

Original Research Article

COMPARATIVE STUDY OF PROXIMAL FEMORAL NAILING (PFN) VERSUS CEMENTED BIPOLAR HEMIARTHROPLASTY IN UNSTABLE INTERTROCHANTERIC FRACTURES IN ELDERLY PATIENTS

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ABSTRACT

Background: Unstable intertrochanteric fractures are among the most common osteoporotic injuries in the elderly and are associated with significant morbidity, loss of mobility, and increased mortality. Surgical treatment aims to facilitate early mobilization, restore pre-fracture functional status, and minimize complications. Proximal femoral nailing (PFN) is a widely accepted method of internal fixation owing to its biomechanical advantages and minimally invasive nature, whereas cemented bipolar hemiarthroplasty has emerged as an alternative option in elderly patients with severe osteoporosis and highly comminuted fractures by permitting immediate weight-bearing. The optimal surgical treatment for unstable intertrochanteric fractures in elderly patients, however, remains a subject of debate. The aim is to compare the clinical, functional, and radiological outcomes of proximal femoral nailing and cemented bipolar hemiarthroplasty in elderly patients with unstable intertrochanteric fractures.

Materials and Methods: This prospective comparative observational study was conducted in the Department of Orthopaedics, Government Medical College and Hospital (GMCH), Bettiah, Bihar. A total of 80 patients aged 60 years and above with unstable intertrochanteric fractures were enrolled after obtaining informed consent. Patients were divided into two equal groups: Group A (PFN, n=40) and Group B (Cemented Bipolar Hemiarthroplasty, n=40). Baseline demographic characteristics, operative time, intraoperative blood loss, blood transfusion requirement, time to mobilization, duration of hospital stay, postoperative complications, radiological outcomes, and functional outcomes using the Harris Hip Score (HHS) were evaluated. Follow-up assessments were performed at 6 weeks, 3 months, 6 months, and 12 months. Statistical analysis was carried out using appropriate parametric and non-parametric tests, with a p-value <0.05 considered statistically significant.

Results: The mean age of patients was comparable between the PFN group (73.8 ± 6.5 years) and the hemiarthroplasty group (74.4 ± 7.1 years). Females constituted the majority of participants in both groups. PFN demonstrated significantly shorter operative time (68.5 ± 8.7 vs. 92.3 ± 10.6 minutes), lower intraoperative blood loss (168.4 ± 42.8 vs. 358.6 ± 71.5 mL), fewer blood transfusions, and shorter hospital stay (7.4 ± 1.5 vs. 9.2 ± 2.0 days) (all $p < 0.001$). Conversely, patients undergoing cemented bipolar hemiarthroplasty achieved significantly earlier postoperative mobilization (2.1 ± 0.6 vs. 3.8 ± 0.9 days; $p < 0.001$) and demonstrated superior Harris Hip Scores at 6 weeks and 3 months. However, by 12 months, functional outcomes became comparable

between the groups (89.5 ± 5.3 vs. 91.2 ± 4.8 ; $p=0.148$). The incidence of postoperative complications and one-year mortality did not differ significantly between the two treatment modalities.

Conclusion: Both proximal femoral nailing and cemented bipolar hemiarthroplasty are effective surgical options for unstable intertrochanteric fractures in elderly patients. PFN offers the advantages of shorter surgery, reduced blood loss, lower transfusion requirements, and shorter hospitalization, whereas cemented bipolar hemiarthroplasty provides earlier mobilization and better early functional recovery. Long-term functional outcomes were comparable between the two groups. The choice of surgical procedure should therefore be individualized based on fracture configuration, bone quality, patient comorbidities, functional demands, and surgeon expertise.

Keywords: Unstable intertrochanteric fracture, proximal femoral nailing, cemented bipolar hemiarthroplasty, elderly patients, Harris Hip Score, osteoporosis, hip fracture.

INTRODUCTION

Intertrochanteric fractures represent one of the most frequently encountered fragility fractures in elderly individuals and constitute a major cause of disability, hospitalization, and healthcare expenditure worldwide. The global increase in life expectancy has resulted in a rapidly expanding elderly population, leading to a substantial rise in osteoporotic hip fractures. Most intertrochanteric fractures occur following low-energy trauma such as falls from standing height and are strongly associated with decreased bone mineral density, impaired balance, sarcopenia, and multiple medical comorbidities. These fractures significantly impair mobility and independence while contributing to increased mortality during the first year after injury, particularly among frail elderly patients. Early surgical intervention remains the cornerstone of management because prolonged bed rest is associated with complications such as deep vein thrombosis, pulmonary embolism, pressure sores, pneumonia, urinary tract infection, and muscle wasting, all of which adversely affect functional recovery and survival.^[1]

The management of unstable intertrochanteric fractures remains one of the greatest challenges in orthopedic trauma surgery. Unstable fracture patterns, classified according to the AO/OTA and Evans systems, frequently involve posteromedial comminution, disruption of the lateral femoral wall, reverse obliquity, or subtrochanteric extension. These characteristics compromise fracture stability and reduce the success of conventional fixation techniques, especially in osteoporotic bone where implant purchase is poor. Consequently, the choice of surgical treatment must achieve sufficient mechanical stability to permit early mobilization while minimizing complications related to fixation failure.^[2]

Proximal femoral nailing (PFN) has become the preferred fixation method for unstable intertrochanteric fractures because it is an intramedullary device that offers biomechanical advantages by reducing the lever arm across the

fracture site. PFN allows minimally invasive insertion with preservation of fracture hematoma, reduced soft tissue dissection, lower blood loss, and improved load sharing. Numerous clinical studies have demonstrated satisfactory fracture union and good functional outcomes with PFN; however, complications such as screw cut-out, implant breakage, varus collapse, non-union, and reoperation may occur in severely osteoporotic patients or in cases with inadequate fracture reduction.^[3,4]

Cemented bipolar hemiarthroplasty has emerged as an alternative surgical option for elderly patients with unstable intertrochanteric fractures, particularly in the presence of advanced osteoporosis, severe comminution, or pre-existing degenerative hip disease. Unlike internal fixation, hemiarthroplasty replaces the proximal femur, thereby eliminating concerns regarding fracture healing and implant failure. Immediate full weight-bearing is usually possible, enabling earlier rehabilitation and reducing complications associated with prolonged immobilization. However, hemiarthroplasty requires greater surgical exposure, longer operative time, increased blood loss, higher transfusion requirements, and potential prosthesis-related complications including dislocation, infection, and aseptic loosening.^[5]

Despite considerable advances in implant design and surgical techniques, the superiority of PFN over cemented bipolar hemiarthroplasty, or vice versa, remains controversial. While several studies have reported improved early functional recovery following hemiarthroplasty, others have demonstrated lower surgical morbidity and comparable long-term outcomes with PFN. Variations in fracture morphology, patient selection, bone quality, and surgeon experience have contributed to inconsistent findings across published literature.^[6]

In developing countries, including India, the burden of osteoporotic hip fractures continues to increase because of population aging and improved life expectancy. Identifying the optimal treatment strategy for unstable intertrochanteric fractures is therefore essential to reduce postoperative complications, restore mobility, improve quality of

life, and decrease healthcare costs.⁷ The present prospective comparative study has been designed to evaluate and compare proximal femoral nailing and cemented bipolar hemiarthroplasty in elderly patients with unstable intertrochanteric fractures treated at Government Medical College and Hospital (GMCH), Bettiah. The study aims to assess operative characteristics, postoperative recovery, functional outcome, complications, and mortality, thereby providing evidence to guide surgical decision-making in this challenging patient population.

MATERIALS AND METHODS

Study Design: This prospective comparative observational study was conducted to compare the clinical, functional, and radiological outcomes of Proximal Femoral Nailing (PFN) and Cemented Bipolar Hemiarthroplasty (CBH) in elderly patients with unstable intertrochanteric fractures.

Study Setting: The study was conducted in the Department of Orthopaedics, Government Medical College and Hospital (GMCH), Bettiah, Bihar.

Study Duration: The study was carried out over 18 months after obtaining Institutional Ethics Committee approval.

Study Population: Elderly patients presenting with radiologically confirmed unstable intertrochanteric fractures who fulfilled the eligibility criteria were included after obtaining written informed consent.

Sample Size

A total of 80 patients were enrolled and equally divided into:

- Group A: PFN (n = 40)
- Group B: Cemented Bipolar Hemiarthroplasty (n = 40)

Inclusion Criteria

- Age ≥ 60 years.
- Fresh unstable intertrochanteric fracture (AO/OTA or Evans classification).
- Injury within two weeks.
- Ambulatory before injury.
- Medically fit for surgery.
- Written informed consent.

Exclusion Criteria

- Stable or pathological fractures.
- Polytrauma.
- Previous surgery on the affected hip.
- Open fractures.
- Active infection.
- Severe neurological disorders affecting gait.
- Medically unfit patients.
- Refusal to participate.

Preoperative Assessment: All patients underwent detailed history, physical and neurovascular examination, routine hematological and biochemical investigations, ECG, chest radiograph, and other investigations as indicated. Radiological assessment included anteroposterior pelvis, anteroposterior hip, and lateral hip radiographs. Fractures were classified

according to the AO/OTA and Evans classification systems.

Surgical Procedure

Group A (PFN): Patients underwent closed or minimally open reduction followed by fixation using a standard proximal femoral nail under fluoroscopic guidance.

Group B (CBH): Patients underwent cemented bipolar hemiarthroplasty through a standard surgical approach with reconstruction of trochanteric fragments whenever required.

Perioperative Management: All patients received standard perioperative care including prophylactic antibiotics, thromboprophylaxis, analgesics, blood transfusion when necessary, physiotherapy, and measures for prevention of deep vein thrombosis.

Postoperative Rehabilitation: Patients in the hemiarthroplasty group were mobilized with weight-bearing as tolerated from the early postoperative period. Patients treated with PFN underwent gradual mobilization with progressive weight-bearing according to fracture stability and radiological healing. Standard physiotherapy protocols were followed in both groups.

Outcome Measures

Primary Outcome

- Functional outcome assessed using the Harris Hip Score (HHS).

Secondary Outcomes

- Operative time.
- Blood loss.
- Blood transfusion requirement.
- Time to mobilization.
- Hospital stay.
- Time to full weight-bearing.
- Radiological union.
- Limb length discrepancy.
- Implant/prosthesis-related complications.
- Surgical site infection.
- Deep vein thrombosis.
- Pressure sores.
- Pneumonia.
- Reoperation.
- Mortality.

Follow-up: Patients were reviewed at 6 weeks, 3 months, 6 months, and 12 months with clinical examination, Harris Hip Score assessment, radiographic evaluation, and documentation of complications.

Statistical Analysis: Data were analyzed using IBM SPSS Statistics version 26.0. Continuous variables were expressed as mean $\pm$ SD and categorical variables as frequency and percentage. Independent Student's t-test, Mann-Whitney U test, Chi-square/Fisher's exact test, and repeated measures ANOVA were used as appropriate. A p-value < 0.05 was considered statistically significant.

Ethical Considerations: Institutional Ethics Committee approval was obtained before study commencement. Written informed consent was obtained from all participants, and confidentiality

was maintained throughout the study in accordance with the Declaration of Helsinki.

RESULTS

A total of 80 elderly patients with unstable intertrochanteric fractures were enrolled in the present prospective comparative study conducted in

the Department of Orthopaedics, Government Medical College and Hospital (GMCH), Bettiah, Bihar. All patients fulfilled the predefined eligibility criteria and completed the scheduled follow-up. The study population was equally divided into Group A (Proximal Femoral Nailing, PFN; n = 40) and Group B (Cemented Bipolar Hemiarthroplasty, CBH; n = 40).

Table 1: Baseline Demographic and Clinical Characteristics of the Study Population

Variable	Group A (PFN) n=40	Group B (CBH) n=40	p-value
Age (years), Mean $\pm$ SD	73.8 $\pm$ 6.5	74.4 $\pm$ 7.1	0.69
Age Group			0.88
60–69 years	10 (25.0%)	9 (22.5%)	
70–79 years	20 (50.0%)	21 (52.5%)	
$\geq$ 80 years	10 (25.0%)	10 (25.0%)	
Gender			0.81
Male	16 (40.0%)	15 (37.5%)	
Female	24 (60.0%)	25 (62.5%)	
Mechanism of Injury			0.77
Domestic fall	33 (82.5%)	34 (85.0%)	
Road traffic accident	7 (17.5%)	6 (15.0%)	
AO/OTA Type 31-A2	27 (67.5%)	26 (65.0%)	0.81
AO/OTA Type 31-A3	13 (32.5%)	14 (35.0%)	
Hypertension	19 (47.5%)	21 (52.5%)	0.65
Diabetes Mellitus	14 (35.0%)	15 (37.5%)	0.81

The baseline characteristics of both groups were comparable. The mean age was 73.8 $\pm$ 6.5 years in the PFN group and 74.4 $\pm$ 7.1 years in the hemiarthroplasty group (p=0.69). Most patients were 70–79 years old, females predominated in both groups (60.0% vs. 62.5%), and low-energy domestic falls accounted for over 80% of injuries. AO/OTA type 31-A2 fractures were more frequent than type 31-A3, while the prevalence of hypertension and diabetes mellitus was similar between groups

(p>0.05), indicating comparable baseline characteristics.

All patients underwent surgery without intraoperative mortality. Compared with cemented bipolar hemiarthroplasty, the PFN group had significantly shorter operative time, lower blood loss, fewer blood transfusions, and shorter hospital stay (p<0.001). In contrast, patients treated with hemiarthroplasty achieved earlier postoperative mobilization because of immediate weight-bearing.

Table 2: Comparison of Perioperative Parameters Between PFN and Cemented Bipolar Hemiarthroplasty

Parameter	Group A (PFN) Mean $\pm$ SD	Group B (CBH) Mean $\pm$ SD	p-value
Operative time (minutes)	68.5 $\pm$ 8.7	92.3 $\pm$ 10.6	<0.001
Intraoperative blood loss (mL)	168.4 $\pm$ 42.8	358.6 $\pm$ 71.5	<0.001
Blood transfusion (units)	0.7 $\pm$ 0.6	1.6 $\pm$ 0.8	<0.001
Time to first mobilization (days)	3.8 $\pm$ 0.9	2.1 $\pm$ 0.6	<0.001
Hospital stay (days)	7.4 $\pm$ 1.5	9.2 $\pm$ 2.0	<0.001

The PFN group had a significantly shorter operative time (68.5 $\pm$ 8.7 vs. 92.3 $\pm$ 10.6 minutes), lower intraoperative blood loss (168.4 $\pm$ 42.8 vs. 358.6 $\pm$ 71.5 mL), and reduced blood transfusion requirement (0.7 $\pm$ 0.6 vs. 1.6 $\pm$ 0.8 units) compared with the hemiarthroplasty group (all p<0.001). Patients undergoing cemented bipolar hemiarthroplasty achieved earlier postoperative mobilization (2.1 $\pm$ 0.6

vs. 3.8 $\pm$ 0.9 days; p<0.001), whereas the PFN group had a shorter hospital stay (7.4 $\pm$ 1.5 vs. 9.2 $\pm$ 2.0 days; p<0.001). Overall, PFN was associated with less surgical trauma, reduced blood loss, and shorter hospitalization, while cemented bipolar hemiarthroplasty provided the advantage of earlier weight-bearing and postoperative mobilization.

Table 3: Functional Outcome and Postoperative Complications

Parameter	Group A (PFN) n=40	Group B (CBH) n=40	p-value
Harris Hip Score (Mean $\pm$ SD)			
6 Weeks	61.8 $\pm$ 7.4	69.6 $\pm$ 6.8	<0.001
3 Months	73.9 $\pm$ 6.9	79.8 $\pm$ 6.5	0.001
6 Months	83.7 $\pm$ 6.2	86.5 $\pm$ 5.8	0.051
12 Months	89.5 $\pm$ 5.3	91.2 $\pm$ 4.8	0.148
Excellent Outcome (HHS $\geq$ 90)	24 (60.0%)	28 (70.0%)	0.34
Good Outcome (80–89)	11 (27.5%)	9 (22.5%)	
Fair Outcome (70–79)	4 (10.0%)	2 (5.0%)	
Poor Outcome (<70)	1 (2.5%)	1 (2.5%)	

Superficial Surgical Site Infection	2 (5.0%)	3 (7.5%)	0.64
Implant Failure / Screw Cut-out	2 (5.0%)	0	0.15
Prosthetic Dislocation	0	1 (2.5%)	0.31
Deep Vein Thrombosis	1 (2.5%)	2 (5.0%)	0.55
Pneumonia	2 (5.0%)	3 (7.5%)	0.64
Pressure Sores	2 (5.0%)	1 (2.5%)	0.55
One-Year Mortality	2 (5.0%)	3 (7.5%)	0.64

Patients undergoing cemented bipolar hemiarthroplasty showed significantly better early functional recovery, with higher Harris Hip Scores at 6 weeks (69.6 ± 6.8 vs. 61.8 ± 7.4 ; $p < 0.001$) and 3 months (79.8 ± 6.5 vs. 73.9 ± 6.9 ; $p = 0.001$) compared with the PFN group. However, by 6 months and 12 months, functional outcomes became comparable between the groups ($p > 0.05$).

At one year, 70.0% of patients in the hemiarthroplasty group and 60.0% in the PFN group achieved excellent Harris Hip Scores, while poor outcomes were observed in only 2.5% of patients in each group.

Postoperative complications were infrequent and comparable between groups. Superficial surgical site infection occurred in 5.0% of PFN patients and 7.5% of hemiarthroplasty patients. Implant failure was observed only in the PFN group (5.0%), whereas prosthetic dislocation occurred in one patient (2.5%) following hemiarthroplasty. The incidences of deep vein thrombosis, pneumonia, pressure sores, and one-year mortality (5.0% vs. 7.5%) showed no statistically significant differences ($p > 0.05$).

DISCUSSION

The present prospective comparative study evaluated the outcomes of proximal femoral nailing (PFN) and cemented bipolar hemiarthroplasty (CBH) in the management of unstable intertrochanteric fractures in elderly patients. The findings demonstrated that both procedures produced satisfactory clinical and functional outcomes; however, each technique exhibited distinct advantages. PFN was associated with shorter operative time, reduced intraoperative blood loss, lower transfusion requirements, and shorter hospital stay, whereas cemented bipolar hemiarthroplasty enabled earlier mobilization and superior functional recovery during the early postoperative period. These observations are consistent with the growing body of evidence suggesting that treatment selection should be individualized according to fracture pattern, bone quality, physiological reserve, and pre-injury functional status rather than relying on a single universally applicable surgical technique.^[7,8]

The baseline demographic characteristics were comparable between the two groups, with the majority of patients aged between 70 and 79 years and a predominance of female patients. This demographic pattern reflects the higher prevalence of osteoporosis among postmenopausal women and the increasing incidence of fragility fractures with advancing age. Similar demographic distributions

have been reported in previous comparative studies evaluating surgical management of unstable intertrochanteric fractures, thereby supporting the external validity of the present findings.^[9]

Operative parameters in the current study clearly favored PFN. Patients undergoing PFN had significantly shorter operative duration and substantially lower intraoperative blood loss compared with those treated by cemented bipolar hemiarthroplasty. The minimally invasive nature of intramedullary fixation, limited soft-tissue dissection, and preservation of fracture hematoma explain these advantages. Lower blood loss is particularly important in elderly patients who frequently have anemia, cardiovascular disease, and reduced physiological reserve. Similar findings have been reported in several systematic reviews and meta-analyses comparing internal fixation and arthroplasty for unstable intertrochanteric fractures.^[10,11]

Despite longer surgery and greater blood loss, patients treated with cemented bipolar hemiarthroplasty achieved significantly earlier postoperative mobilization. Early unrestricted weight-bearing minimizes complications associated with prolonged recumbency, including pressure sores, venous thromboembolism, pulmonary infections, muscle wasting, and functional decline. This advantage is particularly valuable in elderly patients with severe osteoporosis or markedly comminuted fractures where internal fixation carries an increased risk of mechanical failure. Previous investigations have similarly demonstrated faster rehabilitation and improved early functional independence following primary hemiarthroplasty.^[12]

Functional recovery assessed using the Harris Hip Score demonstrated significantly better outcomes in the hemiarthroplasty group during the first three postoperative months. However, by six months the difference between the groups had narrowed considerably, and at one year both treatment modalities produced comparable functional results. These findings suggest that while arthroplasty accelerates early rehabilitation, successful fracture union following PFN allows gradual recovery to a similar level of hip function over time. Comparable observations have been described by several randomized and observational studies comparing intramedullary fixation with hemiarthroplasty in elderly patients.^[13]

Postoperative complications in the present study remained relatively low in both groups. Implant-related complications such as screw cut-out and fixation failure occurred only in the PFN group,

whereas prosthesis-related complications including dislocation were confined to the hemiarthroplasty group. Surgical site infection, pneumonia, deep vein thrombosis, and pressure sores were uncommon and showed no statistically significant difference between the treatment groups. These findings indicate that careful surgical technique, standardized perioperative care, and structured rehabilitation can effectively minimize procedure-related morbidity irrespective of the surgical method employed. Similar complication profiles have been documented in recent comparative clinical studies and meta-analyses.^[14]

One-year mortality was low and comparable between the two groups. Mortality after hip fracture is influenced not only by the surgical technique but also by age, nutritional status, pre-existing comorbidities, cognitive impairment, timing of surgery, and quality of postoperative rehabilitation. Contemporary literature increasingly emphasizes multidisciplinary orthogeriatric management, early optimization of medical conditions, prompt surgical intervention, and comprehensive rehabilitation as major determinants of long-term survival rather than the choice of implant alone.^[15]

Overall, the findings of the present study support individualized decision-making in elderly patients with unstable intertrochanteric fractures. PFN remains an excellent option for patients with adequate bone stock and reconstructable fracture patterns because of its minimally invasive nature and reduced perioperative morbidity. Conversely, cemented bipolar hemiarthroplasty may be preferable in patients with severe osteoporosis, extensive comminution, or limited rehabilitation potential where immediate full weight-bearing is desirable. Modern evidence therefore suggests that neither procedure is universally superior; instead, optimal outcomes are achieved when surgical treatment is tailored to patient characteristics, fracture morphology, physiological reserve, and surgeon expertise.

CONCLUSION

Both proximal femoral nailing (PFN) and cemented bipolar hemiarthroplasty are effective surgical options for the management of unstable intertrochanteric fractures in elderly patients. PFN offers the advantages of shorter operative time, reduced intraoperative blood loss, lower transfusion requirements, and shorter hospital stay, making it a suitable choice for patients with reconstructable fractures and acceptable bone quality. In contrast, cemented bipolar hemiarthroplasty facilitates earlier mobilization and superior functional recovery during the early postoperative period, particularly in patients with severe osteoporosis and highly comminuted fractures. Although the complication profiles differ between the two procedures, the overall complication rates and one-year functional outcomes are

comparable. Therefore, the choice of surgical technique should be individualized based on fracture configuration, bone quality, patient comorbidities, pre-injury functional status, and surgeon experience to achieve optimal clinical and functional outcomes.

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