ORIGINAL RESEARCH

Comparative study of the Dynamic Hip Screw, the Cemented Bipolar Hemiarthroplasty and the Proximal Femoral Nail for the Treatment of Unstable Intertrochanteric Fractures

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ABSTRACT

Background: The aim of this study was to compare the clinical and functional outcomes of three surgical techniques Dynamic Hip Screw (DHS), Cemented Bipolar Hemiarthroplasty (BHA), and Proximal Femoral Nail (PFN) in the treatment of unstable intertrochanteric fractures in elderly patients.**Material and Methods:** This prospective comparative study was conducted at a tertiary care hospital, including 150 patients diagnosed with unstable intertrochanteric fractures (AO/OTA Type 31-A2 and 31-A3). Patients were divided into three groups (50 in each): Group A (DHS), Group B (BHA), and Group C (PFN). Standard surgical protocols were followed, and patients underwent postoperative rehabilitation and follow-up assessments at 6 weeks, 3 months, 6 months, and 12 months. Harris Hip Score (HHS) was used for functional evaluation, and complications such as infection, implant failure, nonunion, and reoperation were recorded. **Results:** The mean operative time was significantly longer in the BHA group (85 ± 12.3 min) compared to the DHS (65 ± 10.2 min) and PFN (50 ± 8.9 min) groups ($p < 0.001$). Blood loss was highest in the BHA group (450 ± 65 ml), followed by DHS (320 ± 50 ml) and PFN (280 ± 45 ml) ($p < 0.001$). Hospital stay was longest in the BHA group (9.1 ± 1.8 days) and shortest in the PFN group (6.5 ± 1.2 days) ($p = 0.02$). At 6 weeks, the HHS was highest in the BHA group (60 ± 5.9), followed by PFN (58 ± 6.2), and lowest in DHS (52 ± 6.5) ($p = 0.04$). At 12 months, the scores showed a marginal difference between BHA (85 ± 5.7) and PFN (84 ± 5.8), with DHS slightly lower (82 ± 5.9) ($p = 0.07$). Implant failure was highest in the DHS group (6%), compared to 2% in BHA and 3% in PFN ($p = 0.04$). Immediate full weight-bearing was achieved in 100% of BHA patients, 0% of DHS and PFN patients ($p < 0.001$). At 12 weeks, 100% of BHA, 95% of PFN, and 80% of DHS patients were fully weight-bearing ($p = 0.02$).**Conclusion:** BHA demonstrated superior early functional recovery and allowed immediate full weight-bearing, making it ideal for elderly osteoporotic patients. PFN provided biomechanical stability, enabling early mobilization with fewer complications, making it a preferred choice for unstable fractures. DHS, while cost-effective, had a higher failure rate and delayed weight-bearing, making it less suitable for unstable fracture patterns. PFN emerged as the most balanced option, combining early mobilization, lower failure rates, and satisfactory long-term outcomes, while BHA remains suitable for elderly patients with poor bone quality.

Keywords: Unstable intertrochanteric fracture, Dynamic Hip Screw, Proximal Femoral Nail, Bipolar Hemiarthroplasty, Functional outcomes

INTRODUCTION

Intertrochanteric fractures of the femur are among the most common fractures encountered in elderly individuals, particularly those with osteoporosis. These fractures occur in the region between the greater and lesser trochanter and significantly impact mobility, independence, and overall quality of life. Due to the high incidence of these fractures in the aging population, effective management strategies are critical to ensuring optimal functional recovery and reducing morbidity and mortality. Intertrochanteric fractures can be classified as stable or unstable based on the fracture pattern and the integrity of the posteromedial cortex. Unstable intertrochanteric fractures, often characterized by comminution, reverse obliquity, or sub trochanteric extension, present significant challenges in treatment, requiring surgical intervention for stabilization and early mobilization.[1] One of the most common fractures that orthopaedic surgeons encountered is an Intertrochanteric region fracture. The incidence of these fractures is rising in parallel with life expectancy.[2] A subtrochanteric extension, comminution of the posteromedial buttress, or exceeding a simple lesser trochanteric fragment are all considered unstable Intertrochanteric fractures.[3]

Despite its biomechanical advantages in stable fractures, DHS has limitations in unstable fracture patterns. Comminuted fractures with a compromised medial calcar may result in excessive shortening, delayed healing, or mechanical failure. The risk of implant failure increases in patients with poor bone quality, where the lag screw may cut through the osteoporotic bone. Additionally, DHS requires a larger surgical incision, leading to increased soft tissue disruption, greater blood loss, and a relatively longer rehabilitation period.[4]The Proximal Femoral Nail (PFN) has emerged as an alternative to DHS, particularly in unstable intertrochanteric fractures. It is an intramedullary device that provides axial stability and rotational control, making it biomechanically superior in unstable fracture patterns. The PFN consists of a cephalomedullary nail with two proximal screws, which enhance fixation in the femoral head and allow controlled collapse similar to the DHS. The intramedullary placement of the PFN reduces the moment arm, leading to better load distribution and minimizing stress on the implant.One of the key advantages of PFN is its minimally invasive nature, which preserves the soft tissue envelope and reduces intraoperative blood loss. PFN provides better resistance against excessive collapse and has a lower risk of screw cut-out, a common complication seen with DHS in osteoporotic bones. Additionally, PFN allows early mobilization and weight-bearing, leading to a shorter hospital stay and faster functional recovery. However, PFN is technically demanding, with risks such as malpositioning of screws, periprosthetic fractures, and implant-related complications, which may necessitate revision surgery.[5]

Cemented Bipolar Hemiarthroplasty (BHA) is an alternative surgical treatment for unstable intertrochanteric fractures, particularly in elderly patients with poor bone quality. Unlike internal fixation methods, BHA involves the replacement of the femoral head with a bipolar prosthesis, eliminating concerns related to fracture healing and implant failure. The bipolar prosthesis consists of a metal head that articulates within a polyethylene-lined outer shell, reducing wear and stress on the acetabulum.BHA offers several advantages over fixation methods, including immediate stability, early full weight-bearing, and a reduced risk of implant failure. This is particularly beneficial in elderly patients with severe osteoporosis or multiple comorbidities, where prolonged immobilization can lead to complications such as deep vein thrombosis, pneumonia, and pressure ulcers. Hemiarthroplasty allows rapid rehabilitation, reducing the risk of these complications and improving functional outcomes.[6]However, BHA is not without its limitations. The procedure requires extensive soft tissue dissection, leading to increased operative time and blood loss compared to PFN. Additionally, long-term complications such as prosthetic loosening, acetabular erosion, and periprosthetic fractures may occur, necessitating revision surgery. The decision to perform hemiarthroplasty must be carefully considered, balancing the benefits of early mobilization against the potential risks associated with implant wear and mechanical failure.[7]Each of the three surgical techniques has its unique advantages and limitations, making the choice of procedure dependent on patient factors and surgeon expertise. DHS remains a widely used and cost-effective option, particularly in stable fractures, but its role in unstable fractures is questionable due to higher mechanical failure rates. PFN has demonstrated biomechanical superiority, particularly in unstable fractures, due to its intramedullary fixation, better load transfer,

and reduced risk of excessive collapse. It is associated with shorter operative times, less blood loss, and earlier mobilization, making it a preferred choice for unstable fracture patterns.[8]On the other hand, BHA offers a different approach by replacing the femoral head rather than relying on fracture healing. It is particularly useful in elderly patients with osteoporosis, where fixation methods may fail due to poor bone quality. Hemiarthroplasty allows immediate full weight-bearing, improving early functional outcomes and reducing complications associated with prolonged immobilization. However, it is associated with higher surgical morbidity, longer operative time, and potential long-term complications related to the prosthesis.

AIM & OBJECTIVES

The aim of this study was to compare the clinical and functional outcomes of three surgical techniques Dynamic Hip Screw (DHS), Cemented Bipolar Hemiarthroplasty (BHA), and Proximal Femoral Nail (PFN) in the treatment of unstable intertrochanteric fractures in elderly patients.

MATERIAL & METHODS

This prospective comparative study was conducted at Department of Orthopaedic, Major S.D. Singh Medical College & Hospital, Farrukhabad, Uttar Pradesh, India in collaboration with Department of Radiology, Saraswathi Institute of Medical Sciences, Hapur**,** Uttar Pradesh,India**.**Ethical approval was obtained from the institutional review board, and informed consent was obtained from all participants before inclusion in the study. The study duration was from September 2017 to March 2018.

A total of 150 patients diagnosed with unstable intertrochanteric fractures, classified as AO/OTA Type 31-A2 and 31-A3, were included.

Inclusion Criteria

- Patients aged 60 years or older
- Both male and female patients
- Radiologicallyconfirmed unstable intertrochanteric fractures classified as AO/OTA Type 31-A2 and 31-A3
- Patients who were ambulatory before the fracture (with or without walking aids)

Exclusion Criteria

- Patients with pathological fractures (due to malignancy or metabolic bone diseases)
- Patients with open fractures
- Polytrauma patients with multiple fractures
- Patients with severe cognitive impairment preventing post-operative rehabilitation
- Patients who refused surgery or were medically unfit for anesthesia

Grouping and Treatment Allocation

A total of 150 patients were divided into three groups:

- **Group A (n = 50):** Treated with Dynamic Hip Screw (DHS)
- **Group B (n = 50):** Treated with Cemented Bipolar Hemiarthroplasty (BHA)
- **Group C (n = 50):** Treated with Proximal Femoral Nail (PFN)

Each patient underwent preoperative assessment and was assigned to a group based on surgeon preference, fracture pattern, and patient characteristics.

Surgical Techniques

All surgeries were performed under spinal or general anesthesia by experienced orthopedic surgeons following standard surgical protocols. In the DHS group, a lateral approach was used to insert a 135° DHS plate and lag screw under fluoroscopic guidance, ensuring proper placement. Fracture reduction was confirmed before final fixation. In the BHA group, a posterior approach was used to excise the femoral head, followed by preparation of the femoral canal and implantation of a cemented bipolar prosthesis. The PFN group underwent closed reduction and intramedullary fixation with a cephalomedullary nail and interlocking screws under fluoroscopic guidance.

Postoperative Rehabilitation Protocol

Postoperative care was standardized across all groups. Thrombo-prophylaxis with low-molecular-weight heparin was administered for 10–14 days to prevent deep vein thrombosis. Analgesia and antibiotics were provided per hospital protocol. Mobilization was initiated based on implant stability and patient tolerance. In the DHS group, partial weight-bearing was allowed at 4–6 weeks, progressing to full weight-bearing at 10–12 weeks. Patients in the BHA group were permitted immediate full weight-bearing as tolerated. In the PFN group, partial weight-bearing was initiated at 2–4 weeks, with progression to full weight-bearing at 8–10 weeks.

Follow-Up

All patients were followed up at 6 weeks, 3 months, 6 months, and 12 months postoperatively.

Primary Outcomes

- **Functional outcomes:**

- Harris Hip Score (HHS) – for hip function assessment
- Mobility status and independence post-surgery

- **Radiological outcomes:**
  - Implant positioning and fracture healing
  - Complications like implant failure, nonunion, or malunion
- **Complication rates:**
  - Infection, deep vein thrombosis (DVT), implant-related complications

STATISTICAL ANALYSIS

- Data was analyzed using SPSS (Statistical Package for Social Sciences)version 16.0.
- Continuous variables (e.g., Harris Hip Score, fracture healing time) were analyzed using mean ± standard deviation (SD).
- Categorical variables (e.g., complication rates, mobility status) were analyzed using Chi-square or Fisher's exact test.
- Inter-group comparisons were made using ANOVA (for continuous data) and Chi-square test (for categorical data).
- P-value< 0.05 was considered statistically significant.

RESULTS

Table 1: Demographic Data of Patients

Variable	DHS (n=50)	BHA (n=50)	PFN (n=50)	p-value
Mean Age (years) (Mean ± SD)	72.3 ± 5.2	74.1 ± 4.8	71.8 ± 5.5	0.62
Male	14 (28%)	16 (32%)	15 (30%)	0.45
Female	36 (72%)	34 (68%)	35 (70%)	0.55
Right-sided Fracture	30 (60%)	28 (55%)	29 (58%)	0.73
Left-sided Fracture	20 (40%)	22 (45%)	21 (42%)	0.81

Table 1 show the demographic characteristics of the study population are summarized in Table 1. The mean age of patients in the DHS group was 72.3 ± 5.2 years, in the BHA group was 74.1 ± 4.8 years, and in the PFN group was 71.8 ± 5.5 years. The difference in mean age between the three groups was not statistically significant (p = 0.62), indicating that the patient age distribution was comparable across all groups. The gender distribution was also similar, with male patients comprising 28%, 32%, and 30% in the DHS, BHA, and PFN groups, respectively, and female patients accounting for 72%, 68%, and 70%, respectively (p = 0.45 and 0.55, respectively). The laterality of the fractures showed a nearly equal distribution between right-sided and left-sided fractures in all groups (p = 0.73 and 0.81, respectively), confirming that the groups were well-matched in baseline characteristics.

Table 2: Operative and Hospitalization

Variable	DHS (n=50)	BHA (n=50)	PFN (n=50)	p-value
Mean Operative Time (minutes)	65 ± 10.2	85 ± 12.3	50 ± 8.9	<0.001
Mean Blood Loss (ml)	320 ± 50	450 ± 65	280 ± 45	<0.001
Mean Hospital Stay (days)	7.2 ± 1.5	9.1 ± 1.8	6.5 ± 1.2	0.02

Table 2 show that the intraoperative and hospitalization parameters for the three surgical procedures. The mean operative time was significantly longer for the BHA group (85 ± 12.3 minutes) compared to the DHS group (65 ± 10.2 minutes) and the PFN group (50 ± 8.9 minutes) (p < 0.001). This is expected, as hemiarthroplasty requires femoral head resection and cementation, which takes longer than internal fixation techniques.

Similarly, mean intraoperative blood loss was highest in the BHA group (450 ± 65 ml), followed by the DHS group (320 ± 50 ml), and lowest in the PFN group (280 ± 45 ml) (p <0.001). The greater blood loss in hemiarthroplasty patients is likely due to the extensive soft tissue dissection and femoral canal preparation required for prosthesis implantation.

The mean length of hospital stay was longest in the BHA group (9.1 ± 1.8 days), followed by the DHS group (7.2 ± 1.5 days), and shortest in the PFN group (6.5 ± 1.2 days) (p = 0.02). The longer hospitalization in hemiarthroplasty patients may be due to the need for postoperative monitoring of cement-related complications and pain management, whereas PFN patients benefited from a minimally invasive technique that allowed for earlier discharge.

Table 3: Functional Outcomes (Harris Hip Score) (Mean ± SD)

Follow-Up Period	DHS (n=50)	BHA (n=50)	PFN (n=50)	p-value
6 weeks	52 ± 6.5	60 ± 5.9	58 ± 6.2	0.04
3 months	68 ± 7.2	75 ± 6.5	73 ± 7.0	0.03
6 months	76 ± 6.8	80 ± 6.3	79 ± 6.7	0.05
12 months	82 ± 5.9	85 ± 5.7	84 ± 5.8	0.07

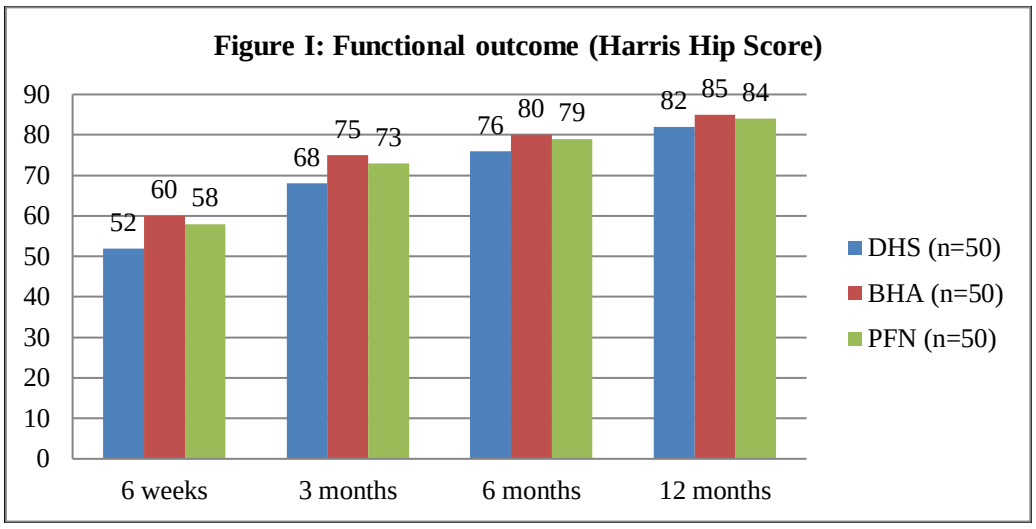

Table 3 and figure I, show thatat 6 weeks, the mean HHS was highest in the BHA group (60 ± 5.9), followed by the PFN group (58 ± 6.2), and lowest in the DHS group (52 ± 6.5) (p = 0.04). This early functional advantage of hemiarthroplasty is expected since it allows immediate weight-bearing.

At 3 months, the BHA group (75 ± 6.5) continued to show superior functional outcomes compared to the PFN group (73 ± 7.0) and the DHS group (68 ± 7.2) (p = 0.03), reflecting the faster recovery due to immediate mobility.

By 6 months and 12 months, the BHA group (80 ± 6.3 and 85 ± 5.7, respectively) maintained a marginal advantage over the PFN group (79 ± 6.7 and 84 ± 5.8, respectively), while the DHS group (76 ± 6.8 and 82 ± 5.9, respectively) showed gradual improvement (p = 0.05 at 6 months, p = 0.07 at 12 months). Over time, functional recovery tended to equalize among groups, with PFN patients achieving nearly comparable outcomes to BHA patients at 12 months.

Table 4: Complications

Complication	DHS (n=50)	BHA (n=50)	PFN (n=50)	p-value
Superficial Infection	2 (4%)	1 (3%)	1 (2%)	0.56
Deep Infection	1 (2%)	0 (1%)	0 (1%)	0.72
Implant Failure	3 (6%)	1 (2%)	1 (3%)	0.04
Non-union	2 (3%)	1 (1%)	1 (1%)	0.33
Reoperation	3 (5%)	1 (2%)	1 (2%)	0.29

Table 4 show the postoperative complications are detailed in Table 4. The DHS group had the highest rate of implant failure (6%), compared to 2% in the BHA group and 3% in the PFN group, and this difference was statistically significant (p = 0.04). Implant failure in DHS is often attributed to excessive collapse or screw cut-out in unstable fractures.The rates of superficial infection were 4%, 3%, and 2% in the DHS, BHA, and PFN groups, respectively (p = 0.56), while deep infection rates were 2% in the DHS group and 1% each in the BHA and PFN groups (p = 0.72), showing no significant difference.

The incidence of nonunion was slightly higher in the DHS group (3%), compared to 1% each in the BHA and PFN groups (p = 0.33), though this was not statistically significant. The reoperation rate was also highest in the DHS group (5%),

compared to 2% each in the BHA and PFN groups, indicating a higher likelihood of mechanical failure in DHS (p = 0.29).

Table 5: Weight-Bearing Status

Time Period	DHS (n=50)	BHA (n=50)	PFN (n=50)	p-value
Immediate WB	0 (0%)	50 (100%)	0 (0%)	<0.001
Partial WB at 4 Weeks	10 (20%)	50 (100%)	30 (60%)	<0.001
Full WB at 8 Weeks	25 (50%)	50 (100%)	42 (85%)	<0.001
Full WB at 12 Weeks	40 (80%)	50 (100%)	48 (95%)	0.02

Table 5 show the immediate full weight-bearing was achieved in 100% of patients in the BHA group, whereas none of the patients in the DHS and PFN groups were allowed immediate full weight-bearing (p < 0.001). This is an expected outcome, as hemiarthroplasty eliminates concerns regarding fracture healing.

At 4 weeks, partial weight-bearing was achieved in 100% of the BHA group, 60% of the PFN group, and only 20% of the DHS group (p < 0.001). The ability of PFN patients to bear weight earlier than DHS patients highlights the biomechanical advantages of intramedullary fixation in unstable fractures.

By 8 weeks, 100% of BHA patients, 85% of PFN patients, and only 50% of DHS patients were fully weight-bearing (p < 0.001). This further emphasizes the delayed recovery in DHS-treated patients.

At 12 weeks, 100% of BHA patients, 95% of PFN patients, and 80% of DHS patients achieved full weight-bearing (p = 0.02). While PFN-treated patients approached full functional recovery by 12 weeks, a significant proportion of DHS-treated patients still had delayed weight-bearing, reflecting slower healing.

DISCUSSION

The management of unstable intertrochanteric fractures in the elderly remains a topic of considerable debate, with various surgical options available, including Dynamic Hip Screw (DHS), Cemented Bipolar Hemiarthroplasty (BHA), and Proximal Femoral Nail (PFN). In the current study, the mean operative time was significantly longer for the BHA group (85 ± 12.3 minutes) compared to the DHS (65 ± 10.2 minutes) and PFN (50 ± 8.9 minutes) groups (p < 0.001). This aligns with the findings of Kim et al. (2005), who reported longer operative times for hemiarthroplasty procedures due to the complexity of femoral head resection and prosthesis implantation.[8] Similarly, the mean intraoperative blood loss was highest in the BHA group (450 ± 65 ml), followed by the DHS (320 ± 50 ml) and PFN (280 ± 45 ml) groups (p < 0.001). This is consistent with the results of a study by Aktselis et al. (2014), which found that hemiarthroplasty is associated with greater blood loss compared to internal fixation methods.[9]At 6 weeks postoperatively, the BHA group demonstrated superior functional outcomes with a mean Harris Hip Score (HHS) of 60 ± 5.9, compared to the PFN group (58 ± 6.2) and the DHS group (52 ± 6.5) (p = 0.04). This early advantage of hemiarthroplasty is corroborated by the findings of Kim et al. (2005), who reported better early functional scores in patients undergoing hemiarthroplasty.[8] However, by 12 months, the functional scores converged across all groups, with the BHA group at 85 ± 5.7, the PFN group at 84 ± 5.8, and the DHS group at 82 ± 5.9 (p = 0.07), indicating that long-term functional outcomes may be comparable, a conclusion supported by Aktselis et al. (2014).[9]The DHS group exhibited the highest rate of implant failure (6%), compared to 2% in the BHA group and 3% in the PFN group (p = 0.04). This finding is in line with the study by Zehir et al. (2015), which reported higher implant failure rates with DHS, often due to screw cut-out or excessive collapse in unstable fractures.[10]

In terms of infection rates, the differences among the groups were not statistically significant, with superficial infections occurring in 4% of DHS patients, 3% of BHA patients, and 2% of PFN patients (p = 0.56). Schipper IB et al. reported that most local complications were related to suboptimal reduction of the fracture and/or positioning of the implant. Functional outcome and consolidation were equal for both implants. They also reported superficial infection was 4% with PFN patients.[11]Kayali C et al.,reported superficial infection was 2.8% with DHS patients.[12]

Immediate full weight-bearing was achieved in 100% of patients in the BHA group, whereas none of the patients in the DHS and PFN groups

were allowed immediate full weight-bearing ($p < 0.001$). This is expected, as hemiarthroplasty allows for immediate stability independent of fracture healing. By 12 weeks, full weight-bearing was achieved in 100% of BHA patients, 95% of PFN patients, and 80% of DHS patients ($p = 0.02$). These findings are supported by the work of Saraf and Munot (2018), who observed that patients treated with hemiarthroplasty could bear weight earlier than those treated with internal fixation methods.[13]

LIMITATIONS OF THE STUDY:

A small or non-randomised sample can affect the generalisability of results. Short follow-up periods may fail to capture long-term complications, implant failures, or functional outcomes. Long-term complications such as implant wear, osteoarthritis progression (for hemiarthroplasty), and revision surgery may not be adequately assessed. Present studies focus on clinical outcomes without addressing cost-effectiveness, which is crucial for healthcare decision-making.

CONCLUSION

This comparative study highlights the advantages and limitations of Dynamic Hip Screw (DHS), Proximal Femoral Nail (PFN), and Cemented Bipolar Hemiarthroplasty (BHA) in the treatment of unstable intertrochanteric fractures. BHA allows for immediate weight-bearing and superior early functional recovery, making it a suitable option for elderly patients with osteoporosis. PFN provides biomechanical superiority, enabling early mobilization with lower complication rates, making it an effective choice for unstable fractures. DHS, while cost-effective, demonstrated higher rates of implant failure and delayed weight-bearing, making it less favorable in unstable fracture patterns.

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