapse.[8] In particular, the lateral wall of the femur plays a pivotal biomechanical role by acting as a buttress for the proximal fragment; any disruption of this wall results in loss of stability, particularly when using extramedullary fixation devices. Therefore, preservation or reconstruction of the lateral wall is considered critical during surgical fixation of unstable intertrochanteric fractures.[9]

The primary goal of surgical management in such fractures is to achieve stable internal fixation that permits early mobilization, facilitates union, reduces morbidity, and restores pre-injury functional status at the earliest. A wide variety of internal fixation devices have been developed to serve this purpose.[10] These can broadly be classified into **intramedullary devices**, such as the Proximal Femoral Nail (PFN), Proximal Femoral Nail Anti-rotation (PFNA), and Intramedullary Hip Screw (IMHS)- and **extramedullary devices**, including the Dynamic Hip Screw (DHS), Compression Hip Screw (CHS), and Dynamic Condylar

Screw (DCS).[11] Intramedullary implants are mechanically superior as they align closer to the body's weight-bearing axis, generate shorter lever arms, and facilitate earlier weight-bearing- an advantage in unstable fracture configurations.[12] Conversely, extramedullary implants like the DCS, though biomechanically less favourable, remain popular due to their familiarity, cost-effectiveness, and versatility in resource-limited settings.[13]

Despite advances in fixation techniques, considerable debate persists regarding the optimal implant choice for unstable intertrochanteric fractures.[14] Multiple clinical and biomechanical studies have reported that PFN is associated with reduced operative time, less intraoperative blood loss, shorter hospital stays, and earlier mobilization.[15] However, complications such as implant cut-out, femoral shaft fractures, and technical errors during insertion have also been noted.[16] On the other hand, DCS provides a controlled fixation method, particularly useful in fractures with lateral wall deficiency or severe comminution, although it requires a longer incision and greater soft-tissue dissection, potentially delaying recovery. Some studies also suggest that both PFN and DCS yield comparable outcomes in terms of union rates and long-term functional recovery.[17]

Given these conflicting perspectives, a direct, prospective, and randomized comparison between the Proximal Femoral Nail and the Dynamic Condylar Screw is warranted to provide robust clinical evidence. This is especially relevant in tertiary teaching hospitals in India, where both implants are frequently employed and patients present with a diverse spectrum of fracture patterns and comorbidities. The present study was undertaken to evaluate and compare the functional and radiological outcomes of unstable intertrochanteric fractures treated with PFN and DCS, using standardized scoring systems- the Harris Hip Score for functional assessment and the Radiographic Union Score for Hip (RUSH) for radiological evaluation- over a six-month follow-up period. The findings of this study aim to clarify implant selection and guide evidence-based surgical decision-making in the management of unstable intertrochanteric fractures.

2. Materials and Methods

Study Design and Ethical Approval

This hospital-based, prospective, randomized interventional study was conducted in the Department of Orthopaedics, SMS Medical College and Attached Hospitals, Jaipur, Rajasthan. The study aimed to evaluate and compare the clinical, functional, and radiological outcomes of unstable intertrochanteric fractures treated with Proximal Femoral Nail (PFN) and Dynamic Condylar Screw (DCS) fixation.

Ethical clearance for the study was obtained from the Institutional Ethics Committee (IEC) of SMS Medical College under Ref. No. 357/MC/EC/2024, dated 16 January 2024, following approval during the committee meeting. Informed written consent was obtained from all participants before enrollment.

Study Population and Duration

The study included adult patients presenting with radiologically confirmed unstable intertrochanteric fractures of the femur, who were eligible for surgical fixation. Recruitment, surgery, and follow-up were carried out from January 2024 to December 2024, with a minimum follow-up period of six months postoperatively for all cases.

Sample Size and Randomization

A total of 60 patients were enrolled and randomized into two equal groups:

- Group A (n = 30): Treated with Proximal Femoral Nail (PFN) fixation.
- Group B (n = 30): Treated with Dynamic Condylar Screw (DCS) fixation.

Sample size was determined based on previously published literature and institutional feasibility, ensuring adequate statistical power (95% confidence level, 80% power) to detect meaningful differences in outcomes between the two fixation techniques. Randomization was performed using a computer-generated random sequence, and allocation concealment was maintained through sealed opaque envelopes.

Eligibility Criteria

Inclusion criteria:

- Adults aged ≥ 18 years.
- Unstable intertrochanteric fractures classified as AO/OTA 31-A2 or 31-A3.
- Fractures less than three weeks old.
- Patients medically fit for anaesthesia and surgery who provided informed consent.

Exclusion criteria:

- Pathological fractures (other than osteoporotic).
- Polytrauma or ipsilateral lower limb fractures.
- Old, malunited, or neglected fractures.
- Patients unfit for anaesthesia or unwilling to participate.

Preoperative Evaluation

All patients underwent detailed history taking, clinical examination, and radiological assessment. Radiographs of the pelvis with both hips (AP view) and the affected femur (lateral view) were obtained to confirm diagnosis and classify fracture patterns. Routine haematological and biochemical investigations were performed as part of pre-anaesthetic evaluation. Comorbid conditions such as diabetes or hypertension were optimized prior to surgery.

Surgical Technique

All operations were performed under spinal anaesthesia on an orthopaedic fracture table under C-arm image intensifier guidance by surgeons experienced in trauma surgery.

- *Group A (PFN):* Closed or minimally open reduction was achieved, and an appropriately sized Proximal Femoral Nail was inserted through the tip of the greater trochanter. Both proximal and distal locking were performed following standard AO techniques.
- *Group B (DCS):* Open reduction was performed through a lateral approach to the proximal femur. A 95° Dynamic Condylar Screw with side plate was applied after anatomical reduction and fixed with cortical screws for stability.

Intraoperative parameters such as duration of surgery, blood loss, and fluoroscopy exposure time were recorded. Wounds were closed in layers, and sterile dressings were applied.

Postoperative Protocol and Follow-Up

Patients received intravenous antibiotics for 48 hours postoperatively, along with analgesics and thromboprophylaxis as indicated. Quadriceps exercises and ankle mobilization were initiated from the first postoperative day. Partial weight-bearing was permitted between the 6th and 8th week, depending on radiological signs of healing, and full weight-bearing was allowed once union was evident.

Follow-up evaluations were performed at 6 weeks, 3 months, and 6 months. At each visit, both clinical and radiological assessments were conducted.

- Functional evaluation: Performed using the Harris Hip Score (HHS).
- Radiological evaluation: Conducted using the Radiographic Union Score for Hip (RUSH).
- Complications such as infection, implant failure, varus collapse, limb shortening, delayed union, or non-union were documented and analyzed.

Statistical Analysis

All data were compiled in Microsoft Excel and analyzed using IBM SPSS Statistics version 26.0. Continuous variables were expressed as mean ± standard deviation (SD), while categorical data were represented as frequencies and percentages.

Intergroup comparisons were performed using the Student's t-test for continuous variables and the Chi-square test for categorical variables. A p-value of < 0.05 was considered statistically significant.

3. Results

Baseline Patient Characteristics

A total of 60 patients with unstable intertrochanteric femoral fractures were included, divided equally into Group A (DCS, n = 30) and Group B (PFN, n = 30).

The mean age was 72.07 ± 7.35 years in Group A and 72.57 ± 9.20 years in Group B. There was a mild female predominance (31 females, 29 males). Most patients were between 61–80 years, reflecting the age group most vulnerable to osteoporotic hip fractures.

Baseline demographic characteristics, gender distribution, fracture type, and timing of surgery were comparable between both groups ($p > 0.05$).

Table 1: Baseline Demographic and Fracture Characteristics (n = 60)

Variable	Group A (DCS)	Group B (PFN)	p-value
Mean Age (years ± SD)	72.07 ± 7.35	72.57 ± 9.20	0.845
Gender (Male/Female)	13 / 17	16 / 14	0.438
AO Fracture Type (A2.2 / A2.3 / A3.1 / A3.2)	10 / 6 / 5 / 9	7 / 8 / 7 / 8	0.751
Time from Injury to Surgery (days ± SD)	2.40 ± 1.13	2.80 ± 1.21	0.192

Baseline demographics and fracture complexity were similar across both groups, ensuring comparability.

Intraoperative Parameters

All surgeries were performed within 1–3 days post-injury. The mean operative time was significantly shorter in the PFN group (64.80 ± 7.92 min) compared to DCS (112.70 ± 11.06 min) ($p < 0.001$).

Similarly, mean intraoperative blood loss was substantially lower with PFN (116.27 ± 36.11 mL) than with DCS (281.60 ± 84.05 mL, $p < 0.001$).

Tip-Apex Distance (TAD) values were comparable between groups, confirming consistent surgical precision.

Table 2: Intraoperative Parameters

Parameter	Group A (DCS)	Group B (PFN)	p-value
Operative Time (minutes ± SD)	112.70 ± 11.06	64.80 ± 7.92	<0.001*
Blood Loss (mL ± SD)	281.60 ± 84.05	116.27 ± 36.11	<0.001*
Tip–Apex Distance (mm ± SD)	22.67 ± 5.38	22.50 ± 5.03	0.902

PFN significantly reduced operative duration and blood loss, confirming its minimally invasive nature.

Radiological Outcomes

Radiological union was assessed using the Radiographic Union Score for Hip (RUSH). Both groups showed progressive improvement in healing over time, with slightly higher mean RUSH scores in the PFN group at each follow-up.

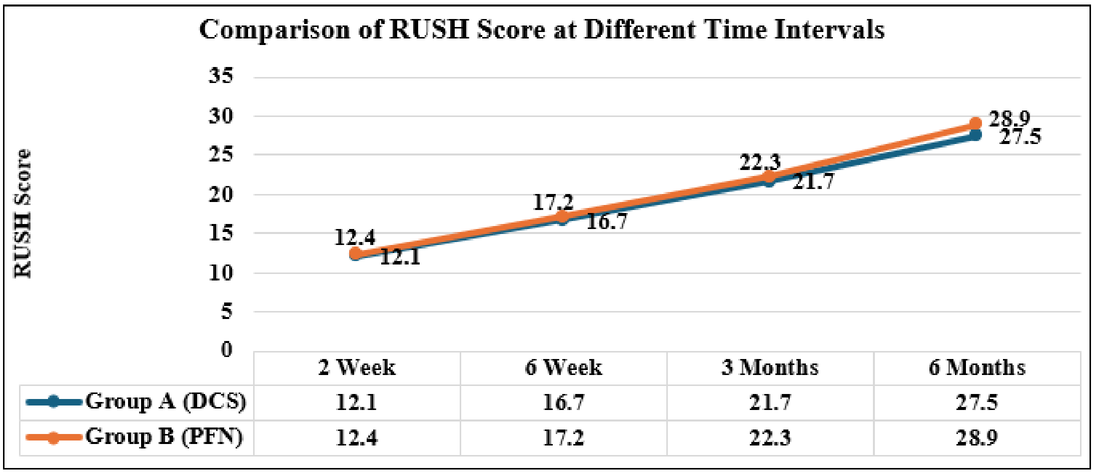
By 6 months, the mean RUSH score was 27.5 ± 3.83 (DCS) versus 28.9 ± 2.05 (PFN) ($p = 0.083$).

Union was achieved in 80% of DCS and 90% of PFN cases by 6 months, though the difference was not statistically significant ($p = 0.278$).

Table 3: Radiological Union and RUSH Scores

Outcome	Group A (DCS)	Group B (PFN)	p-value
RUSH Score – 2 weeks	12.1 ± 1.03	12.4 ± 0.81	0.215
RUSH Score – 6 weeks	16.7 ± 2.00	17.2 ± 1.19	0.244
RUSH Score – 3 months	21.7 ± 3.24	22.3 ± 2.23	0.407
RUSH Score – 6 months	27.5 ± 3.83	28.9 ± 2.05	0.083
Union at 6 months (n, %)	24 (80%)	27 (90%)	0.278

Although differences were not significant, PFN demonstrated a consistent trend toward earlier and stronger union.



Functional Outcomes

Functional recovery, measured by Harris Hip Score (HHS), improved progressively in both groups from 2 weeks to 6 months.

At final follow-up, the mean HHS was 82.6 ± 9.83 (DCS) and 83.7 ± 8.00 (PFN) (*p = 0.636*).

Distribution of functional grades was similar- Good to Excellent outcomes in 63% of DCS and 73% of PFN cases, with no statistically significant difference.

Table 4: Functional Outcomes (HHS)

Time Point	Group A (DCS)	Group B (PFN)	p-value
2 weeks	50.4 ± 11.21	49.1 ± 9.39	0.619
6 weeks	58.9 ± 13.14	57.3 ± 10.95	0.625
3 months	67.3 ± 14.94	65.5 ± 12.56	0.622
6 months	82.6 ± 9.83	83.7 ± 8.00	0.636

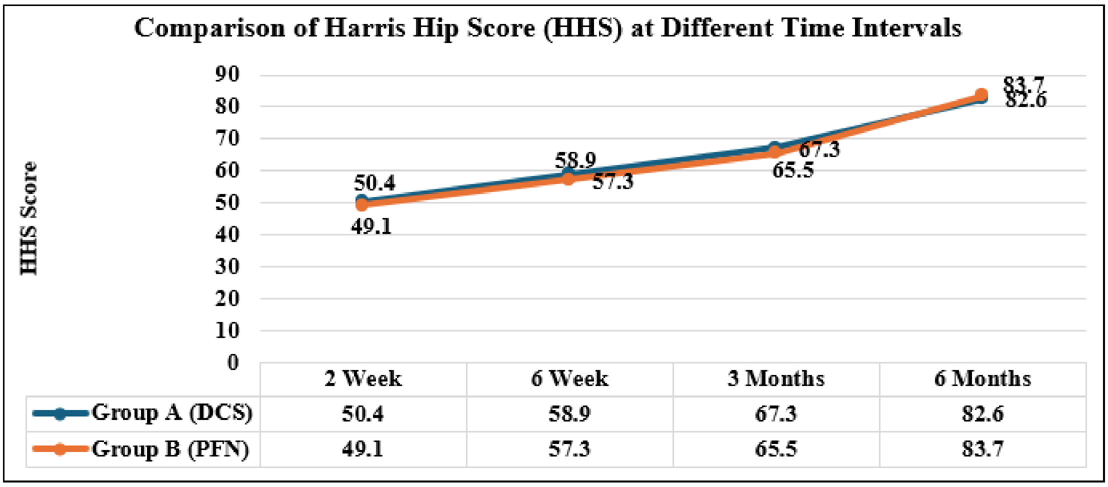
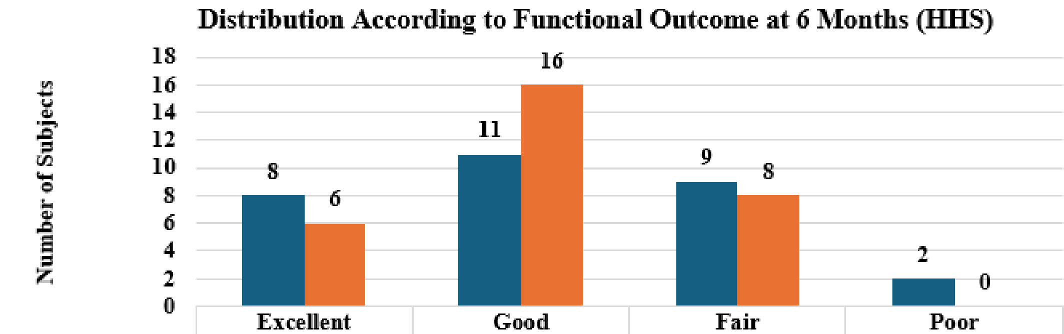


Table 5: Functional Outcome Categories at 6 Months

HHS Grade	Group A (DCS)	Group B (PFN)	p-value
Excellent	8 (26.7%)	6 (20.0%)	0.352
Good	11 (36.7%)	16 (53.3%)	
Fair	9 (30.0%)	8 (26.7%)	
Poor	2 (6.6%)	0 (0%)	



	Excellent	Good	Fair	Poor
Group A (DCS)	8	11	9	2
Group B (PFN)	6	16	8	0

Functional recovery progressed similarly in both groups; PFN showed a mild, non-significant edge in good-to-excellent outcomes.

Complications and Hospital Course

The mean hospital stay was comparable- 4.67 ± 1.45 days (DCS) versus 5.20 ± 1.52 days (PFN) (*p = 0.169*).

At 6 months, complication rates were similar in both groups. Limp and walking aid use persisted in a minority of patients, while implant failure occurred in one patient per group.

Surgical site infection was slightly more frequent with DCS.

Table 6: Complications and Hospital Stay

Outcome / Complication	Group A (DCS)	Group B (PFN)	p-value
Hospital Stay (days ± SD)	4.67 ± 1.45	5.20 ± 1.52	0.169
Limp (n, %)	11 (36.7%)	8 (26.7%)	0.412
Walking Aid Use (n, %)	11 (36.7%)	8 (26.7%)	0.412
Implant Failure (n, %)	1 (3.3%)	1 (3.3%)	—
Surgical Site Infection (n, %)	5 (16.7%)	4 (13.3%)	0.726

Overall complication rates were low and statistically comparable, suggesting both fixation techniques are safe and reliable.

4. Discussion

The present randomized study compared Proximal Femoral Nail (PFN) and Dynamic Condylar Screw (DCS) fixation for unstable intertrochanteric femoral fractures in an elderly population. Mean age was 72.07 ± 7.35 years (DCS) and 72.57 ± 9.20 years (PFN), aligning with prior reports that fragility hip fractures cluster in the seventh–eighth decades (e.g., Elis et al.[18]; Şahin et al.[19]; Ghilzai et al.[20]; Akhtar et al.[21]; Fuse et al.[22]; Islam et al.[23]; Tena et al.[24]; Zafir et al.[25]; Kumar et al.[26]; Rehman et al.[27]). This alignment supports the external validity of our cohort and indicates our findings are applicable to typical osteoporotic demographics.

Gender distribution was balanced (DCS 13/17 M/F; PFN 16/14; p = 0.438), mirroring literature that often shows a slight female predominance due to postmenopausal osteoporosis but minimal gender effect on outcomes when groups are matched (Şahin et al.[19]; Akhtar et al.[21]; Jamil et al.[28]; Islam et al.[23]; Tena et al.[24]; Mohamed et al.[29]; Sowmianarayanan et al.[30]; Veeragandham et al.[31]; Kachewar et al.[32]). This parity enhances internal validity by reducing sex-related confounding.

Fracture configuration was comparable across arms, with most cases in AO/OTA 31-A2 to A3 (p = 0.751). This pattern resembles series where unstable A2/A3 subtypes predominate and implant biomechanics are most consequential (Ghilzai et al.[20]; Jamil et al.[28]; Islam MU et al.[33]; Sarkar et al.[34]; Elis et al.[18]; Zafir et al.[25]; Akhtar et al.[21]; Fuse et al.[22]; Kumar et al.[26]). Prior work frequently reports PFN advantages in reverse obliquity (A3.1) and lateral-wall–deficient patterns due to shorter lever arms and intramedullary load sharing, while acknowledging technique- and protocol-dependent results.

Time to surgery was early and similar (2.40 ± 1.13 vs 2.80 ± 1.21 days; p = 0.192), consistent with recommendations favouring fixation within 48–96 hours to limit morbidity in older adults (Fuse et al.[22]; Kachewar et al.[32]; Ghilzai et al.[20]; Jamil et al.[28]; Akhtar et al.[21]; Veeragandham et al.[31]). Studies with longer preoperative delays often cite medical optimization or logistics; timely surgery in our cohort likely contributed to uniformly favourable recovery trajectories.

Operatively, PFN demonstrated clear efficiency gains: markedly shorter operative time (64.80 ± 7.92 vs 112.70 ± 11.06 min; p < 0.001) and lower blood loss (116.27 ± 36.11 vs 281.60 ± 84.05 mL; p < 0.001). These differences match multiple trials and a meta-analysis (Şahin et al.[19]; Ghilzai et al.[20]; Jamil et al.[28]; Akhtar et al.[21]; Fuse et al.[22]; Mohamed et al.[29]; Kumar et al.[26]; Sarkar et al.[34]; Tena et al.[24]; Zafir et al.[25]), and are clinically meaningful in frail patients where anesthesia time and hemodynamic stability matter. Mechanistically, the percutaneous and intramedullary design of the PFN minimizes soft-tissue dissection compared with the open lateral approach and plate alignment required for DCS.

Implant positioning quality was high in both groups. The mean Tip–Apex Distance (TAD) (~22.5 mm) was virtually identical (p = 0.902) and below the <25 mm threshold associated with reduced cut-out. Prior studies emphasize TAD as a key technical variable across devices; our comparable TAD reduces a major source of mechanical bias (Şahin et al.[19]; Ghilzai et al.[20]; Kachewar et al.[32]; Mohamed et al.[29]; Fuse et al.[22]; Veeragandham et al.[31]; Islam MM et al.[23]; Shah et al.[35]; Zafir et al.[25]; Tena et al.[24]).

Despite intraoperative advantages, hospital stay was not significantly different (4.67 ± 1.45 vs 5.20 ± 1.52 days; p =

0.169). While many series trend toward shorter stays with PFN, meta-analytic results are mixed and sensitive to system factors (physiotherapy access, discharge policies). Our small between-group difference likely reflects institutional pathways rather than device performance (Ghilzai et al.[20]; Fuse et al.[22]; Mohamed et al.[29]; Zafir et al.[25]; Sarkar et al.[34]; Şahin et al.[19]; Akhtar et al.[21]; Tena et al.[24]; Islam MM et al.[23]; Shah et al.[35]).

Radiographic healing- assessed by RUSH- improved steadily in both arms with a consistent, non-significant trend favouring PFN, nearing significance at six months (28.9 ± 2.05 vs 27.5 ± 3.83; p = 0.083). Union at six months was 90% (PFN) vs 80% (DCS) (p = 0.278). Prior studies frequently demonstrate faster union with PFN, attributed to load sharing and reduced soft-tissue trauma (Akhtar et al.[21]; Kachewar et al.[32]; Ghilzai et al.[20]; Jamil et al.[28]; Mohamed et al.[29]; Sarkar et al.[34]; Tena et al.[24]). Nonetheless, some cohorts favour DCS under specific protocols or surgeon experience, underscoring the role of technique and rehabilitation adherence (Islam MM et al.[23]).

Functional recovery (HHS) rose in parallel from 2 weeks to 6 months, without significant between-group differences at any interval; categorical outcomes modestly favored PFN (more “Good” and fewer “Poor”) but did not reach significance. Literature is heterogeneous: several series and meta-analyses show superior mid-term function with PFN in unstable patterns, whereas others report equivalence when reductions are anatomic and rehab is standardized (Ghilzai et al.[20]; Fuse et al.[22]; Jamil et al.[28]; Akhtar et al.[21]; Mohamed et al.[29]; Sarkar et al.[34]; Islam MM et al.[23]; Rehman et al.[27]). Our data align with functional equivalence at six months with a small clinical edge for PFN.

Complications were low and similar: limp (36.7% DCS vs 26.7% PFN) and walking-aid use mirrored each other; implant failure occurred in 1 patient per group; surgical-site infection rates were comparable (16.7% vs 13.3%). Previous studies have often reported fewer wound complications with PFN and occasional higher mechanical issues with plates in osteoporotic bone, but meticulous reduction, optimal TAD, and uniform protocols tend to equalize risks (Ghilzai et al.[20]; Fuse et al.[22]; Şahin et al.[19]; Akhtar et al.[21]; Tena et al.[24]; Zafir et al.[25]; Jamil et al.[28]; Sarkar et al.[34]; Mohamed et al.[29]; Islam MM et al.[23]; Veeragandham et al.[31]).

5. Clinical Implications

For unstable intertrochanteric fractures in elderly patients, PFN provides clear intraoperative advantages (shorter procedures, less blood loss) and shows a trend toward faster radiographic consolidation, while functional outcomes and six-month union rates are broadly equivalent to DCS in our setting. PFN can be considered the preferred implant where resources and expertise are available; DCS remains a valid alternative in select scenarios (e.g., intramedullary contraindications, need for lateral buttress), provided exacting technique and rehabilitation are ensured.

6. Limitations and Future Directions

This is a single-center study with a modest sample size (n = 60) and six-month follow-up, which may not capture late failures or functional divergence. We did not stratify by lateral-wall integrity, bone density, or surgeon experience, and no cost-effectiveness analysis was performed. Future work should include multicenter trials, longer follow-up (≥12–24 months), stratification by fracture morphology and bone quality, standardized rehab pathways, and health-economic evaluations. Comparisons across modern intramedullary designs, lateral-wall reconstruction strategies, and weight-bearing protocols would further refine implant selection in unstable intertrochanteric fractures.

7. Conclusion

The present study demonstrated that both Proximal Femoral Nail (PFN) and Dynamic Condylar Screw (DCS) are effective fixation methods for unstable intertrochanteric femoral fractures in elderly patients. Functional and radiological outcomes at six months were comparable between the two groups. However, PFN offered significant intraoperative advantages, including shorter operative time, reduced blood loss, and a trend toward faster radiological union, reflecting its biomechanical and minimally invasive benefits. While DCS remains a reliable alternative—particularly in settings where intramedullary nailing is not feasible- PFN can be considered the preferred implant for most unstable intertrochanteric fractures due to its operative efficiency, early recovery potential, and favourable complication profile. Further large-scale, multicentric studies with longer follow-up are warranted to confirm long-term functional superiority and cost-effectiveness between the two fixation methods. Evaluation are recommended to validate long-term stability and functional outcomes.

Conflict of Interest: The authors declare that they have no conflict of interest related to this research.

Source of Funding: This study was conducted as part of the academic requirements at S.M.S. Medical College & Attached Hospitals, Jaipur. No external funding was received for this research.

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

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